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WILLIAM WOOD & COMPANY NEW YORK

PRACTICAL
MEDICAL ANATOMY

A GUIDE TO THE PHYSICIAN
IN THE STUDY OF THE RELATIONS OF THE VISCERA TO EACH OTHER IN HEALTH AND DISEASE
AND
IN THE DIAGNOSIS OF THE
MEDICAL AND SURGICAL CONDITIONS OF THE ANATOMICAL STRUCTURES OF THE HEAD AND TRUNK

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I dedicate this Volume

TO

MY WIFE,

to whose discreet counsel, courage, faith, and loving companionship, I owe more than this simple acknowledgment.

INTRODUCTION.

Dr. Darwin, when he wrote the preface to his "Zoonomia," stated his proposed object in the following sentences: "A theory founded on Nature, that should bind together the scattered facts of medical knowledge, and converge into one point of view the laws of organic life, would thus on many accounts contribute to the interests of society. It would capacitate men of moderate abilities to practise the art of healing with real advantage to the public; it would enable every man of literary attainments to distinguish the genuine disciples of medicine from those of boastful effrontery or of wily address; and would teach mankind in some important situations the knowledge of themselves."

To achieve pre-eminence in the discovery of a general law, or to attain renown in science by the value of original investigation is an enviable as well as an uncommon privilege; but in the voluminous literature of medical science, many a fact still remains which will bear constant repetition, which is pregnant with practical value, and which might otherwise be either forgotten by, or unknown to, the general reader. Compilation is therefore not without some decided value, if discreetly performed.

The anatomy of man must always be the groundwork of all medical knowledge, since by it alone are we able to understand the various functions of the human frame, the symptoms of disease, and the rationale of treatment. In our present enlightenment, physiology, histology, and pathology are becoming so inseparable from the dry detail of mere anatomical description, and the surgical bearings of the various structures are so intimately connected with general diagnosis, that it is no longer possible, within the limited scope of a single volume, to present to the general practitioner all the valuable points which can be daily applied in the various departments of medicine.

To any one, familiar with the earlier writers, the fact must, however, be apparent, that, in spite of the rapid strides which are constantly being made (through the aid of greater facilities for research, improved apparatus, and new discoveries as to the application of general laws in physics as a means of diagnosis), most of the fundamental facts, upon which great stress is still laid, were known and skilfully used centuries ago. One, who attempts to establish priority to-day in almost any branch, is more than likely to find, in these earlier works, evidences of previous thought in the same direction; derived often from investigation pursued with a diligence that deserves more than simple praise, when the difficulties which then existed are considered. The use of the special senses of the physician were then educated to a degree of acuteness which few of our modern savants can justly claim for themselves. The expressions of the sick were once made a special study; the attitudes assumed in certain types of disease were carefully noted and impressed upon the student; the sense of touch was educated until the most trifling variation in the pulse, or the contour of the various anatomical regions seldom escaped detection; the anatomy of the living subject was taught in those days in all its practical bearings in connection with dissection; and the student, by a constant repetition of the more important anatomical guides, became familiarized with the contents of surgical regions, the relations of the viscera to each other, the value of the bony prominences, and the general plan of construction which characterizes the biped from the quadruped, man from the lower animals. Taste and smell were, to the physician of that time, faculties which afforded practical points in diagnosis; and the secretions and excretions of the body had not alone a physiological importance, but were often used by the skilful physician as valuable aids to diagnosis.

It is, to my mind, a question if our present methods of medical instruction, as evidenced in our literature, do not tend to make the medical reader attach but a trivial importance to some of those aids which made these men great and which cause their writings to be still respected. Does it not tend to make us rely solely upon the later science of auscultation and percussion in our examinations for obscure diseases of the viscera, to the partial or utter disregard of many of the outward symptoms which were then so carefully studied; and to bring into prominence chemical and microscopical analyses to the exclusion of the special senses, when positive information upon subjects, to which they are all equally applicable, is demanded?

This volume is an indirect outgrowth of two courses of lectures delivered by me before the students of the Medical Department of the University of the City of New York, during the winters of 1879 and 1880, upon the anatomy of the circulatory and nervous systems, and one in the spring of 1878, upon the anatomy of the viscera. Then, more than ever before, I realized that all practical points were received with greed by the student; in contrast to the apathy with which long descriptive detail must necessarily be accompanied, unless, by illustration, it can be made clear that dry facts are not deficient in interest, and that anatomy is not alone a mere preparatory drill to the practical branches, but a source of ever varying utility in all the walks of professional life. It struck me then that if anatomy could be so presented in all its departments as to convince the medical reader that it could be made a source, not only of pleasure at the time, but of unceasing benefit in whatever direction his professional taste might call him, its study would cease to be wearisome and its details no longer a task of memory.

The following pages, such as they are, have cost me many hours of research to write; and it is to be hoped they will afford some useful hints to those who read them. As a prominent author puts it: "That writer accomplishes the most, who gives his reader the *most* knowledge, and takes from him the *least* time;" and I have not forgotten, in my effort to make the work useful to all, the wise observation of him who says "in the same meadow the ox seeks the herbage; the dog the hare; and the stork, the lizard."

In deliberating upon the plan of arrangement of this work, the question naturally arose how the subject could be best treated to systematize its study and at the same time to facilitate reference. It has long been a custom with authors of works upon descriptive anatomy, to exhaust each of the separate divisions of this subject before proceeding to the consideration of the next, thus treating in successive chapters of osteology, arthrology, myology, etc.; while, in works designed for use at the dissecting table, custom has modified the plan so that we find all of the structures contained in special anatomical regions so grouped as to furnish the student with a detailed description of the vessels, muscles, nerves, etc., as they are met with in practical anatomy.

The object of this latter plan is obvious; it furnishes the reader the information for which he seeks, without the necessity of constant reference to different portions of the volume, which would not be afforded by a general treatise. On the other hand, such a plan in a descriptive treatise would tend to confuse the *beginner*, who is supposed to be ignorant of anatomy, and even of the terms used in it, and who, very properly, can best acquire a mastery of the general subject by a thorough comprehension of each of the separate departments of anatomy in their proper order; and thus its utility as a text-book would be impaired. Furthermore, a different plan in a general treatise greatly facilitates reference, and thus adds to its popularity with the general medical public.

I have concluded, after much deliberation, to combine these two methods, in the presentation of this work; since, although, I can see some defects in the arrangement which may cause others to disagree with me in my decision, I believe that the aims of this volume will be best promoted thereby.

As this work is not intended to be a treatise upon descriptive anatomy, but rather a collection of hints which shall serve as a guide to the study of the *practical bearings* of the different portions of the head and trunk upon the field of general medicine, only such points will be touched upon as seem to the author worthy of incorporation from a physiological, surgical, or medical point of view, or bearing, in such a way, upon the boundless field of comparative anatomy as to add to the interest of the reader in showing the object of the Creator in causing man to so deviate from the type of the lower animals.

I have separated the description of the head and the neck, because, anatomically, the latter region is only a portion of the trunk, although, by so doing, the branches of some of the large arteries of the neck will be described before the main trunks have been considered, which to the beginner might possibly create confusion. But the same objection applies with equal force to all dissecting manuals; and, as the present volume presupposes some education on the part of its readers, it seems to the author that the benefits which this arrangement affords far outweigh its disadvantages. I have, however, followed the plan of general text-books upon anatomy, as regards the grouping of such points as pertain to the bones, muscles, vessels, and nerves, since, by so doing, reference is greatly facilitated, and the danger of any important omissions on the part of the author decreased.

In regard to the vessels, it is impossible to avoid reference to the surgical anatomy of the more important trunks, in attempting to teach the practical points pertaining to them; while, as to the nerves of the body, some hints that properly pertain to physiology and surgery cannot be omitted, if the aim of this work is to be fully attained, although the limited size of this volume will preclude the insertion of but scattered hints in this direction. It is not to be inferred, however, that this work pretends to cover the ground, either of physiology or of operative surgery, since but a small portion of the former science treats of the vessels and nerves, while the latter department embraces remedial measures for every existing condition demanding surgical interference.

Again, when special bones are under discussion, and the attachments of the muscles of each seem to indicate that memory will be assisted by a reference to the action of some of these muscles which assist in producing special types of deformity, in case of fracture of the bone, it must not be forgotten that the bearing of anatomy upon the subject ceases with the enumeration of those facts, and cannot possibly suggest a discussion either of its symptoms or of the surgical appliances used for its relief.

The points of practical utility which pertain to the integument are chiefly confined to the region of the head. Many of them are unquestionably due to the insertion of small slips from the facial muscles into the skin and subcutaneous tissues, but they are, nevertheless, constant, and may often prove of great value. It is common with many authors of the present day to either totally disregard the valuable points of diagnosis afforded by the face, or to stamp as visionary all points of diagnostic value which have been attributed by authors, in the past, to special lines and wrinkles. While, perhaps, there may be, in many instances, sufficient ground for such scepticism, still the entire subject of medical physiognomy should not, in my opinion, be totally disregarded or pronounced absolutely worthless. If all our examinations of those afflicted with diseases of the thoracic and abdominal viscera were confined alone to a physical examination through the aids of percussion and auscultation, without the opportunity of studying the physiognomy of the patient, an unfavorable prognosis as to the duration of life would frequently be pronounced; when, could the brilliancy of the eye, the expressions of the mouth, and the general facial characteristics of the individual bespeak the vitality of temperament and the reactive power which no physical examination could possibly determine, the prognosis might appear less grave. I do not offer this as an apology for the few scattered hints given as to the value of facial lines as a means of diagnosis, or for the illustration of special types of countenance afforded by disease. Each reader must for himself determine to what extent the guides thus afforded by the earlier investigators are of value, and, by practical investigation, confirm some which have been mentioned in this volume, and discard those which seem visionary or hypothetical.

If the term "medical anatomy" be taken in its most restricted sense, the title of this work is a misnomer. It has been written for the use of the general practitioner, in his daily practice, with the hope that it might present to him the study of anatomy from the stand-point of its general interest and practical utility, and afford him a means of refreshing certain points which can be constantly applied, without entailing upon him much descriptive detail. It is properly called "medical," since it deals only with the head and the trunk, and the organs contained within the cavities of the thorax and abdomen; but it would be insufficient for the wants of the general practitioner if it contained only such points as could be applied to the diseases of the viscera alone. I have, therefore, seen fit to incorporate many anatomical guides to the superficial, as well as the deeper structures, and to leave no region as complete, until the various parts contained in it have been considered in many of their practical relations, whether they be of a surgical or purely medical character. I have furthermore incorporated such suggestions as would tend to show a definite object in the construction of the human frame, and, in many instances, have called attention to the variations of the human body from that of the lower animals, when such deviations could be explained as a wise provision on the part of Nature.

Some portions of this work have already appeared in print in various medical journals both in this country and in Europe, but they have been altered and enlarged to meet the demands of this work; while the abundance of illustration will still further assist in making the points more forcible and easy of comprehension to the reader. It is not to be expected, nor is intended, that this work can serve all the purposes of an extended anatomical treatise, since, of necessity, much that pertains to the blood-vessels, nerves, and viscera has been omitted; but this objection applies with equal force to such valuable works as those of Sibson and Hilton, each of which fills the place for which it was designed.

I have used italics more frequently than would be deemed necessary, or, perhaps, in good taste, if the book were simply intended to be read from a stand-point of its general interest, and I have, in many instances, divided the text into shorter paragraphs than is conducive to the best appearance of the page, but this volume must, of necessity, consist of fragmentary jottings, each of which brings out some individual point of value, and the italics will greatly assist reference to different portions of the text, when much time might be otherwise lost in seeking for some special suggestion.

I have purposely omitted the illustration of anatomical statement or of theory, by the details of cases, even where these rules may have been applied by myself and others with benefit, and I have refrained from dwelling, at any length, upon the methods of treatment employed in the various diseases which have been discussed; since I consider that the anatomical character of the work should ever be kept uppermost in the mind both of the author and the reader, and that any deviation from the strict line of the task is to be deprecated rather than encouraged. It has been my earnest endeavor, as far as the limited size of the volume would allow, to incorporate all that can be commended in the works of authors in the same field, and to omit all that seemed visionary or hypothetical.

If the work, as it stands, will help to verify that hackneyed phrase, with which most courses of anatomical lectures are prefaced, but which few of the listeners are ever able to appreciate, in all of its bearings and truthfulness of statement—"that anatomy is the foundation of all medical knowledge"—the author will feel that his labor has not been done in vain.

156 Madison Ave., New York City.

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PRACTICAL
MEDICAL ANATOMY.

PART I.

CHAPTER I.

THE BONES OF THE HEAD.

It is a fact to be regretted that the study of the bony framework should be so often made one of dry detail to the medical reader, especially as it is usually the first subject which, as an aspirant for medical honors, the student is obliged to encounter, and it too often tends to cast a shadow over the bright visions which his fancies had painted, as its perplexities increase.

Sir Charles Bell was in the habit of frequently employing the *living subject* as one of the most efficient means of teaching anatomy, and the points which he thus impressed upon his pupils were furthermore made matters, not only of information, but of practical interest, by the constant application of the regions discussed to the needs of the physician in his daily associations with the sick.

There are many well-known facts in anatomy which can be taught without the aid of dissection; and many of those well versed in theoretical anatomy, and who could, if necessary, pass a satisfactory examination upon the subject, would utterly fail if compelled to point out many of the structures upon the cadaver, concerning which they think themselves familiar. Holden recognized the necessity of this method of demonstration of anatomy upon the living subject, and the need of guidance, which the general profession accepted, when he published his "Surgical and Anatomical Landmarks;" and the success of the effort has justified its republication in one of our popular text-books.

In this chapter it is my aim to direct attention to such points upon the cranial bones as seem capable of being applied to the general practice of medicine and surgery; and I shall endeavor to so apply them as to once more recall scattered points which may have been known and forgotten, and, if possible, suggest means by which this information may be fixed in the memory. It is not to be expected that many original ideas will be presented, as the researches of the greater anatomists have left little to be added, which can help to make this line of study attractive, to which a claim of originality can justly be laid; but much that is old will bear repeating with profit, and many facts which are now scattered throughout text-books will be rendered more useful if compiled.

The entire skull is sometimes deficient at the time of birth, and the term "acrania" was applied by Béclard[1] to this condition; while the term "anencephalia" was also applied by him to those forms of arrested development of the skull where the base only is present.

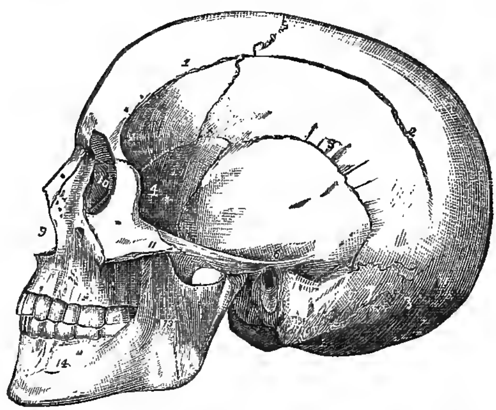


FIG. 1.—The skull. 1, frontal bone; 2, parietal bone. The line or ridge below these numbers is the outer limit of the origin of the temporal muscle; ×, coronal suture uniting the frontal and parietal bones; 3, occipital bone—the figure is placed at the lower end of the lambdoidal suture, uniting the parietal and occipital bones; 4, greater wing of the sphenoid bone; 5, is placed just above the upper edge of the temporal bone as it lies upon the parietal; 6, is on the lower part of the temporal bone where the zygoma joins it; the oval opening a little lower down is the entrance to the bony canal of the ear; 7, mastoid portion of the temporal bone; the pointed projection in front of it is the mastoid process; 9, the opening of the nasal cavity; 10, inner wall of the orbit, or the lachrymal bone: 11, the malar bone close to its junction with the zygoma; 12, superior maxillary bone; 13, ramus of the lower jaw; 14, body of the lower jaw.

We find that the *orifice of the ear* nearly corresponds, in the normal skull, to the level of the floor of the cerebrum; so that the height of the skull above this point indicates, in general, the relative amount of brain possessed by an individual. If a string be made to pass from one external auditory meatus to the other over any part of the calvaria, the development of that portion of the brain to other portions can be approximately determined.

The *bony skull-cap* is not often symmetrically developed upon its two lateral halves. The frequency of this lack of symmetry may be appreciated by examining the impressions of heads taken by any of our prominent

[1] Elements of General Anatomy (Togno's translation). Philadelphia, 1830.

hatters. No two skulls have identical measurements or contour, since, although faces are never alike, mechanical causes may furthermore alter the shape of the head. This is evidenced to a marked degree in certain Indian tribes, where the heads of the young are mechanically compressed.

In the head we have the bony framework of the cranium and face covered by its soft tissues. We have its numerous cavities, ridges, depressions, prominences, and foramina. In its soft tissues ramify many of the more important nerves and vessels of the body, while, within its cavities, are contained the organs which afford the special senses of sight, smell, hearing, and taste, and also the brain with its ganglia, its protective coverings, its vessels, and the nerves by which it performs its various functions.

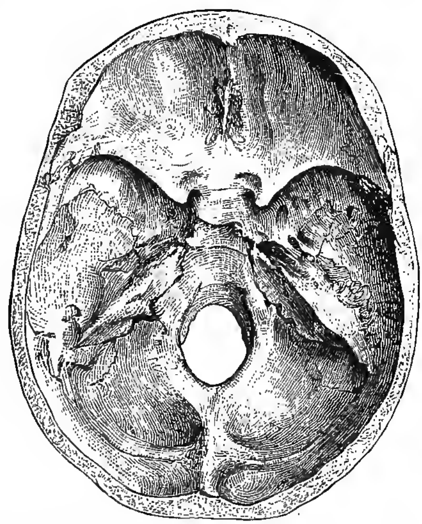


FIG. 2.—Drawing of base of skull, introduced to show the want of correspondence between certain parts of the base of the skull and of the brain. (After Hilton.)

We find these various component parts so nicely adjusted, *as to weight*, that the head is almost perfectly balanced upon the spinal column, and so articulated to the trunk, as to facilitate the motions of flexion, extension, and rotation without injury to any of its structures.

It is my intention, in this chapter, to treat of those practical points which are afforded by the osteology of the head alone, and to show in how many ways the study of this portion of human anatomy may constantly suggest to the physician new thoughts of value.

THICKNESS OF THE SKULL.

The skull-cap is not of *equal thickness* in all its parts; neither is it of the same thickness in all individuals. It is thicker at the occipital protuberance than elsewhere, and thinnest over the temple. Holden's[1]

[1] Surgical and Anatomical Landmarks. London, 1876.

rule for trephining should never be forgotton: "Think you are operating upon the thinnest skull ever seen, and thinner in one half of the circle than the other."

Trephining the cranium should be regarded as an operation always fraught with danger,[1] and only to be performed from absolute necessity. The following general rules[2] should guide in deciding the question: 1st, In *diffused injuries* to the cranium and its contents all operative interference is unjustifiable; 2d, in simple fractures, with or without depression, operative interference is only called for when marked and persistent symptoms of *local compression* of the brain exist; 3d, in compound comminuted fractures, with or without brain symptoms, the *depressed bones* should be elevated and the fragments removed, with the object of taking away known sources of irritation to the membranes, a common cause of encephalitis; 4th, in all cases of local traumatism of the cranium,

FIG. 3.—Iron arrow-head impacted in left temporal bone, without fissure. No. 5908, Sec. 1, A. M. M.

of fracture, or other injury, followed by clear clinical evidence of *local inflammation* of the bone and persistent symptoms of *brain irritation* or *subosteal suppuration,* the operation should be undertaken.

Old people often suffer absorption of the diploë, and are thus especially liable to present very thin skulls.

The exterior of the skull-cap *does not correspond* absolutely to the *eminences* and *depressions of the interior surface,* but it bears, in some cases, a resemblance to its general outline. Phrenology cannot, therefore, be more than an approximate science.

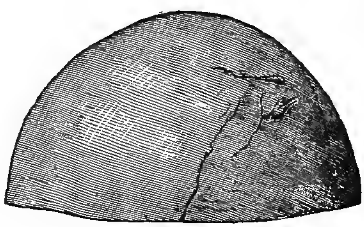
The thickness of the skull-cap seems to be modified somewhat by the exposure of the head to the effect of the sun, as it is usually very thick in the Egyptian, and in other races where the head is generally uncov-

[1] Erichsen: Science and Art of Surgery. Philadelphia, 1860.
[2] T. Bryant: Practice of Surgery. London, 1872.

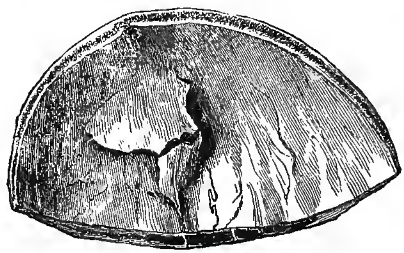
ered; while it is liable to be very thin and soft in the Persian race, and in other races where the head is covered with a turban from infancy.[1]

TABLETS OF THE SKULL.

The *middle tablet* of the skull-cap (diploë) is abundantly supplied with veins. It is not infrequent that a *suppurative phlebitis* of these veins is created by wounds received upon the head, even when the scalp is not lacerated, or symptoms of depression of the skull exist. Such an occurrence usually results in disintegration of the blood-clots formed within the inflamed veins, which are carried downward to the heart, and are then thrown into the arteries, only to act as emboli and induce infarction and metastatic abscesses in the various viscera. This probably explains why *pyæmia* sometimes occurs in closed wounds, where no opportunity seems to be afforded for the absorption of any poisonous miasm generated from decomposing pus.[2]



Outer tablet.



Inner tablet.

FIGS. 4 AND 5.—Fissure of the outer table, with depression of the inner. (U. S A. Med. Museum, No. 24. From Circular No. 6.)

The *tablets of the skull* differ in their relative densities, the inner tablet being extremely brittle, the middle being spongy and vascular, while the outer tablet is more yielding and tenacious than the inner. Guthrie[3] states that sabre-cuts of the head, making only an incision of the outer tablet, may splinter and depress the inner tablet over a large extent of surface.

The large number of cases in which the inner tablet has been fractured when the outer tablet has been uninjured, seems to prove that the brittleness of the inner tablet, as well as the fact that it is the last to feel the blow inflicted, tends to render it especially liable to fracture. It is, therefore, important that all forms of injury of the head be examined for evidences of *local pressure* upon or lesions of the adjacent brain-substance, even if no superficial injury to the bone can be detected.

The aperture of exit of a bullet is always larger than that of its

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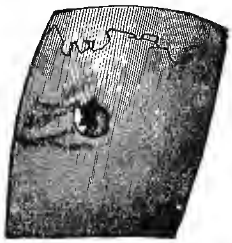
[1] Holden: Human Osteology. London, 1876.

[2] See article on Pyæmia by the author; Annals of Anatomy and Surgery. Brooklyn, November, 1881.

[3] Guthrie: Commentaries, Lect. xviii.

entry,[1] and in gun-shot wounds of the skull, the most damage to surrounding parts may thus be confidently sought for at that point.

It is also a well-known fact that some forms of injury to the bony vault of the head are followed by an enormous *increase* over the *average thickness* of the skull-cap at the seat of injury, and thus a valuable point in diagnosis is sometimes afforded, when, from defective memory on the part of the patient, or other causes, the seat of former traumatism cannot be absolutely defined.



Outer plate.

Inner plate.

FIGS. 6 AND 7.—"Punctured" gunshot fracture caused by a pistol ball. (U. S. Army Med. Museum, No. 1673. From Circular No. 6.)

GUIDES TO INTRA-CEREBRAL POINTS OF INTEREST.

A line, drawn from the *external angular process* of the frontal bone to the *external auditory meatus*, corresponds closely to the level of the floor of the anterior and middle lobes of the brain ; while one, drawn from the *external auditory meatus* to the *occipital protuberance*, corresponds to the level of the base of the posterior lobe of the cerebrum, and to the upper surface of the cerebellum.

The level of the *floor of the brain*, in front, corresponds to a line drawn transversely across the forehead, about one-quarter of an inch above the supra-orbital arch.

The *lowest level* of the *cerebellum* cannot be defined upon the living subject by any given rule. It depends entirely upon the extent to which the occipital fossa bulges into the neck. It is this variation which produces the peculiarities of outline of the back and lower portion of the skull in different individuals. The *longitudinal sinuses* of the brain may be injured by any wound in the median line of the cranium, above the level of the occipital protuberance, since these venous channels are formed by the separation of the two layers of the falx cerebri. It was an old practice among the earlier physicians to *leech the nose* to relieve congestion of the brain, and it is recognized that epistaxis is often a great relief in cases of congestive headache. This circumstance is explained by the anatomical fact that the veins of the *frontal sinus* communicate, through the foramen cæcum, with the superior longitudinal sinus of

[1] Erichsen: Science and Art of Surgery. Philadelphia, 1860.

the brain.[1] In the tiger, cats, and other of the feline race, the partition between the lateral halves of the cerebrum, corresponding to the *falx cerebri* of man, is not fibrous in character, but is composed entirely of bone.

The *lateral sinuses* correspond, for a part of their course, to a line drawn from the mastoid process to the occipital protuberance, but that portion of the lateral sinus which is indicated by a groove in the postero-inferior angle of the parietal bone, may be defined by measuring one inch from the *anterior border* of *the mastoid process*, on a line with the zygoma. The *tentorium cerebelli*, in man, supports the posterior lobe of the brain and protects it from the injuries which must, of necessity, often occur from concussion, if it rested upon bone. In the carnivora and other mammalia, the tentorium cerebelli is ossified.

From my late work upon the applied anatomy of the nervous system I quote as follows: "In the year 1861, Broca invented a scientific method of determining the relations of different parts of the cerebrum to the exterior of the skull, which consisted of driving pegs through the skulls of animals and of cadavers, holes having been previously bored through the bone in order to prevent fracture and injury to surrounding parts. The skull-cap was then removed with extreme care, and the convolutions which were wounded were thus determined. It was discovered by this observer that the *fissure of Rolando*, whose relation to the coronal suture was then unknown, lay obliquely; and that its upper extremity could be placed, with great accuracy in man, at a point situated *forty millimetres behind the coronal suture.* This fissure was particularly studied on account of its relation to the *motor region of the cerebral cortex*, and its exact relation to the exterior of the skull was, therefore, of great importance. The same observer was also able to prove that the *external parieto-occipital fissure* of the cerebrum lay under the *lambdoidal suture* of the cranium. In 1873, the experiments of Heftler and Bischoff were added to those of Broca, while Turner followed with his researches in 1874, and Féré in 1875. The drawings which Turner furnished were admirable in their way, but are, to my mind, hardly adapted to the purposes of the surgeon, since the guides which the bony prominences of the skull afford are not brought into such prominence as to be readily comprehended by the casual reader. If the surgeon is to utilize the valuable researches of the investigators above named (and several most brilliant surgical operations have already been performed from the light which the newly-acquired knowledge of the topography of the cerebrum has afforded), certain *bony prominences* of the skull must be designated as of importance as guides to the special convolutions and fissures of the brain. Now, there is one line which is easily drawn upon the head of the living subject (the alveolo-condyloid plane of Broca), upon which certain perpendicular lines may

[1] Quain: Human Anatomy. London, 1849.

be described, intersecting certain bony points, which can be utilized as guides to parts whose situation is now positively known. This base line should be a straight one, and should intersect the tip of the mastoid process and the line of the cusps of the teeth of the upper jaw.[1]

"This is the natural posture of the human skull when the lower jaw is removed and the skull placed upon a table; hence it is a plane admirably adapted for the study of the guides, which will be given, upon the skeleton in the office of each practitioner, previous to an operation. Furthermore, a skull can easily be painted upon its exterior so as to bring the lines designated as important into prominence, and thus assist the surgeon in the review of those points which possess special value. The contribution of Féré is, to my mind, the best of all the authors named, since it presents the points most needed by the surgeon in a

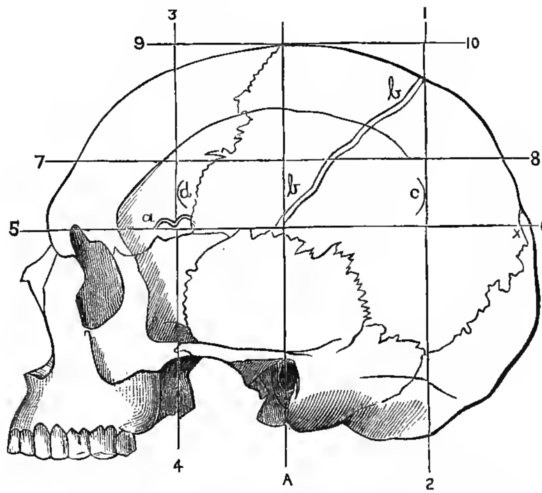


FIG. 8.—Outline of Skull resting upon the Alveolo-Condyloid Plane of Broca; modified by Seguin from Topinard ("Anthropology").

Vertical line A, or auriculo-bregmatic. Line 9–10, drawn parallel to the plane of Broca. Upon this line, at a distance of 45 mm. posterior to the bregma, a vertical line, 1–2, will pass through the upper (inner) end of the fissure of Rolando, *b*, *b*, and through the posterior extremity of the thalamus opticus (*c*). A third vertical line, 3–4, drawn at 30 mm. forward of the bregma, will pass through the fold of the third frontal gyrus (*a*), and through the head of the nucleus caudatus (*d*). The horizontal line, 7–8, at 45 mm. below the bregma (scalp), indicates the upper limit of the central ganglia. The third horizontal line, 5–6, passing through the external angular process of the frontal bone and the occipito-parietal junction, approximately indicates the course of the fissure of Sylvius, and serves for measurements. At 18 or 20 mm. behind the external angular process on this line is the speech centre of Broca; 5 to 8 mm. behind the intersection of 3–4 and 5–6 is the beginning of the fissure of Sylvius, and at 28 or 30 mm. behind this intersection is the lower end of the fissure of Rolando, *b*, *b*, placed a little too far back in the cut. At × (near 6), near the median line, is the location of the occipito-parietal fissure.

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[1] This author places the line as intersecting the *condyle of the occipital bone*; but, as this cannot be felt in the living subject, and as it closely corresponds to the tip of the *mastoid process*, I have modified the guide so as to simplify its exact situation upon the exterior of the skull.

practical way; and his guides are so tersely and clearly stated in Fig. 8 that it would be useless to attempt to improve upon it. It will be perceived in the plate, introduced to make these guides more apparent than a mere verbal description, that the line described, viz., the alveolo-condyloid plane of Broca, is used as a base-line upon which to erect perpendiculars at distances which can be accurately measured upon it; and that these perpendicular lines intersect certain regions which, from facts previously recorded, are of the greatest importance.

"With this plate as a guide, and a thorough knowledge of the facts comprised in cerebral anatomy and physiology, it is not out of the bounds of possibility to definitely locate the existence of lesions in certain portions of the human brain, to map out their situation upon the exterior of the skull, and to reach them with surgical means of relief, provided the case be one which would justify such a measure. When Broca has been successful in trephining directly over an abscess of the third frontal convolution, which was suspected, and when successful cases have been reported of trephining of the skull for fragments of the inner tablet which were compressing the ascending gyri of the frontal and parietal lobes, thus causing paralysis, have we not every reason to hope that the day is coming when the rules governing this operation will be those based upon science rather than upon empiricism, and when the surgeon will owe his success to the researches of the physiologist and the labors of the pathologist?

"There are certain suggestions which may be thrown out in this connection, which are safe ones to follow in cases where the propriety of surgical relief is called into question. These may be stated in the form of propositions, which are of necessity based upon physiological and pathological investigations.

"1. If the injury sustained, provided the case in question be one of a traumatic origin, be *situated over the motor area* of the cortex, the presence of *anæsthesia* in combination with *motor hemiplegia* is a contra-indication to attempts at surgical relief. This symptom (anæsthesia) probably indicates some injury to the posterior third of the internal capsule, or to the white substance of the hemispheres; hence the lesion is probably too extensive to be relieved by trephining.

"2. If the *sensory region* of the cortex be involved, and *paralysis* or *convulsive movements* occur, an operation is contra-indicated; since the lesion has either been so extensive as to extend to the motor area, or has torn or compressed the cerebrum at a point removed from the apparent seat of injury.

"3. The occurrence of *paralysis on the same side* as that upon which the injury was received is always a contra-indication to any surgical procedure at the seat of injury, since it indicates some lesion of the opposite side, probably dependent upon transmitted force (*contre-coup*).

"4. The *completeness of the paralysis* may be often taken as a guide to the amount of injury done to the cerebrum: if the paralysis be very profound, the chance of success from trephining is extremely small, since the injury has probably affected parts deeper than the cortex centres.

"5. The appearance of *paralysis of any of the special nerves of the cranium,* or the development of the symptoms due to lesions of the base of the brain or of the basal ganglia, such as the Cheyne-Stokes respiration,[1] choked disk, and vomiting, may be regarded as contra-indications to surgical interference.

"6. When an injury to the skull is followed, after a lapse of some weeks, by *aphasia,* the diagnosis of abscess of the base of the third frontal convolution, or possibly involving the island of Reil, or the white substance situated between the third frontal convolution and the base of the cerebrum,[2] may be safely made. In such a case, the operation of trephining, as performed by Broca, affords a strong probability of relief.

"7. Cases of injury which are *followed immediately by aphasia* are strongly diagnostic of either a spicula of bone or the pressure of a clot in the neighborhood of the centre of Broca. The former condition would be strongly in support of surgical interference, since it would probably continue to create pressure or irritation until removed, while the pressure of a clot might also be relieved by trephining.

"8. If the *region over the fissure of Rolando* be subjected to apparent injury, and the symptoms of some of the *special types of monoplegia* appear (affecting the muscles of the face, arm, leg, or any of these combined), or even the occurrence of a *slight form of hemiplegia* follow, successful trephining may be reasonably expected. The presence of anæsthesia, as before mentioned, would, however, still be a strong contra-indication to such a step, since it would prove that the lesion was probably of too deep a character to be benefited by the simple removal of a button of bone, as the posterior third of the internal capsule would probably be found to be impaired. It must be also remembered that the motor paralysis, of whatever kind it may be, must be confined to the side of the body opposite to the seat of injury, if benefit is to be expected. The type of monoplegia which exists may often be used as a guide to determine the extent of the lesion as well as its situation."[3]

SUTURES OF THE CRANIUM.

The *coronal suture* (frontal-parietal) separates the frontal bone from

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[1] A respiration whose rhythm steadily increases and then decreases in a short interval of time, described in 1818 by Cheyne, and by Stokes in 1846.

[2] E. C. Seguin, Medical Record, 1878.

[3] The motor centres situated in the ascending frontal and parietal convolutions, and the various forms of monoplegia will be found described in the late work by the author, The Applied Anatomy of the Nervous System. N. Y., 1881.

the parietal bone of either side. In the coronal suture, the middle portion is formed by the frontal bone overlapping the parietal, while, at the sides, the parietal bone overlaps the frontal; a provision which manifestly is intended to prevent displacement of the bones.

The *lambdoidal suture* (parieto-occipital) also extends, like the coronal, transversely across the head, separating the posterior borders of each parietal bone from the occipital bone. Its relation to the external parieto-occipital fissure of the cerebrum gives it an importance as a surgical guide (see p. 8).

The *frontal suture* separates the two lateral halves of the frontal bone until ossification is perfected between them. It is, therefore, situated in the median line of the forehead. In one out of every eleven cases of adult skulls found in the catacombs at Paris, the frontal suture remained unobliterated.[1]

FIG. 9.—Bones of the skull separated at the sutures. 1, Frontal bone; 2, parietal bone; 3, occipital bone; 4, temporal bone; 5, nasal bone; 6, malar bone; 7, superior maxillary bone; 8, lachrymal bone; 9, inferior maxillary bone.

The *masto-parietal suture* separates the posterior inferior angle of the parietal bone from the mastoid portion of the temporal bone. In the mastoid suture, small isolated bones called "Wormian bones" are chiefly found.[2]

The *squamous suture* separates the parietal bone, and the great wing of the sphenoid bone, from the squamous portion of the temporal bone. It consists, therefore, of two portions, viz.: the "*squamo-parietal*" and the "*squamo-sphenoidal*" sutures.

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[1] Flower (as quoted by Holden).

[2] Leach (as quoted by Holden). This fact is also described by Eustachius and Paracelsus. The name is applied to these small bones from Olaus Wormius, a physician of Copenhagen.

The *sagittal suture* runs from the frontal to the superior angle of the occipital bone, and lies in the mesial line of the skull. At either end of it, lie the two *largest fontanelles,* viz., the anterior and the posterior. The edges of the parietal bones which form this suture are very much serrated, except opposite the parietal foramina, where these serrations are much less prominent.[1]

The *sutures* of the *cranium* are of great practical interest for the following reasons:

1. Because they may be mistaken for a fracture, as was done by Hippocrates himself.[2]

2. Because, in any form of injury to the skull, it is not advisable to trephine over the normal situation of a *suture,* as the emissary veins usually pass through them; besides, they are often in the immediate proximity of large venous sinuses.

3. Because they enable us definitely to locate the position of any portion of the head of the child during labor.

OCCIPITAL BONE.

The *basilar process* of the *occipital bone* is within reach of the finger, when introduced behind the soft palate until it touches the base of the skull (the position of the patient being the same as when the posterior nares are to be explored). It is often the seat of attachment of polypi within the pharynx, and a positive diagnosis can thus be made by the sense of touch, if sight or the laryngoscopic mirror detect the existence of such a tumor, and its point of attachment is a matter of doubt.

The upper surface of this process, although situated within the cranial cavity, affords support to the *medulla oblongata.* This important ganglion does not, however, rest upon the bone itself, since a thin *layer of cerebro-spinal fluid* is interposed, like a water-bed, to prevent injury to it in case of concussion being transmitted to the head through the spinal column.[3]

The strength of the ligaments which bind the head to the vertebral column do not alone prevent its dislocation, since the *deep cups* of the atlas hold the *condyle* of the *occipital bone* firmly in place.[4]

The *centre* of the *condyles* upon which the head moves may be defined by a line which shall connect the tips of the two *mastoid processes* of the temporal bones. It is thus easy to designate their position on the living subject.

The *condyles* of the *occipital bone* are much longer than the articulating cups of the atlas, and thus permit the forward and backward

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[1] Broca: Ostéologie du Crâne, 1872.

[2] Celsus (as quoted by Holden, Human Osteology).

[3] Hilton: Rest and Pain. New York, 1879.

[4] Darling and Ranney: Essentials of Anatomy. New York, 1880.

motion of the head, while *deep fossæ behind the condyles* allow an extra amount of motion in the backward direction, so that vision can be directed perpendicularly as well as horizontally.

The *occipital protuberance*, being the thickest portion of the skull, is seldom fractured by violence received upon that point; but the same force, by being transmitted, may create fractures either of the base or anterior portions of the skull.

THE SPHENOID BONE.

This bone, being situated at the base of the skull, cannot be studied upon the living subject, in all of its parts, although the *pterygoid processes* form the outer wall of each nasal cavity, and can, therefore, be seen with the laryngoscopic mirror, and felt by the finger when thrust upward behind the soft palate.

It is not devoid of surgical interest, however, in spite of its situation, and plays a most important part in the general plan of the construction of the head, since it acts as a point of meeting of all the buttresses[1] of the skull; while its pterygoid processes, furthermore, support the bones of the upper jaw, and thus greatly assist in making the attachment of the face to the cranium firm and immovable. This latter process, moreover, affords attachment to the powerful pterygoid muscles, which help to grind the food, and also to the tensor palati muscle, which is an important factor in the act of deglutition.[2]

The little hook (hamular process) at the end of the internal pterygoid plate, around which the tendon of this latter muscle so beautifully plays, can be felt within the mouth, when the finger is crowded along the upper jaw, close to the commencement of the soft palate and in the immediate vicinity of the last molar tooth.

The *twelve foramïna* of the sphenoid bone afford a means of exit, from the cavity of the cranium, for the nerves of the eye itself, and of the ocular muscles, and, also, for the great nerve of sensation of the face (trigeminus or fifth nerve); while the middle meningeal and ophthalmic arteries are also thus enabled to reach their respective points of distribution. It can, therefore, be readily understood why fractures of this bone may create impairment of any one of these nerves or vessels; and the situation of the bone itself, in addition to the numerous foramina within it, renders such an accident extremely common, when a force is transmitted to it from any portion of the cranium,[3] or even from the face, since it acts as a buttress to the upper jaw.

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[1] See page 26 of this volume.

[2] See Essentials of Anatomy: G. P. Putnam's Sons, N. Y., 1880; and also the late work of the author: The Applied Anatomy of the Nervous System, N. Y., 1880.

[3] The reader is referred to page 26 of this volume, where the buttresses of the skull are discussed in their relation to the so-called "fracture by *contre-coup*."

The *body of the sphenoid* bone is hollowed out into a *large chamber*, which contains air, and, like the cavities of the frontal sinuses, the mastoid cells, and the antrum of either side, tends to lighten the weight of the skull, in addition to other functions.

This cavity is often extended into the basilar process of the occipital bone. In birds, Nature forms most of the bones on this plan, and often causes the respired air to communicate with the cavities so formed, since the heated air still further reduces the weight of the body, and thus assists in their flight. The owl has enormous air-chambers in the frontal region, which accounts for the prominence of the forehead. In those types of birds to which the power of very rapid motion is afforded, every bone, even to the tips of the claws, is hollowed out.

The mucous lining of the cavity of the sphenoid communicates with that of the nasal chambers—a point often of importance in diagnosis of a fracture of the base of the skull, as will be shown in a later chapter. The relations of the large venous sinuses at the base of the skull to the body of the sphenoid bone (see page 20) may also possibly help to explain some of the symptoms of those fractures of the base of the skull which involve the sphenoid to a greater or less extent.

FRONTAL BONE.

The *orbital plates* of the *frontal bone* are often absorbed in the aged, and large holes in them may frequently be discovered. Their extreme thinness renders any form of punctured wound of the orbit liable to be complicated with injury to the frontal lobe of the brain.[1] The arch of the orbital plate is not uniform in all skulls; and, if great, the frontal lobes of the brain are proportionately small. In the monkey tribe, this is very apparent.

In the frontal bone, after puberty has been reached, the tablets of the skull-cap begin to separate, thus leaving a cavity called the *frontal sinus*, whose situation is usually indicated by a prominence of the forehead. It is a point of surgical value, that the frontal sinus may not always be proportionate to this eminence; and, in rare cases, this eminence may be entirely absent, in case the sinus be formed by a recession alone of the inner tablet of the skull. Wounds of the forehead over the sinus may break the skull without injury to the brain. Small insects have been known to enter this cavity through the nose. The sense of pain in the frontal region, which accompanies nasal catarrh, has been explained by some authors as an extension of the inflammation to the mucous membrane which lines this cavity.

Blumenbach mentions the case of a lady (Poulet ascribes this case to Maréchal, of Metz) in whose frontal sinus a centipede managed to

[1] Holden: Human Osteology. London, 1876.

pass, after entering the nostril. It gave her intense pain, and was expelled alive one year afterwards during an attack of sneezing.[1]

The larvæ of insects, especially those of the horse-fly, not infrequently are found in the frontal cells of animals.[2]

Sir Charles Bell[3] reports a case, where a patient, who had slept in barns, had a corn insect enter the frontal sinus, and which was eventually discharged as a worm.

Fractures of the skull, over the frontal sinus, may cause fragments of bone to be discharged by the nose, and loss of smell is often produced by such accidents. Emphysema of the tissues[4] about the forehead may be produced during attacks of sneezing or coughing, if the outer wall of the frontal sinus be injured, and air be thus allowed to escape.

In some tribes (especially the Australians), where the frontal sinuses are imperfecty developed, a want of resonance to the voice is produced.[5] Musket-balls have been found within the frontal sinuses.[6]

The *enormous air-chambers* in the head of the elephant, situated in the frontal region, explain why musket-balls may be shot into the cranium of that animal without apparent injury, unless it happen to wound the hollow at the root of the nose (at which place the encasement of the brain is very thin), or chance to enter the orbit. This arrangement, constituting an approach to a double skull, is a protective one on the part of Nature, since the falling of trees, etc., to which dangers this animal is constantly subjected, would otherwise be liable to produce fatal injuries.

The extent of the *frontal sinuses* differs in races and with age. They may reach, in extreme development, a depth of one inch, and extend more than half-way up the forehead.

Wounds of the frontal region are especially dangerous to life for four reasons: first, on account of nerves which may be wounded; second, from the danger of meningeal inflammation; third, from the fact that the frontal vessels, being derived from the same trunks as those of the cerebrum, may induce similar changes in the brain; and, fourth, because the shock may create a tendency to inflammatory effusions upon the meninges, or within the ventricles.[7]

The danger of this class of wounds was recognized by the ancients who attributed it to injury of the "Galea Capitis,"[8] which, from its white color, they mistook for nerve-tissue.

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[1] Holden, op. cit.

[2] Poulet: A Treatise on Foreign Bodies in Surgery. New York, 1880.

[3] System of Surgery. London, 1826.

[4] Hyrtl: Topog. Anatomie, 1857.

[5] Amman: De Loquela, 1700 (as quoted by Holden).

[6] Guthrie: Commentaries on Surgery. London, 1855.

[7] Blandin: Anat. Topog., 1834.

[8] Another name for the tendon of the occipito-frontalis muscle.

The *internal angular process* of the frontal bone is used as a guide to detect the reflected tendon of the superior oblique muscle of the eye, which can be felt by pressing the finger beneath this process, and should always be carefully avoided in operations in the vicinity of the orbit.

PARIETAL BONE.

The *sutures* of the *parietal bone* are wonderfully adapted by Nature to prevent displacement inward, since they are bevelled upon alternate sides. It is, therefore, impossible to injure the brain in this region without a fracture having previously occurred.[1]

There are six portions of the cranium where ossification is delayed and where the pulsations of the brain may be felt. These spots are called *fontanelles,* since the brain pulsations were first likened to the bubbling of a spring. The fontanelles are called the anterior, posterior, and lateral of either side;[2] and they exist at the points where the angles of the several bones eventually meet. The *anterior* is quadrilateral, and is formed by the two parietal bones and the two halves of the frontal bone. The *posterior* is triangular, and is formed by the two parietal and the occipital bones. The *lateral* are usually nearly filled at the time of birth.

These openings are of value to the obstetrician in determining, by the sense of touch, the position of the child's head during the first and second stages of labor.

TEMPORAL BONE.

On the whole, the skeleton of the temple is thinner than that of the preceding region, and its external and internal periostea, which are united to each other by fibrous bands and emissary veins, adhere to it more firmly, because there are here more sutures.

The temporal region, although the bone encasement of the skull is extremely thin in that locality, is seldom fractured by direct violence, as it is so thoroughly protected by muscular tissue. Blows which are received, however, upon the region of the *orbital arch* frequently cause a fracture of the *temporal bone,* and in this way a spicula of bone has been known to wound the *middle meningeal artery,* which lies in close relation with the interior surface of that bone. Such a form of injury, if followed by symptoms referable to the brain, would probably indicate a fracture of the temporal region of the skull, and, possibly, a complicating hemorrhage from the artery mentioned, even if no direct injury to the orbital arch could be discovered.

The *mastoid process* is intended chiefly to afford additional leverage to the muscles destined to act upon it.

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[1] Horner: Treatise on Anatomy. Philadelphia, 1830.

[2] Vogel: Diseases of Children.

The presence of the *lateral fontanelle*, in the region of the mastoid process of the temporal bone, renders a protrusion of some part of the encephalon possible at this point; and tumors situated in this vicinity should, therefore, be examined with the special object of ascertaining any possible connection with the brain before operation.[1]

The *mastoid process* contains numerous cells, which communicate with the cavity of the middle ear. It has occasionally to be trephined in cases of suppurative otitis, in order to afford an exit for the infiltrated pus. Its *cells* are constantly filled with warm air, which enters the tympanum through the Eustachian tube, and thus render the bone lighter than if it were not thus excavated. These cells are undoubtedly an aid to the full development of the sense of hearing, since they increase the space in which the vibrations of the air, contained within the middle ear, may be diffused.

It was formerly the practice to *open these cells* in the mastoid process as a remedy for deafness, dependent upon obstruction of the Eustachian tube, since, by so doing, air was freely admitted to the cavity of the tympanum. The operation fell, however, into disrepute, from the death of the physician of the king of Denmark (Just Berger), who was himself made a subject for the operation.

In wounds received close to the region of the mastoid process, *severe hemorrhage* is often occasioned, on account of the close proximity of large vessels to that portion of the temporal bone; while, in this region, caries, necrosis, and exostoses are extremely liable to occur during the tertiary form of syphilis.

The groove between the skin covering the mastoid process and the back of the ear is a frequent site for that form of ulceration which accompanies the scrofulous diathesis.

The mastoid process transmits, through the "mastoid foramen," a vein which communicates with the *lateral sinus* of the brain. This explains why leeches behind the ears relieve congestion of the brain or its coverings.

The abnormalities in length of the *styloid processes* of the skull, which are occasionally found, are dependent upon an ossification of the stylo-hyoid ligament.

The *supra-mastoid ridge* on the side of the skull is so extensively developed in the negro race that it might possibly be mistaken for an acquired deformity.

The *post-glenoid process* of the temporal bone is intended by Nature as a protection against backward dislocation of the condyle of the lower jaw. It is much more extensively developed in the negro race and gorilla than in the European.

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[1] See A Treatise on Surgical Diagnosis. By the author. New York, 1880.

The *external auditory canal* is narrowest at about its middle point.[1] For that reason, foreign bodies which enter the ear are apt to be pushed beyond this constriction during attempts at removal, and thus additional difficulty in the extraction is afforded. In addition to this fact, the natural moisture of the ear may cause some foreign bodies to swell, and thus render their removal a matter of great difficulty. This subject will receive further consideration in a subsequent chapter.

The *temporal fossæ* are largest in the carnivorous animals, as their size depends upon the relative strength and development of the *temporal muscles*. In some animals, the temporal muscle almost entirely covers the cranium.

The *zygomatic arch* is modified, as to its size, in all animals, by the development of the muscles of the jaw and the character of the teeth which exist. It is most strongly marked in the carnivora, where it is arched both in a horizonal and a vertical direction, so as to afford abundant room for the play of the temporal muscle; while in the ant-eater, which has no teeth, the zygomatic arch is incomplete.[2]

Between the *zygoma* and the ear can often be felt the pulsations of the main trunk of the temporal artery.

When it becomes necessary to trephine over the temporal region, a suggestion has been made by a prominent author,[3] to make a "V" shaped flap, whose apex should look toward the ear, and which should be allowed to remain attached, while the other portion of the flap is dissected from the bone, thus preserving the fibres of the temporal muscle from being unnecessarily injured, and greatly facilitating in the subsequent union of the flap.

THE NASAL FOSSA.

The *external aperture of the nose* lies on a plane below the bony floor of the nasal fossa.[4] The nose has, therefore, to be pulled upward, to allow of a free inspection of the inferior meatus for polypi or foreign bodies. Since the perpendicular axis of the inferior meatus is much greater than the transverse, forceps introduced into the nose, for the purpose of removing either a growth or foreign body, should be opened in the longest axis of the fossa.[5]

The *turbinated bones* serve to afford a large expanse of surface for the distribution of the nerves of smell (olfactory). They are, therefore, studded with grooves and canals, through which the nerves come down from the cribriform plate of the ethmoid to spread themselves out upon the mucous membrane of the nose. In man, they only form a *single*

[1] Poulet: Foreign Bodies in Surgery. New York, 1880.
[2] Holden: Human Osteology. London, 1875.
[3] Blandin, op. cit. [4] Holden: Human Osteology. London, 1875.
[5] Darling and Ranney: Essentials of Anatomy. New York, 1880.

curve; but in animals, where the sense of smell is greatly developed, they often make rolls within rolls, like a sheet of parchment which has been rolled together. In the seal, they are arranged as individual and parallel plates, and of great number, so that 120 square inches of surface has been computed to exist in each nostril.

An arrest in the progressive ossification of the perpendicular plate of the *ethmoid bone* occasions the deformity known as the "pug nose."

The *roof* of the nose is extremely thin, being formed only of the *cribriform plate* of the *ethmoid* bone, so that perforation of the brain is extremely easy to be performed at this point. The old Egyptians were in the habit of first removing the brain through the nose with an iron hook before commencing the process of embalming,[1] and subsequently the cavity of the cranium was filled with drugs through the same channel.[2]

An anatomical peculiarity of the skull of the negro race is often exhibited in the nasal fossa, as a *fourth meatus,* which lies above the superior turbinated bone.

The *bony edge* of the *anterior nares* is a guide to the lower orifice of the nasal duct, which appears as a minute slit, about one-quarter of an inch behind the bony edge of the nose, on a level with the inferior turbinated bone. The nasal duct is usually probed from above downward, in case the escape of the tears is obstructed, as its lower opening is difficult to reach, especially as it is situate upon the outer wall of the inferior meatus of the nose.[3]

The *vomer* is not always felt to be in the median line, as it is often deflected toward either the right or left side. Cases are recorded where such an abnormality, when associated with a tumefaction of its mucous covering, has been mistaken for a polypus of the posterior nares, and attempts at its removal have been made. The *edge of the vomer* may be felt in examining the posterior nares with the finger. To accomplish this, the head must be thrown as far back as possible, in order to bring the upper and posterior part of the pharynx below the level of the soft palate, and the finger should be pushed upward behind the palate, and hooked forward till it enters the posterior nares. This step has a practical value in estimating the size of a plug (usually one inch long and six lines wide), to arrest epistaxis, and in the diagnosis of polypi of the posterior portion of the nasal fossa. When the nasal fossa is considered in a subsequent chapter as a special surgical region, other points of interest

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[1] Herodotus: Euterpe, chap. 86, 87, 88 (as quoted by Holden).

[2] Holden states that in the collection of Egyptian skulls brought from Thebes by Prof. Flower, of London, every one showed the cribriform plate of the ethmoid bone destroyed.

[3] Horner, op. cit. Broca: Ostéologie du Crâne, 1875.

will be given; and the practical utility of a knowledge of its anatomical formation will be made more apparent to the reader.

BASE OF THE SKULL.

In *fractures* of the *base of the skull*, blood and cerebro-spinal fluid may flow from the ear of the affected side. If the latter escape, it indicates that the petrous portion of the temporal bone has been fissured,[1] and the dura-mater sheath to the auditory and facial nerves has been also lacerated.[2]

In this form of injury, as well as in diseases of the ear, the *facial nerve* may be implicated, since it passes through a canal (the aquæductus Fallopii) in the petrous portion of the temporal bone; and this explains why we sometimes have paralysis of the muscles of one side of the face

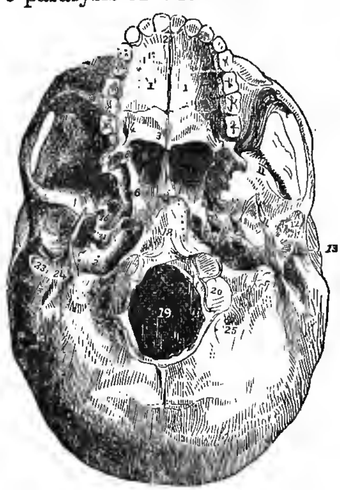

FIG. 10.—Base of the skull. 1, Palate plate of superior maxillary bone; 2, alveolar ridge of superior maxillary bone; 3, palate plates of palate bone; 4, posterior palatine foramen; 5, vomer; 6, internal pterygoid plate of the sphenoid bone; 7, external pterygoid plate of same; 8, hamular process of same; 9, entrance to posterior nares; 10, scaphoid fossa; 11, zygomatic fossa; 12, glenoid fossa; 13, mastoid process; 14, styloid process; 15, foramen ovale; 16, foramen spinosum; 17, carotid canal; 18, basilar process of occipital bone; 19, foramen magnum; 20, condyles of occipital bone; 21, jugular fossa; 22, jugular process of occipital bone; 23, auricular fissure; 24, styloid process of temporal bone; 25, posterior condyloid foramen; 26, external occipital protuberance.

under these circumstances. Pressure on this nerve, at its escape from the bone, as in case of tumors, parotid abscess, etc., may also produce a like effect.

In fracture at the base of the skull, *blood* often escapes from the

[1] Prescott Hewitt. See also article by Dr. Buck, Medical Record, 1880.

[2] It is asserted by some authors that if blood escape from the ear after an injury, not only must the petrous portion of the temporal bone be fractured, but that one of the large venous sinuses of the dura-mater must be also in direct communication with the seat of fracture.

nose. This is due to the fact that the air-cells in the *body of the sphenoid bone* are lined by a prolongation of the mucous membrane of the nose; and any fracture which involves the body of the sphenoid bone is liable to be associated with hemorrhage from the nostril.

Ecchymosis of the *lower eyelid* is a symptom very frequently associated with fracture of the base of the skull. This discoloration is subconjunctival in character, and appears, as a rule, within the first twenty-four hours after the accident. It may be explained as an infiltration of blood from the nasal cavity into the orbit; or by an escape of blood into the orbit, through the spheno-maxillary fissure, in case some one of the numerous vessels which enter the cranium at its base are involved. It may also occur if the orbital plate of the frontal bone be involved, or when blood escapes through the sphenoidal fissure into the orbit.

BONES OF THE FACE.

Much of the character exhibited in the face depends upon the superior maxillary and inferior maxillary bones. In them the teeth are inserted, which contribute much to fill out the cheeks and to modify the character

FIG. 12.—Antero-lateral view of the skull. 1, Frontal bone; 2, parietal bone; 3, temporal bone; 4, sphenoid bone; 5, palate bone; 6, sup. max. bone; 7, malar bone; 8, lachrymal bone; 9, nasal bone; 10, inf. maxillary bone; *a*, frontal portion of orbit; *b*, part of temporal fossa; *c*, malar portion of orbit; *d*, mastoid process; *e*, left orbit; *f*, sup. maxillary portion of orbit; *g*, infra-orbital foramen; *h*, mental foramen; *i*, symphysis; *j*, ramus; *k*, coronoid process; *l*, condyle; *m*, angle of jaw.

of the mouth, while most of the muscles of expression are also attached to them.

THE ORBITS.

The orbits are *surrounded*, at the facial margin, by a very strong ring of bone, while their upper wall is as thin as parchment. The mechanical object of thus protecting the exposed portion of the orbit from injury is still further shown by the strong ridge of bone which runs from the zygoma. It is thus almost impossible to directly crush in the orbit, except the most extreme violence be used.

The *axes of the orbits* are so directed that, if prolonged backward, they would meet at the sella turcica. This divergence gives to the eye a range of vision greatly in excess of that which would be afforded were the orbits directed in the antero-posterior plane.

The muscles of the eye are enabled to retract it within its socket, and thus to still further protect it from violence.

Injuries from pointed instruments within the orbit may produce death from *injury to the brain.*

THE NOSTRILS.

The *septum* between the nostrils is seldom exactly in the median line, and this should not be considered as a deformity unless one nostril be seriously occluded.[1]

The lower edge of the *superior* and *middle turbinated bones* can be made visible by widely dilating the nostril. This is of importance in attempting to include the pedicle of a polypus within the grasp of a forceps.[2]

THE UPPER JAW.

The *second molar tooth* of the *upper jaw* is a guide to the orifice of the duct of the parotid gland (Steno's), which can be seen in the mouth as a small papilla on the mucous membrane of the cheek.

A line drawn from the interval between the *two bicuspid teeth* to the point of junction of the inner and middle thirds of the supra-orbital arch, will cross the *supra-orbital* and *infra-orbital foramina,* and, if prolonged downward, will intersect the *mental foramen.* This point is of value in dividing nerves for facial neuralgia. The division of the main trunks of either the third, fifth, or seventh nerves, in removing tumors or other operations upon the face, is apt to cause distortion of the features or loss of sensibility.[3] But in nearly every instance, as any deep incision must necessarily divide some portions of the nerves of the part, the surgeon can do little more than bear in mind the importance of avoiding them, if possible, or, at least, of not excising their trunks if they should be divided, as union may possibly restore their function.[4]

Modifications in the configuration of the *hard palate* often affect the tone of the voice. On the hard palate can often be felt the pulsation of

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[1] Holden: Human Osteology. London, 1875.

[2] Gross: System of Surgery.

[3] Horner: Special Anatomy. Philadelphia, 1830.

[4] H. H. Smith: Treatise on Neuroma. Dublin, 1848.

the posterior palatine artery, which escapes at the inner side of the last molar tooth.

A pin introduced in the centre of the crucial suture of the hard palate would touch five bones, the fifth one being the vomer.

The fact that no muscles are attached to the hard palate except at its posterior margin, and the density of its investing structures, are a sufficient mechanical explanation why fractures in this vicinity are seldom associated with displacement.

The *last molar tooth* is a guide to the introduction of a tube into the mouth, in case of tetanic fixation of the jaw requiring forced alimentation, since a space exists between that tooth and the ramus of the jaw sufficiently large to admit a tube of moderate size.

The *cavity* of the *superior maxillary bone* (the antrum [1] or "maxillary sinus") is the frequent seat of disease. Within it [2] may be developed either solid or cystic tumors, and pus not infrequently accumulates. The close relation of the different walls of this cavity to important structures gives to these growths more than a passing interest.

If the inner wall becomes expanded, the nostril may be occluded ; if the lower wall, the roof of the mouth may be depressed; while the inferior maxillary nerve, which runs above it, may be pressed upon if the upper wall is affected, and the orbit may furthermore be so encroached upon as to greatly displace the eye. If the posterior wall be crowded backward, the zygomatic fossa will be encroached upon, and tumors have thus created a marked swelling in the region of the temple.[3] Finally, the anterior wall may become prominent, and thus greatly distort and disfigure that side of the face.

The walls of the antrum are thicker in the child than in the adult, and for that reason the growth of tumors within that cavity will be liable to progress more rapidly after puberty than before. Suppuration of the antrum arises not infrequently from decay of the teeth, or from a failure to remove a nerve within a tooth after it has been killed by caustics previous to filling a cavity, since the putrefying nerve creates gas, which escapes from the end of the fang, and thus causes suppuration in and about the alveolar process.

The antrum is the largest of the air cavities of the head.[4] A large-sized musket-ball has been known to remain loose within it for years, and in some instances such balls have been known to escape through the roof of the mouth.[5]

Drake [6] reports a case where a woman endeavored to explore the cavity

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[1] Galen: Epitome Operum, 1643.

[2] Highmore (as quoted by Holden).

[3] Blandin : Anat. Topog., 1834.

[4] Guthrie: Commentaries. London, 1855.

[5] Jargavay : Anatomie chirurgicale.

[6] As quoted by Holden.

of the antrum through a socket of a tooth with a quill pen, and, to her horror, introduced the whole six inches of its length by its assuming a spiral direction within the cavity, and thus curling upon itself. She sought medical assistance, supposing it had entered her brain.

The *antrum* should be tapped in case of its distention from fluid either within the mouth, at a point situated one inch above the margin of the gum, covering the *first molar tooth,* or that tooth having been drawn, puncture of the antrum should afterward be made through the socket ; or, in case it is deemed important to preserve the teeth, puncture through the canine fossa, as recommended by Desault, or through the molar tuberosity, as recommended by Lemorier, can be performed.

THE NASAL BONES.

The *nasal bones,* although slight and small in themselves, from an arch of enormous strength, whose buttresses are the superior maxillary bones, and whose centre is supported by the spine of the frontal bone. The feats of supporting great weights, such as a ladder with an adult on the top, as seen in the circuses, attest to the strength of this method of construction.

It is for this reason that fractures of the nasal bones are usually associated with a fracture of the perpendicular plate of the ethmoid bone, and occasionally with a fracture at the base of the skull.

THE INFERIOR MAXILLARY BONE.

The *lower jaw* in man consists of one bone, but in the serpent it consists of two symmetrical bones joined by an elastic band or ligament, which allows them to be separated in a lateral direction to a great extent. It is by means of this arrangement that the serpent is able to swallow its prey, which is often as large or even larger than its own body. In man, however, this bone is very strong, so as to perform mastication even of hard substances, and its points for muscular attachment are rough and prominent, to afford the firmest possible union between the bone and the power which moves it.

The *absorption of the sockets* (the alveoli), which is natural in the old, constitutes a disease when it occurs in youth or middle life. Such an absorption is liable to occur in cases of long salivation, scurvy, or purpura, and a premature age of the jaws is produced.

The teeth are not fitted directly into a bony socket, since a very vascular and elastic periosteum is interposed between the tooth and its receptacle in the alveolar process of the jaw. This membrane not only serves to nourish the tooth, but its elasticity tends also to break shocks transmitted through the teeth to the facial bones. It is the shrinking of this periosteal covering of the tooth that causes the socket to become too large in old age, so that the teeth become loose.

When the jaws are closed, we see that *each tooth* is *opposed by two* *teeth* in the other jaw, being an evident attempt on the part of Nature to render the loss of any one tooth hardly perceptible in the act of mastication.

Each *external cusp* of the lower teeth fits into the hollows between the cusps of the teeth of the upper jaw, and thus insures a more perfect adaptation of the grinding surfaces.

The two *condyles*, or articulating surfaces of the lower jaw, are not directed absolutely backward, but are placed at such an angle that, if their long axes were prolonged, they would intersect each other at the anterior edge of the "foramen magnum." This is to facilitate the rotary movements necessary for the mastication of our food.

Each *condyle* of the *lower jaw* can be felt in front of the ear, on motion being attempted. It can be felt to move forward when the mouth is held wide open, and return when the mouth is closed, thus affording the grinding motion demanded during mastication of food.

The *ramus* of the *lower jaw* partially protects the external carotid artery from injury, since the artery enters the parotid gland close to its posterior border.

The *symphysis* of the *lower jaw*, within the mouth, is a guide to divide the genio-hyo-glossus muscle, in case the tongue has to be drawn far out of the mouth to remove tumors of that organ, or in case it is divided as a means of cure for stammering.

The *coronoid process* of the *lower jaw* can be felt at the lateral and posterior part of the mouth. Its inner surface is a guide, in some cases, for puncture of a deep temporal abscess, since pus burrows between it and the tuberosity of the superior maxillary bone.

An attempt has been made to decide as to the character of food indicated by Nature for the best nutrition of an animal by the character of his teeth. It does not always hold good, however, as, while man would seem adapted to masticate both vegetable and animal food, the bat species have incisors, canines, and molars, and still some are purely frugivorous, while others live entirely on insects. The monkey tribe also has large canines, yet they live exclusively on vegetables.

The *angle* of the *lower jaw* marks a region of special surgical interest, since the temporal, temporo-maxillary, facial, external jugular and internal jugular veins can be found in the immediate vicinity. Hence the necessity of caution in operating in this region.

THE CRANIUM AS A WHOLE.

Holden, in his work on osteology, lays great stress upon the relative situation of the various *buttresses* of the different regions of the cranium, since, "like all other arches, the cranium transmits a shock toward its buttresses."

Thus, the *frontal bone* is supported by the malar bones and the wings of the sphenoid; the *parietal bones* by the temporal bones; the *occipital bone* by its entering the base of the skull and adjoining the body of the sphenoid.

It may, therefore, often be possible to predict the *direction* of the *course of a fracture,* produced by transmission of a force applied to the vault of the cranium, by a knowledge of the *exact seat at which the force was first applied;* and, by a thorough familiarity with the surgical bearings of the special cranial foramina, and the parts which lie in close contact with the different portions of each of the cranial bones, to *predict symptoms* which may be subsequently developed.

By far, the greater proportion of the blows received by the head is applied to the *parietal region.* This bone rests upon the temporal bone, which is weakened by the following cavities and foramina: the meatus auditorius externus and internus, the tympanum, the cochlea and semi-circular canals, the aquæductus Fallopii, the jugular fossa, the carotid canal, the opening of the Eustachian tube, the Glasserian fissure, and other smaller canals. It is, therefore, extremely probable that a fracture of the parietal bone will extend in a direction to involve some of these special portions of the temporal bone.

It has been argued in the past, by Malgaigne, Velpeau, and Béclard, that the analogy between the head and a sphere will account for many of the phenomena of transmitted force, producing the so-called "*fracture by contre-coup;*" and since, a sphere, when struck smartly, is most apt to break at the point immediately opposite to the point where the blow was received, such an analogy would theoretically indicate a like effect within the skull. Practical observation seems to have proved this, however, to be a fallacy, and the defect in the analogy will account for the error in deduction.

The skull is in no respects a sphere; on the contrary, it can, with far more reason, be *compared to an arch,* and all mechanical deductions on the latter basis will approximate far more closely to the facts presented by Nature than upon the previous hypothesis. It is the buttresses of the arch, all of which converge toward the body of the sphenoid bone as a centre, that feel, first and chiefly, the effects of transmitted force, and most "fractures by contre-coup" will be found to affect, not antagonistic portions of the cranium, but the supports of that portion of the vault which is injured.

VARIATIONS IN THE FORM OF THE SKULL.

An external view of the head may show variations in its form. These may be due either to age, sex, national characteristics, or mechanical causes.

The *skull of the infant* is large in its occipital region; while its frontal region is imperfectly developed; and the face is extremely small in comparison with the skull, being usually only one-eighth of the entire weight. The sutures are usually separated or imperfectly closed, and the fontanelles are apparent.

In *childhood,* the face increases in its relative size, reaching one-quarter to one-third the weight of the skull; and the frontal and parietal regions also develop rapidly, giving the head a more symmetrical appearance.

The *skull of the female* is characterized by the following peculiarities:

1. The bones are individually *smoother, lighter,* and *smaller.*
2. The *face* is smaller in proportion to the skull.
3. The *frontal sinuses* are smaller than in the male.
4. The *parietal region* is very large in comparison with the frontal and occipital regions.
5. The *jaws* are much narrower than in the male.

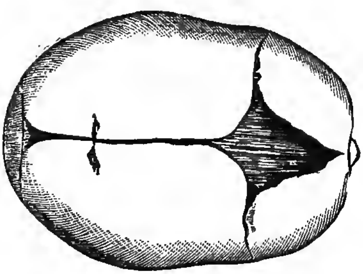

FIG. 12.

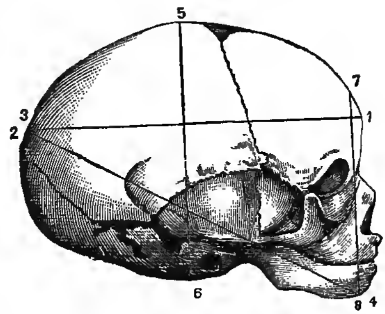

FIG. 13.

FIG. 12.—View of the head showing the fontanelles. (After Byford.)

FIG. 13 shows the longitudinal and vertical diameters of the fœtal head. 1, 2, Occipito-frontal; 3, 4, occipito-mental; 5, 6, trachelo-bregmatic; 7, 8, fronto-mental. (After Byford.)

Camper[1] first pointed out the variations in the *skulls of different races,* and showed the modifications which ensued as civilization advanced. The more important points to which he called attention were as follows:

1. The smallest skulls are found in the Hindoo and the ancient Peruvian races.
2. The largest skulls are found in the Caffre and Scandinavian races.
3. The skulls of all *rude tribes* are characterized chiefly by the following deviations from those of the civilized races:
   (*a*) Prominent temporal regions.
   (*b*) Extremely wide zygomatic arches.
   (*c*) " " anterior nares.
   (*d*) Extreme length and strength of the jaws.
   (*e*) " " of the incisor teeth.
   (*f*) Obliquity of the incisor teeth to each other when approximated (in contrast to the *right angle* found in civilized nations).
   (*g*) Prominence of the points of muscular attachments.

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[1] Anatomy and the Arts, London, 1821.

Among the deviations in form, dependent upon mechanical causes, may be enumerated:

1. Non-closure of the sutures (as in chronic hydrocephalus).
2. Imperfect ossification (as in rickets).
3. Excessive development.
4. Irregularities in shape, dependent upon a premature obliteration of the sutures (synostosis).
5. Acquired distortion, from compression, etc. (as in the flat-head Indian tribe).
6. New growths.

POISE OF THE HEAD AND THE DIAGNOSTIC VALUE OF DEVIATIONS FROM THE NORMAL ATTITUDE.

No part of the osseous system of man affords more striking evidence of his adaptation for the erect attitude than the cranium. The vertebral column forms a right angle with its base, and thus affords it a direct support. The condyles, or points of articulation, are situated very near to the centre of its base, by which arrangement little active muscular power is required to maintain it *in equilibrio*. In this respect the human cranium differs from that of other animals, in which the condyles are usually placed much further back, especially in those animals where the head is suspended by an elastic structure (the ligamentum nuchæ) at the extremity of a spinal column which lies horizontally.

The head, as has been observed, consists of two distinct portions, the *cranium* and the *face;* the one being intended to contain the brain—the organ of the mind—and the organ of hearing; the other to inclose the organs of sight, smell, and taste. The more the organs of smell and taste are developed, the greater is the size of the face and the greater its relative proportion to that of the cranium. On the contrary, the larger the brain, the greater must be the capacity of the skull, and the greater its proportion to the face.

On this principle, a large cranium and a small face indicate a large brain, with a restricted development of the sense of smell and taste; but a small cranium and a large face mark an opposite conformation. This point is of special value to the naturalist, insomuch as it affords him a means of relatively estimating the faculties, instincts, and capabilities of different individuals, as well as of different classes of animals.

Camper suggests a simple rule to estimate the proportion of the cranium to that of the face.

If a line be drawn upward *from the side of the chin* to the *most prominent part of the forehead,* it will form an angle with a horizontal line *drawn backward* over the *external auditory foramen* from the margin of the anterior nares; the *size of the angle* so formed will indicate the degree of development of the cranium and brain, as compared with that of the face and the organs of sense.

As examples of this, these lines are so nearly coincident in the crocodile as to form scarcely any appreciable angle; while, in the horse, it measures 23°; in the dog, 20° to 35°; in the orang-outang, 56° to 60°; and in the European adult, from 85° to 95°. Thus, we find man at the top of the scale of all of the animate beings, and distinguished from the rest as well as by his external conformation as by his physical and moral attributes and his internal organization.

The head is capable of direct movement only in one of three directions, viz., forward, backward, and a rotary movement. By means, however, of the cervical vertebræ, which have great mobility, the head may also be given a lateral inclination, and the forward and backward movement of the head may be thus greatly increased. The different attitudes assumed by the head have not only a physiological interest, but also a diagnostic value. By permitting a free and unrestricted use of the head, mankind is afforded a *scope of vision* equal to that of those animals, where the absence of such latitude of movement requires that the eye shall have such a prominence as to permit it to cover all points with distinct vision without motion of the head. Furthermore, were it not for this mobility of the head and neck, *hearing* would also be rendered far less acute in man than in those animals who are provided with larger and movable ears.

The physiological acts of *prehension* of food and its mastication, the *sucking* of liquids through a tube, the *swallowing* of food after mastication, and that part of *normal respiration* which is performed in the larynx and hyoid region, are all materially assisted by movements of the head.

Much of the *grace of movement* which characterizes some individuals depends upon the carriage of the head as well as that of the trunk and extremities. The idiot[1] may often be told by the motions of the head alone.

In *convulsions*, the head is usually *inclined to one side*, from the destruction of the proper balance between the antagonistic power of the corresponding muscles on the side opposite those then in active exercise. In *hemiplegia* the same effect is produced, since the loss of nerve power affects only the muscles of one side. In *dislocation* of the *cervical vertebræ*, although an infrequent accident, the head is usually inclined from the mesial line of the trunk; and in *glandular swellings*, and *large cicatrices* from burns of the lateral aspect of the neck, a mechanical impediment is often produced to an erect poise of the head, which may demand surgical relief.

The head is bent *forward* in some types of vertebral malformations: in case of large growths upon the neck or shoulders, in emphysema, in the cicatrices of burns affecting the anterior portion of the neck, and in

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[1] Connelly: Med. Times and Gazette, 1861–2.

many conditions of the spinal column, muscles, or vessels, which render the erect position painful.

In almost all diseases resulting in *extreme dyspnœa*,[1] such as croup, laryngismus stridulus, laryngeal obstruction from foreign bodies, new growths, or paralysis, growths in the neck, asthma, pneumo-thorax, heart lesions, etc., the head is, as a rule, thrown *backward* to afford an unobstructed channel for air through the mouth, nares, and pharynx. The same attitude will be also perceived in tetanus, cerebro-spinal meningitis, and brain affections of children.[2]

As in some cases of deformity, resulting from permanent contraction of the muscles which affect the attitude of the head, a knowledge of the muscles which are involved may prove of service, I append a list[3] of the muscles, which may assist in the various forms of distortion.

THE HEAD MAY BE MOVED.

Forward by	*Backward* by	*Laterally*, by
Rectus cap. ant. major.	Rectus cap. post. major.	Platysma.
" " " minor.	" " " minor.	Sterno-mastoid.
Sterno-mastoid.	Complexus.	Part of trapezius.
Platysma myoides.	Splenius capitis.	Splenius capitis.
	Obliquus cap. sup.	" colli.
Assisted (*when the lower jaw is fixed*) by	Trachelo-mastoid.	Trachelo-mastoid.
Mylo-hyoid.	Part of trapezius.	Complexus.
Genio-hyoid.		
Genio-hyo-glossus.		
Digastric.		

Certain muscles, which act alone upon the neck, may also assist in displacement of the head from its normal attitude, among which may be chiefly enumerated the longus colli, the scaleni muscles, the levator anguli scapulæ, the omo-hyoid, and some of the deep muscles of the back. The result of the contraction of any of the muscles enumerated must depend entirely upon the associate muscles in contraction, and upon the exciting cause; since, if either muscle acts in common with its fellow of the opposite side, the result will differ materially from that produced by the contraction of the same muscle or muscles acting without its fellow.

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[1] Niemeyer, Corfe, Chas. Bell, Lavater.

[2] Vogel: Diseases of Children. New York, 1870.

[3] Sharpey and Quain: Anatomy. Phila., 1849.

CHAPTER II.

THE HUMAN FACE; ITS MODIFICATIONS IN HEALTH AND DISEASE, AND ITS VALUE AS A GUIDE IN DIAGNOSIS.[1]

THE extent to which the anatomy of the head, as studied from the standpoint of physiognomy, may suggest points of practical value to the physician or surgeon, has not, in my opinion, received sufficient consideration in the popular text-books of the day. From the *British and Foreign Medical Review* of 1841, I quote the following sentence: "Medical physiognomy is, in many instances, a source of diagnosis which seldom fails the practitioner who is himself well versed in it; and we believe that much of the exquisite tact in discrimination of disease, which distinguishes some practitioners and which others can never attain, depends upon the vivid perception of an eye and ear habitually familiar with the lineaments, the tone, and the gestures of disease." Among the earlier authors, who were ignorant of many of the present methods of determining the condition, size, and position of organs, since the art of auscultation and percussion is a growth of later date, the study of the human countenance formed a very important part of the preparatory drill. The followers of Hippocrates and Galen were rendered perfect in their perceptive faculties. The former gave to us, in his masterly work, descriptions of the symptoms of disease which are still considered classic, while the latter, in his essays on the "Temperaments,"[2] is equally careful to note the most trivial alteration either of the face or posture.

There seems to be a growing tendency of late to regard the rational symptoms of disease as subordinate to the results of a physical examination, and of but little value in themselves, except as confirmatory evidence. Authors frequently render the description of the symptoms of disease so terse and indefinite, that but few of the readers of the later medical or surgical works could precisely picture to themselves the *appearance* of a sufferer from any of the maladies, with the pathology and physical symptoms of which they may be thoroughly familiar. It is not infrequently the experience of the most erudite of the profession to be amazed at the gift, which is possessed by some less scholarly brother, of making a diagnosis, which seldom errs, without the aid of the thermome-

[1] This article originally appeared in the N. Y. Med. Journal, and I am indebted to Messrs. Appleton for the use of the cuts then made to illustrate it.

[2] Kuhn's edition.

ter or the stethoscope; and many an old nurse, long accustomed to spend weary nights in watching the sick, can often render a prognosis which seems little short of inspiration when her utter ignorance of all medical knowledge is considered.

Despite the fact that some of our best authors have denounced the attempts of DeSalle, Jadelot, and Seibert to establish certain facial lines and wrinkles as of positive value in diagnosis, and have pronounced all such statements as a mere fantasy, still no one of large experience can deny that the face may at times afford most positive and valuable information.

In 1806, Lavater[1] published his work upon this subject, in which he discusses at great length the diagnostic value of general physiognomy. Subsequently, Sir Charles Bell wrote upon the subject from a purely anatomical point of view, and, in 1824, published his "Essays upon Expression." Baumgaertner[2] added his contribution to the subject in 1839, and Laycock,[3] in 1862, published his course of lectures, with illustrations, which were designed to show the various types of diathesis, and their bearing upon the general development. Corfe, in 1867, published a series of contributions in the *Medical Times and Gazette*, in which the subject was studied from a clinical point of view, and not only the entire field of facial expression, but also that of general physiognomy, was pointed out to the student, so far as the cases under consideration illustrated any points of special interest. Fothergill,[4] Southey (*Lancet*, 1878), S. Wilks[5] and Jonathan Hutchinson, have also been earnest workers in the same field.

Darwin's great work upon the expression of the emotions in animals, and the contributions of Connelly[6] upon the typical shades of expression peculiar to the insane, may well be read by those who question the utility of this much neglected department of science. The careful study of the expressions of the face, and the modifications which age produces in it, is at least very advantageous in furnishing a normal standard by which deviations in disease may be studied. I quote from the most excellent treatise of Blandin[7] the following sentence: "Those who neglect or seek to ridicule this mode of investigation, prove only one thing, that they study pathology without a proper knowledge of anatomy and physiology, upon which the former is founded. The morbid expressions of the face are an extremely useful, and often the only guide of

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[1] L'Art de connaître les Hommes par Physiognomie. Paris, 1806–'7.

[2] Atlas, 1839.

[3] Med. Times and Gazette, 1862, Vol. i.

[4] Principles of Therapeutics, 1880.

[5] Essays on the Temperaments.

[6] Med. Times and Gazette, 1862.

[7] Anatomie Topographique, 1834.

the medical practitioner, in the case of a very young child that can tell nothing in regard to its sufferings."

It is with a view to systematize and arrange the collected investigations of the authors previously named, and to bring within the compass of a single article such practical information as the anatomy of the face may afford the practitioner, that I am led to draw professional attention to this subject once more.

"The physiognomy of the sick presents innumerable shades of expression. It may assume the various conditions expressive of sadness, dejection, attentiveness, indifference, uneasiness, or terror; it may, at times, be smiling; occasionally menacing or wandering; and sometimes show a series of changes in rapid succession." [1]

FIG. 14.—The Transverse Rugæ.

These various conditions of the countenance may not only be the direct result of the influence of the ever-varying passions upon the muscles of the face, as is the case in health, but they may also be classed as morbid phenomena, each of which possesses some special significance. Chomel [2] lays great stress upon these variations of countenance, and endeavors to point out the special diagnostic value of each.

FACIAL LINES AND WRINKLES.—The theories of De Salle, Jadelot, and Seibert [3] as to the diagnostic value of facial lines and wrinkles have had their share of support from time to time; while they have also been considered by some authors as speculative and destitute of any value. The existence of these marks may be attributable to one of two conditions, viz., a disappearance of the fat from the subcutaneous tissues of the face, or the abnormal contraction of certain facial muscles, dependent

[1] Williams: Principles of Medicine. Philadelphia, 1844.

[2] Leçons de clinique méd. Paris, 1834. [3] Williams, op. cit.

upon some apparent irritation of the motor nerves supplying the affected muscles. It is important, in using these lines and wrinkles as guides in diagnosis, that the discrimination be made between those lines which are natural to the face of the sufferer and those which are developed as a result of the disease. For the reason that the face of the adult is always more or less marked by lines,[1] it must be evident that these lines are a more reliable guide in the infant than in later life, if their diagnostic value remains unquestioned. Without entering into a discussion as to the merits of the question, I give the theories advanced, for whatever interest and value they may possess to the reader. The wrinkles of the face may be classified into six groups, as follows:

(1.) *The Transverse Rugæ.*—These are situated upon the forehead, and are formed by the action of the occipito-frontalis muscle. They are thought to be expressive of an extreme amount of pain, arising from causes outside of the cavities of the body.

FIG. 15.—The Oculo-frontal Rugæ.

(2.) *The Oculo-frontal Rugæ.*—These extend vertically from the forehead to the root of the nose, and are formed by the corrugator supercilii muscles. They are thought to express distress, anxiety, anguish, and *excessive pain from some internal cause.* It is said that they furthermore indicate an imperfect or false crisis; and that, in attacks of acute diseases, an impending efflorescence and sometimes a fatal termination may be indicated by their occurrence. In those types of headache where the pain is very excessive, these rugæ may exist simultaneously with the ones previously described. It is stated that, when the former rugæ meet the latter abruptly, during the course of an acute disease, some serious lesion of the brain, or its coverings, is developing.

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[1] Blandin, op. cit.

(3.) *The Linea Oculo-zygomatica.*—This line (the line of Jadelot) extends from the inner angle of the eye downward and outward, passing across the face below the malar bone. It is said to indicate, in children, a *cerebral* or *nervous affection;*[1] and, in adult life, some disease of the genital organs, masturbation or venereal excess.

(4.) *The Linea Nasalis* (Line of De Salle).—This line extends from the upper border of the ala nasi downward, in a direction more or less curved, to the outer edge of the orbicularis muscle. This line is said to be strongly marked in phthisis and in atrophy. Its upper half (the linea nasalis proper) is thought to be a reliable indication of *intestinal disease,* if extensively developed and prominent; the lower half (the linea buc-

FIG. 16.—The Line of Jadelot.

calis) is supposed to indicate the existence of some *disease affecting the stomach.* It is claimed by Peiper that, when this line appears conjointly with the line of Jadelot, it may be regarded as a positive indication of worms in children, if a peculiar fixed condition of the eye exist and a pallor of the face be present.

(5.) *The Linea Labialis.*—This line extends downward from the

[1] Vogel: On Diseases of Children. New York.

angle of the mouth till it becomes lost in the lower portion of the face. It is usually developed in connection with those *diseases which render breathing laborious* or *painful,* and is more common in children than in the adult as a sign of diagnostic value.

(6.) *The Linea Collateralis Nasi.*—This line extends from the nose downward to the chin, in a semicircular direction. It lies outside the linea buccalis, the linea nasalis, and the linea labialis. It is thought to be a reliable guide to diseases of the *thoracic* and *abdominal viscera.*[1]

COLOR OF THE FACE.—The color of the face is subject to variations which, to the eye of the medical adviser, afford unquestioned aid in

FIG. 17.—The Line of De Salle.

diagnosis. *Flushing* of the face, as evidenced by a diffused redness which is of a transient character, is very common in women suffering from irregularity of the menstrual period and during the menopause. In plethora, especially after exertion or excitement, an unnatural redness of the face may occur, associated with symptoms indicative of cerebral hyperæmia. Pressure of tumors, either of the neck or thorax, upon the sympathetic nerve may create an abnormal dilatation of the capillaries, thus resulting in a redness of the skin, with an increase of temperature of the affected region; while section of the sympathetic nerve, although a rare form of accident, would result in a like condition.[2] *Red patches* occur on the cheek during an attack of croupous pneumonia. In wast-

[1] Corfe, Med. Times and Gaz., 1867.

[2] M. Foster: Text-book of Physiology. London, 1878.

ing affections of a chronic character, especially of the lungs, such as phthisis, cancer, etc., a circumscribed redness over the malar bones, known as the "hectic flush," is usually present. It may occasionally affect only one cheek,[1] where only one lung is diseased. *Pallor* of the face is the rule during convalescence from any severe disease, and in patients long deprived of sunlight.[2] A *waxy pallor* exists in chronic Bright's disease, which renders the skin almost transparent. In the chill of fevers and malarial attacks, a *dusky paleness* is usually perceived;

FIG. 18.—The Linea Collateralis Nasi.

while in cases of hemorrhage, where the loss of blood has been sufficient to produce constitutional effects, the pallor of the face assumes a peculiar *leaden color.*[3] A *greenish tint* is present in profound attacks of anæmia and during chlorosis,[4] giving to the face an appearance similar to that of imperfectly bleached wax.

Malaria and cancer are often manifested by a *light straw color* of

[1] Stillé: General Pathology. Philadelphia, 1848.
[2] Williams, op. cit.
[3] Sir Charles Bell: Treatise on Surgery. London, 1826.
[4] Niemeyer: Text-book of Practical Medicine. New York, 1881.

the face, although it may occasionally result in the deep yellow of jaundice.[1] In the early stages of jaundice, the sclerotic coat of the eye and the corners of the mouth first show the *yellow color*, although the discoloration soon tends to become diffused over the entire face. A *blue tinge* exists in those cases where the venous return to the right heart is obstructed, or where, from any cause, the oxygenation of the blood is imperfectly performed. It occurs, therefore, in cyanosis, asphyxia, the fevers, certain diseases of the pulmonary organs which interfere with the circulation, and in diseases of the heart which render its action weak or imperfect. In cases of poisoning from nitrate of silver, the skin assumes a still deeper blue tint than in those cases above mentioned, and the staining is permanent. In Addison's disease of the supra-renal capsules, a *dark-brown color* of the skin results, which may be either uniform or in isolated spots, and, in severe cases, almost rival the pigmentation of the negro. The redness of erysipelas is usually accompanied by an œdema which renders the face intense and shining, and often causes a markedly altered expression of the countenance.

The face is the seat of many of the eruptions, some of which are confined almost exclusively to it, while others are usually found in that region before they appear elsewhere. It would exceed the limits of this chapter to enter into the description of the characters which stamp each of the various eruptions, since they can be easily learned by reference to any of the special treatises.

Corfe suggests as a guide to the student in physiognomy the following table, which designates the prevailing changes in the complexion of the face in the course of the more common disorders. While it is not possible to construct any table which shall give all the information desired upon so important a subject, still this one may prove of some value as a means of aiding the memory:

In cerebral disease	the countenance	is	lethargic.
In emphysema	"	"	livid.
In pulmonary œdema	"	"	dusky and distressed.
In pneumonia	"	"	dusky and flushed.
In pleurisy	"	"	pale and anxious.
In phthisis	"	"	pale and thin.
In malignant disease	"	"	sallow and thin.
In icterus	"	"	yellow and thin.
In renal disease	"	"	thin, puffy, and anæmic.
In peritonitis	"	"	anxious and dragged.
In uterine disease	"	"	sallow and haggard.

Marshall Hall[2] thus describes a countenance which he considers typical of the acute form of dyspepsia: "This affection is accompanied by some paleness or sallowness, and a dark hue about the eye. The lips are

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[1] Reynolds: System of Medicine. London, 1871.
[2] On Diagnosis. London, 1817.

slightly pale and livid. The cutaneous vessels exude a little oily perspiration, and the muscles of the face, and especially of the chin and lips, are affected with a degree of tremor, particularly on any hurry or surprise, or on speaking."

The hue of the skin may be deepened, resembling that of plethora, in the condition of atheroma, associated with a gouty heart.

The condition of cyanosis, if met with in babies, indicates a congenital malformation of the heart or some imperfection in its development. It is, therefore, a most serious symptom.

A purplish color of the face, when associated with rapid respiration and other symptoms of phthisis, suggests a bad prognosis, as it indicates extensive disease.

When, in young subjects, the face appears vascular, and the features "blurred as to their outlines," especially if the lips and alæ of the nose appear full and prominent, mitral disease may be reasonably suspected. In adults, a similar condition is met with among women at the menopause, and it is to be explained as the result of a semi-paralysis of the vaso-motor nerves associated with low arterial tension.[1]

An unnatural smoothness of the skin of the face of adults in middle life, if a marked pallor co-exists, may often be a guide to the detection of chronic Bright's disease. The skin is usually dry, and perspiration is excited with difficulty.

Phthisis often produces a pallor with a peculiar greasy, unctuous skin; the same may be also met with in aortic disease.

The dry, anæmic, and "parchment-like" skin tightly drawn over the face, and showing a tortuous and visibly pulsating temporal vessel, if seen in the old, usually indicates changes in the viscera; but, when met with in young men, syphilis may be strongly suspected to exist.

THE FOREHEAD.—Fothergill[1] thus clearly puts the clinical aspects of this region: "The forehead is important. When well vaulted it forms a part of the nervous diathesis. When broad and rather low, it usually goes with a stalwart frame and a bulky body. The lofty brow is usually accompanied by a thin flank and a 'weasel-belly'—indeed, with small digestive viscera, and a liability to indigestion; the broad, low brow goes usually with a square abdomen, large digestive organs, and good assimilation—with gout looming in the distance, or even actually present. It may be protuberant from excessive ossification of the centres of the frontal bones, and this is apt to be found with defective development of the rest of the bones, and wide fontanelles, as seen in hydrocephalic infants. It is also seen in the rachitic forehead. 'The head of the child in rickets is generally unusally large, the vertex flattened, and the forehead prominent, broad, and square, with considerable expansion at the centres of the parietal bones.' Sometimes the sutures remain open; at other times they

[1] Semeiology. New York, 1881.

are closed prematurely, and then the growth of the cranium is arrested, and the child remains a child in intellect, or is a cretin or an idiot. Imbecility, however, is not always accompanied by a small cranium. In strumous children with a syphilitic taint, the forehead may become protuberant and project in front of the face. Here the arrested development of the facial bones intensifies the deformity. In some cases, the forehead carries with it a moral significance. There is the broad, eburnated forehead, the forehead Jeremiah recognized when he said, 'Thou hadst a whore's forehead, thou refusedest to be ashamed.' The woman with this forehead will deny pregnancy with the most unblushing effrontery; and is utterly untruthful when anything connected with morals is involved. Then the forehead may manifest one single copper-colored spot, pathognomonic of syphilis. Ulceration of the forehead is always syphilitic, except when the result of a wound. The scars are equally significant and suggestive."

FIG. 19.—Acquired deformity of the nose and mouth.

THE NOSE.—The nostrils are of some practical interest from a medical point of view. They *dilate* forcibly and rapidly in difficult respiration, when produced by disease;[1] and *itching* of the nostril is regarded by many authors as a valuable diagnostic sign of intestinal worms.[2] The nose seldom points directly forward, being, as a rule, slightly inclined toward the right side. This fact is explained by Béclard as the result of the habit of wiping the nose with the right hand, since, in left-handed

[1] Sir Charles Bell: Essays on Expression. London, 1824.

[2] Peiper, op. cit.

people, the opposite deflection exists. The nose of a face perfect in its outline should be one-third of the length of the distance from the root of the hair to the chin; but, in certain races, the variation from this rule affords a special physiognomy. The integument which covers the nose is very firmly attached to the muscles underneath it by a cellulo-fatty layer. Blandin[1] lays great stress upon this fact as explaining the infrequency of œdema of this region, and as an effort on the part of Nature to preserve the uniformity of contour of the nose, which would be seriously impaired by any local swelling of the face, were the skin over the nose loosely attached. The nose is extremely vascular; hence the custom of surgeons to replace severed portions of the organ, even if completely detached, with a hope of obtaining union. Among the ancients, amputation of the nose was practised upon the criminal classes, and the operation of rhinoplasty was first suggested as a means of relief for those so disfigured.

The redness of the nose after an attack of crying indicates a connection between the sympathetic supply of the capillary vessels of the nose and that of the capillaries of the lachrymal apparatus; hence any form of irritation of either of these localities is liable to be accompanied by symptoms referable to the other.[2] Injury to the nose, resulting in fracture, often leaves a permanent facial deformity, and, even when no evidences of serious injury can be ascertained by external examination, cerebral symptoms are liable to follow, as fracture of the base of the skull may result, from a transmission of the force through the perpendicular plate of the ethmoid bone.[3] Vascular tumors of the region of the nose are not uncommon, while a prominence of the capillary vessels of the nose is met with in the aged as the result of a defect in the contractile power of their coats.[4]

Marked elevation of the nostril is regarded by some authorities[5] as an indicator of pain within the cavity of the thorax.

In pyæmia, there is either a singular absence of all expression, or a countenance which exhibits a stupid indifference to all surroundings.

When a sunken bridge to the nose exists, there is suggested at once a strong probability of inherited syphilis; and this is still further confirmed if the patient has had the "snuffles" in infancy.

Over-indulgence in alcohol gives to the tip of the nose a redness and a tendency to small tuberosities upon that region; while chronic indigestion or constipation, especially if associated with disease of the pelvic viscera, may produce a similar result in women.

THE EYE.—"It may appear to many a superfluous task to attempt to judge of the character of an individual by a glance at his face, but, whatever may be thought of the possibility of laying down strict rules for such

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[1] Op. cit. [2] Blandin, op. cit.
[3] Holden: Human Osteology. London, 1855.
[4] Béclard, op. cit. [5] Marshall Hall, op. cit.

judgment, it is a fact of every-day occurrence that we are, almost without reflection on our part, impressed favorably or unfavorably with the temper

FIG. 20.—Deformity from a burn.

and talents of others by the expression of their countenance. The face acquires its expression also from bodily habits, injuries, and from

FIG. 21.—Deformity of the eyes from a burn.

intellectual or sensual pursuits, so that we may pass from the lofty and expanded forehead, with the small, well-formed mouth, of the philosopher, down to the shallow front and protruded muzzle of the negro, whose habits are more bestial than those of the animals he chases for the support of his life."[1]

The intimate communications between the second, the fifth, the seventh, and the sympathetic nerves, through the media of the ciliary, otic, and Meckel's ganglia, would lead us to expect that the eye should exhibit, in its altered appearance, the derangement of internal structures. "When a glance of this organ is caught, what a field of mute expression is open to the mind! This silent and instructive index of the whole man may be bright or dull, heavy or clear, half shut or unnaturally open, sunken or protruded, fixed or oscillating, straight or distorted, staring or

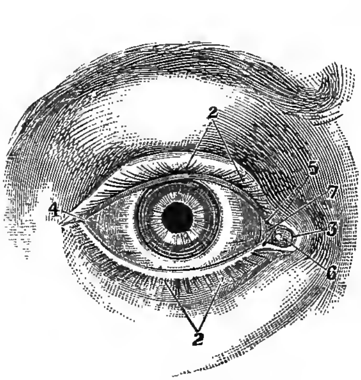

Fig. 22.

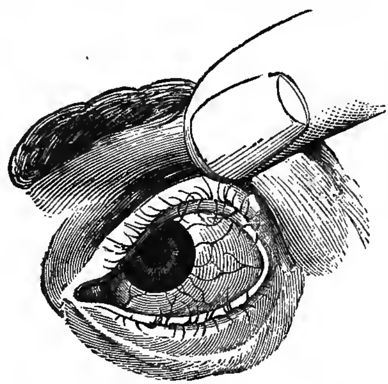

Fig. 23.

Fig. 22.—The external appearance of the normal eye and eyelids; 2, 2, cilia or eyelashes; 3, inner canthus; 4, outer canthus; 5, puncta lachrymalia; 6, caruncula lachrymalis; 7, semilunar fold.

Fig. 23.—Showing the appearance of the blood-vessels in conjunctivitis.

twinkling, fiery or lethargic, anxious or distressed; again, it may be watery or dry, of a pale blue, or its white turned to yellow."[1]

I quote the following suggestions from Fothergill's late pamphlet on Semeiology: "The cornea may be affected, and is chronically inflamed by syphilis about puberty, and until about seventeen. Under proper treatment it may clear up; but if neglected, permanent opacity may result. At the union of the cornea and the sclerotic a ring is sometimes seen; this is the *arcus senilis.* It indicates advancing age, as its name implies; but it is necessary to have clear ideas on the subject, else error may arise. There are two forms of arcus: one very suggestive and of evil omen; the other without any significance. The latter being the more pronounced of the two, careless observers have often been misled. To take the innocent form first may be well. It is very distinct, with sharply-defined outlines and a clear cornea. It is calcareous in its nature, and is very common in hale old people; especially persons with light-blue eyes. It

[1] Corfe, op. cit.

corresponds to the bony plates found in birds at the point of attachment of the cornea to the sclerotic. It has no significance; but the other form tells of tissue-decay. This arcus has badly defined edges; while the cornea is hazy and cloudy from fat-granules being scattered throughout it. It is more pronounced under the eyelids, where the arcus is often to be seen very distinctly, when scarcely recognizable in that portion which is exposed to light. It is often well, then, to lift the upper eyelid when in doubt; as when the question arises as to whether or not there be fatty degeneration in the fibres of the heart. Arcus is a bow: annulus a ring. It is arcus senilis, not annulus senilis. Then as to the pupils. Sometimes the iris is the seat of inflammation; and the formation of a tubercle at the inner or free edge of the iris is common in syphilis. Then the pupils may be of unequal size. Contraction of one pupil is often found in aneurism of the aorta. When the pupils are both contracted, and severely contracted, then the suspicion of opium poisoning is aroused, or indulgence in cough-lozenges containing opium."

The pupils may be contracted or widely dilated, insensible to or

FIG. 24.—Countenance of mania.

FIG. 25.—Countenance of chronic mania.

intolerant of light, oscillating or otherwise, unequal in size, or changed from their natural clearness of outline. "The noble arch of the brow speaks its varied language in every face of suffering humanity. It may be overhanging or corrugated, raised or depressed; while the lid of the eye, an important part of this vault, exhibits alternations of puffiness or hollowness, of smoothness or unevenness, of darkness or paleness, of sallowness or brown discoloration, of white or purple. Lines intersect this region, and the varied tints are perpetually giving new color, new feature, new expression, by their shadows."[1] If the frontal muscle acts in connection with the corrugator supercilii, an acute deflection upward is given to the inner part of the eyebrow, very different from the general action of the muscle, and decidedly expressive of debilitating pain, or of discontent, according to the prevailing cast of the rest of the countenance.

[1] Corfe, op. cit.

An irregularity of the pupils of the two eyes indicates, as a rule, pressure upon nerve-centres or upon the motor oculi nerve. In adynamic fevers, the eyes are heavy and extremely sluggish, and are, as a rule, partially covered by the drooping eyelid; while in certain forms of mania they are seldom motionless.[1] This latter peculiarity is also often noticed in idiocy.

The inner surface of the eyelid is a valuable guide to detect the presence of anæmia, since it shows a pallor which is in marked contrast to the redness of health.

FIG. 26.—"Bell's Paralysis." (Modified from Corfe.)

The eye is apt to be vascular after an excessive indulgence in alcohol. In Bright's disease, a small collection of fluid may often be detected beneath the conjunctiva, which might be mistaken for a tear; it can be moved, however, while a tear cannot be without causing its disappearance.

[1] Connelly, Med. Times and Gaz., 1861–'2.

A squint of the eye is a most significant clinical point in hydrocephalus of infants. It may, at first, be slight, but it tends to become persistent as the disease advances. Internal squint often indicates the presence of a congenital or acquired hyperopia.

In the so-called "Bell's paralysis," due to failure of the facial nerve, the eyelids stand wide open and cannot be voluntarily closed, since the orbicularis palpebrarum muscle is paralyzed. This condition may be further recognized, if unilateral, by a smoothness of the affected side, since the antagonistic muscles tend to draw the face toward the side opposite to the one in which the muscular movement is impaired; an inability to place the mouth in the position of whistling, since for this act the two sides of the face must act in unison; loss of control of saliva, which dribbles from the corner of the mouth; and a tendency to accumulation of food in the cheek, since the buccinator muscle no longer acts.

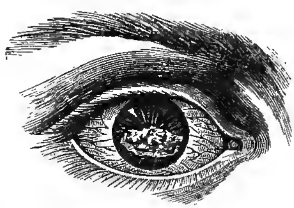

Fig. 27.

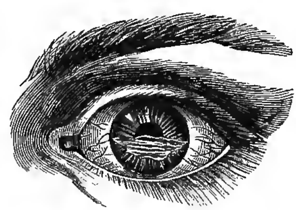

Fig. 28.

Fig. 27.—Appearance of kerato iritis with adhesions.
Fig. 28.—Appearance of keratitis, the opacity partially occluding the pupil.

When the third pair of nerves are affected upon either side, the upper eyelid cannot be voluntarily raised, for the levator palpebræ muscle fails to act; and the eye is caused to diverge outward, since the external rectus muscle, not being supplied by the third pair, and having no counterbalancing muscle, draws the eye from its line of parallelism with its fellow. In photophobia, attempts to open the eye create resistance on the part of the patient, since the entrance of light causes pain; while, as death approaches, or in the state of coma (save in a few exceptions), the eyes are usually open. In cardiac hypertrophy, an unusual brilliancy of the eye is perceived,[1] since the arterial system is overfilled from the additional power of the heart. A peculiar glistening stare exists during the course of scarlet fever, which is in marked contrast with the liquid, tender, and watery eye of measles.[2] Many diseases of the eye itself tend to greatly alter the normal expression of the face. Prominently among these may be mentioned cataract, glaucoma, cancer, staphyloma, exoph-

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[1] Loomis: Lectures on Diseases of the Respiratory Organs, Heart, and Kidneys. New York, 1874.

[2] J. Dugan, quoted by Haviland Hall: Differential Diagnosis. Philadelphia, 1879.

thalmus, iritis, conjunctivitis, amaurosis, episcleritis, pterygium, strabismus, etc., but the special peculiarities of each need not be here described.

Abnormalities of the pupils may afford the practitioner material aid in diagnosis. The pupils are found to be dilated during attacks of dyspnœa and after excessive muscular exertion,[1] in the latter stages of anæsthesia, and in cases of poisoning from belladonna and other drugs of similar action. A contracted state of the pupils exists during alcoholic excitement, in the early stages of anæsthesia from chloroform, and in poisoning by morphia and other preparations of opium, physostigmin, chloral, and some other drugs. Paralysis of the third cranial nerve creates a dilated condition of the pupil of the same side, since that nerve controls the circular fibres of the iris. Spinal sclerosis often produces a failure on the part of the pupil to *respond to light,* but it still contracts when accommodation of vision for near objects is demanded.

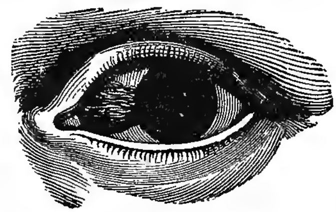

Fig. 29.—Pterygium.

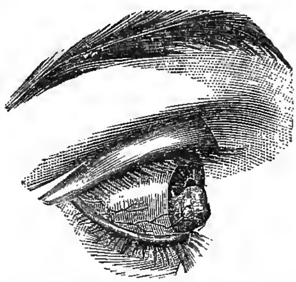

Fig. 30.—Partial staphyloma of the cornea.

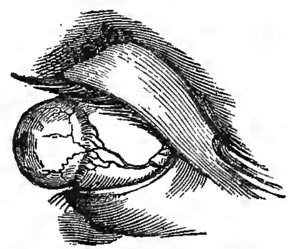

Fig. 31.—Total staphyloma of cornea.

Growths within the deeper portions of the orbit tend to create a displacement of the eye forward, and thus to cause an apparent increase of that organ in size. A similar condition may also result from abscesses or the growth of tumors within the cavity of the antrum. In the so-called Basedow's disease,[2] an abnormal prominence of the eyes accompanies a simultaneous enlargement of the thyroid gland.

The eyelashes, if abnormal, not only in themselves create deformity, but also, by causing irritation of the conjunctiva, produce an alteration in the normal expression of the eye.

The Ears.—"The ear is often instructive. It may contain otolites, pathognomonic of gout. Or as Professor Laycock insisted, the lobe may be red, full, and glistening, as if the stretched skin was about to crack.

[1] M. Foster: Text-Book of Physiology, third edition. London, 1879.

[2] F. von Niemeyer: Text-Book of Practical Medicine. Translated by Hackley and Humphrey. New York, 1869.

This is common in gouty persons in middle age. As nutrition fails, the lobe may become wrinkled. It goes with the skin of the face to a great extent. A wrinkled ear-lobe with a face seamed with wrinkles usually goes with extensive but very chronic visceral cirrhosis. Here the skin is very dry and imperspirable. Then the ear may be deformed by othæmatoma, most commonly seen in the general paralysis of the insane. A discharge from the ear should always claim careful attention; chronic otorrhœa not rarely ends in meningeal inflammation and death."[1]

THE CHEEK.—The cheek is capable of a great variety of movement. During the reception of liquid or solid food into the mouth, it is of the greatest assistance, since by its movements the two acts are greatly facilitated; during mastication, the buccinator muscle helps to force the food between the jaws, which are brought into apposition and rubbed together; and, finally, the cheek can act as an important factor in producing that peculiar type of countenance which is so strongly indicative of the desire of taking nourishment. The respiratory motions of the cheek are manifested in the acts of gaping and blowing, and in the exhibition of intense passion, in which the malar region is markedly in sympathy with a general excitation of the whole respiratory apparatus.

"The cheek may become the mirror of the soul. When the feelings are gay, it is drawn outward and upward; but, when the mind is depressed or saddened, it is drawn obliquely downward. If these movements be carefully noted, it will be perceived that the movable point of the cheek is situated in the immediate vicinity of the naso-labial groove." This is due to the fact that the attachments of several of the small facial muscles at about this point tend to draw the anterior part of the cheek outward from the line of this groove. It may be noticed, as a matter of interest, that, when the mental impressions are slight and trivial, no traces of their effect upon the face are left upon the cheek; but, when they are of a serious or prolonged character, deep and permanent grooves are formed, which are of interest to the physiognomist as an indication of the temperament, and to the medical adviser as often of positive value in diagnosis. "In the young child, the cheek, which is at nearly the same instant alternately moistened with a tear or decked with a smile, preserves in the healthy state the roundness which marks that happy age; but in the adult, the cheek, on the contrary, presents numerous lines and wrinkles, and this appearance becomes still more apparent as old age approaches."[2] There are, however, lines in the cheek of the aged which should not be mistaken for evidences either of the temperament or of disease, since they are produced simply by the approximation of the jaws. Lavater,[3] in his work upon physiognomy, locates most of the sentiment

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[1] Fothergill: Semeiology. New York, 1881.

[2] Blandin, op. cit. [3] Op. cit., Hunter's edition.

of the face in the cheek, and draws comparisons between the base and jealous face and that which is generous and noble, as a support to his theory.

"The color of the cheek varies much, both as a direct result of the passions and from special diseased conditions, which have been mentioned previously in this article. In fear and envy, the cheek is usually pale and colorless, while in love, embarrassment, or anger it is often uncommonly red. To the physiologist, these changes are a beautiful exhibition of the sympathy which exists between the mind and the circulatory and respiratory systems, which are seldom influenced except simultaneously. The changes in the cheek which affect expression, like the respiratory motions, depend chiefly upon the influence of the facial nerve; and thus

FIG. 32.—Deformity of the cheek, nose, and lips, from a burn.

FIG. 33 —Hare-lip complicated by a fissure of the hard palate. (After Buck.)

it is that children and females, in whom the nervous system is is generally more susceptible to impressions, also present, to the greatest degree, more or less transient modifications of the cheek. The cheek suffers a diminution in its fat as age advances, and when the teeth have been lost the approximation of the jaws forces the redundant cheek outward; and its flaccidity, from the loss of fatty tissue, throws it into folds, which are not present in the face of the infant."[1]

The cheek approaches a triangular form in the infant, but it becomes quadrilateral when the teeth are developed; and in the old man, as the teeth are lost, it again returns to the triangular form as in infancy. The fact

[1] Blandin, op. cit.

that the maxillary sinus is very imperfectly developed in the child, and gradually increases as age advances, explains to a great extent why the triangular form tends to become quadrilateral; and the frequency of abnormal protrusions of this region is explained by growths or the accumulation of fluid within this cavity. The changes in the cheek produced by advancing years are also illustrated in its color. "In the child, the bright rose tint, which accompanies exertion and frequently the hours of sleep, bespeaks health and general activity; but in adult age this coloring tends to disappear, and in old age the cheek often assumes a striated redness, which is due to an abnormal dilatation of the capillary vessels, especially the veins."[1] The vascularity of the cheek renders the occurrence of erectile tumors common in this region; and the elasticity of the tissues affords

FIG. 34.—Ulcerated epithelioma of the lower lip. (After Hamilton.)

an anatomical explanation of the little disfigurement which follows the removal of large portions of the cheek, in case surgical interference is demanded from any cause.

THE LIPS.—Certain deformities of the face are common in the region of the lips and mouth. Among these may be mentioned the condition of deficient closure, which is the normal condition of the hare, and to which the term "hare lip" is applied. This deformity may be as associated with that of fissure of the hard palate, and often with imperfect development of the soft palate; and thus not only is the countenance impaired, but the power of sucking, natural to the infant, destroyed, and the articulation of words subsequently rendered imperfect. The vascularity of

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[1] Blandin, op. cit.

the lips renders the development of erectile tumors of this region not infrequent; while hypertrophy of the tissues forming the lips may occur as one of the types of facial deformity.

The lips of the young child are very much longer in proportion to the face than those of the adult, and their increased length renders the act of sucking easier to the infant than if the teeth were present, since the lips can be made almost to cross each other and thus closely embrace the nipple. When the teeth are formed, the excessive length of the lips diminishes and the expression of the face is thus greatly altered; while, in the old man, as the teeth are lost, the lips again become very long, which accounts for their projection forward when the mouth is closed, and which gives to the face of those advanced in years the peculiar pouting expression so often seen.[1] The excessive length of the lips in the aged further-

Fig. 35.—Fibro-cystic tumor of the frontal and orbital regions.

Fig. 36.—Warty tumor of the eyelid.

more acts as a hindrance to mastication, and often renders the articulation of words extremely indistinct.

In sickness, if the angle of the mouth be depressed, pain and languor may be read; and, when the corrugator supercilii muscle coöperates with the depressor muscles of the mouth, acute suffering is proclaimed.[2]

Extreme pallor of the lips is observed in excessive hemorrhage, in purpura, in chlorosis, etc.; deep lividity denotes a defective oxygenation of the blood, and occurs chiefly in diseases of the lungs, heart, and larynx; while pale lividity occurs in cases where the circulation of the surface is languid or imperfect.[3] In painful affections of the abdominal organs, the upper lip is usually raised and stretched over the gums or teeth, so as to give a diagnostic expression to the countenance, which is con-

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[1] Blandin, op. cit. [2] Corfe. [3] Marshall Hall, op. cit.

sidered by some as of great value. In anasarca of the face, the lips, eyes, and cheeks are most affected, since the subcutaneous cellular tissue in these regions admits of distention more readily than in those regions where it is not so loose.

Deformities of the Face.—Among the extraordinary deformities of the orbital region, may be casually mentioned those rare cases of absence of the eyes, and the union of the two orbits, as reported by Tenon and Bartholine. The eyelids may also be found deficient or united at birth; and occasionally turned in or out, when the skin and the conjunctiva are

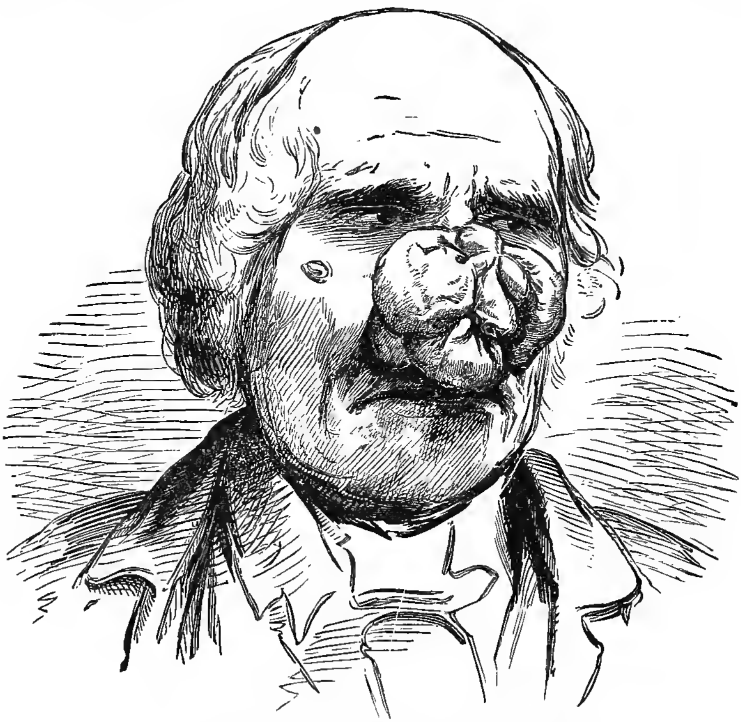

Fig. 37.—Lipoma of the nose. (After Hamilton.)

of unequal length. The last type of deformity is most frequently the result of cicatrization of the tissues of the face, following an injury; while adhesions of the eyelids to the globe of the eye may be either a congenital defect or the result of inflammatory processes. The pupils may be absent at birth, or may be partially incomplete;[1] while deformities of this aperture may also be acquired as the result of adhesions between the iris and the cornea or the crystalline lens, or as the result of an operation in which portions of the iris are excised for the relief of glaucoma.

The entire absence of the face at the time of birth has been recorded

[1] Blandin, op. cit.

by Lecart, Curtius, and Béclard; while in numerous instances the median portions of the face have been absent, or the existence of deep central fissures in the face has been detected. Cases are on record where all evidences of the existence of the nostrils are absent, termed "anarina;" those where the mouth has been found absent, termed "astomia;" and those where a double nose has existed, as recorded by Béclard. In these abnormalities, as in those where the cranium has been partially or totally wanting, an arrest of the process of development at an early stage of fœtal life must have occurred, the date of which in pregnancy may be roughly estimated by the extent and situation of the deformity. In cases of senile atrophy of the forehead, the bones are sometimes completely absorbed, and hernia of the encephalon may thus be spontaneously produced.

FIG. 38.—Erectile tumor of the lips. (After Hamilton.)

FIG. 39.—Congenital hypertrophy of the tongue. (After Buck.)

Tumors of the face always create a deformity, which is confined to the anatomical region affected; some of which have already been referred to in this article in the treatment of certain of the special features. Many conditions of the face, which may properly be spoken of as deformities, are dependent upon disease. Some of those which affect the eye and its appendages, and others which are due to injury of nerves or to disease of nerve centres, will be described later on, among the special types of physiognomy which are of interest in their bearing upon general diagnosis. Severe types of ulceration, as it occurs in lupus and carcinoma, often create so extensive a destruction of tissue as to give rise to hideous deformities, but they have no special bearing upon the diagnosis of the existing disease.

SPECIAL TYPES OF FACE.—Many of the specific forms of disease have their special physiognomy. As examples of this fact, "scrofulous children inherit either a velvety skin, dark-brown complexion, dark hair, dark brilliant eyes, and long lashes, with the lineaments of a face finely drawn and expressive; or a fair complexion, thick and swollen nose, broad chin, teeth irregular and developed late, inflammation of the Meibomian glands, scrofulous ophthalmia, eruptions of the head, nose, and lips, and enlarged cervical glands." [1]

The facial expression of idiots and imbeciles is described by Dr. Langdon Down at length. The following quotation [2] is an abbreviation of his investigations: "Their eyes are oblique, and the face simulates the Mongolian type. There are semilunar folds of skin at the internal canthus of the eye (the third eyelid of the bird). The lips are thick, especially the lower one; they are often marked by transverse fissures; also, they are often deficient in muscular power, so that the saliva dribbles. The angle of the jaw is obtuse, while the ears are placed usually far back. The mouth is arched, the tongue large, rugous, and fissured, while its papillæ are enlarged."

Hippocrates [3] describes a characteristic expression, which has been called after him the "facies Hippocratica," in which the eyebrows are knitted, the eyes are hollow and sunken, the nose is very sharp, the ears are cold, thin, and contracted, with marked shriveling of the lobules; the face is pale and of a greenish, livid, or leaden hue; and the skin about the forehead is tense, dry, and hard. This type of countenance is a most frequent indicator of impending death from chronic disease, or in an acute form of disease which has been unusually prolonged.

The "facies stupida" is distinguished by a dulness of expression, which is its chief characteristic. A peculiarity exists as regards the eyes, which are extremely dull, and resemble those seen in alcoholic stupor. This type of countenance is identical with the so-called "typhoid face," since it is most frequently met with either in connection with typhoid fever or with the typhoid condition associated with some other disease.[4]

Another type of countenance to which attention is frequently drawn is called the "pinched countenance." It can be produced artificially by exposure to cold, and is characterized by an apparent decrease in the size of the face, with a contracted and drawn expression of the features, and pallor or livid color of the skin. It is said to exist most frequently in the course of acute peritoneal inflammation.

"In the long list of diseases which tend to shut off the supply of air to the lungs more or less suddenly, and in those accidents, such as choking, strangulation, smothering, drowning, etc., where the same effect is accomplished, the symptons of apnœa are manifested in the face by flushing and turgidity, at first, and, later on, by a livid and purplish color. The

[1] Williams, op. cit.

[2] J. Milner Fothergill: Semeiology, 1880.

[3] Prognostics (Adams's translation).

[4] Finlayson: Clinical Diagnosis. Philadelphia, 1878.

veins of the neck become markedly swollen, and the eyes seem to protrude from their sockets. A loss of consciousness, and possibly convulsions, precedes death."[1]

The countenance of extreme anæmia is seen in those cases where, from sudden or gradual hemorrhage, the prognosis is rendered alarming. The phenomena which attend this mode of dying are pallor of the face, with a peculiar leaden or clay-like hue,[2] cold sweats, dimness of vision, dilated pupils, a slow, weak, irregular pulse, and speedy insensibility. With these symptoms are frequently conjoined nausea, restlessness and tossing of the limbs, transient delirium; a breathing which is irregular, sighing, and, at last, gasping; and convulsions before the scene closes.

Fig. 40.—Face after Hemorrhage. (Modified from Corfe.)

The expression of the countenance is typically marked in certain of the inflammatory diseases of the eye.[3] "In strumous ophthalmia, the child's brow is knit and contracted, while the ala nasi and the upper lip are drawn upward. Those muscles which tend to exclude the light from the inflamed organ, without shutting out the perception of external objects, are called into action; thus producing a peculiar and distinctive grin. In severe cases, the child will sulk all day in dark corners, or, if compelled to stay in bed, will bury the face in the pillow, since the exclu-

[1] Watson: Practice of Physic (Condie's edition).

[2] Sir Charles Bell, op. cit.

[3] Haynes Walton: Operative Ophthalmic Surgery. Philadelphia, 1853.

sion of all light tends greatly to diminish the suffering. If brought to the window, the eyes are shaded with the hands or the arms; and, if the eye be opened, a profusion of hot, scalding tears will enter the nose and give rise to sneezing, or flow over the face and cause excoriation of the adjoining parts." This special intolerance of light seems to be a chief characteristic of this type of trouble, since it is often out of proportion to the redness which indicates the extent of the inflammation present. In catarrhal ophthalmia, the inflammation seems to be confined to the conjunctiva and the Meibomian follicles. The eyelids are glued together by the lashes, which are bathed in the excessive secretion of the conjunctiva or of the inflamed follicles; and a redness of the surface of the eye, with some pain and uneasiness, is the only other symptom of special diagnostic value.

The condition of iritis is characterized by a redness of the sclerotic; a change in the color of the iris, and in its general appearance, as compared with the healthy eye; an irregularity in the pupil, produced by adhesion of the iris to the adjacent structures; possibly immobility of the pupil, as the result of such adhesions; and a visible deposit of coagulable lymph. The pupil, in acute iritis, seldom dilates in the dark, on account of the intense congestion which exists,[1] and it is usually smaller than that of the unaffected eye. Some pain and excessive photophobia are usually also present in attacks of acute iritis. There is something very peculiar in the expression of the countenance of a person suffering from amaurosis, by which alone the physician may almost recognize the disease. "Such a patient enters a room with an air of great uncertainty as to movement, the eyes are not directed toward surrounding objects, the eyelids are wide open, and the patient seems gazing into vacancy. This unmeaning stare of the face is due, in great measure, to an absence of that harmony of movement and expression which results largely from the information obtained by the exercise of vision."[2] This seeming stare at nothing is not observed in patients who are blind in consequence of opacity of the crystalline lens or of its capsule, *i. e.*, in consequence of cataract. They, on the contrary, while they cannot see, still seem to look about them, as if they were conscious that the power of sight remained in the retina, although the perception of objects was shut out from it. Patients afflicted with cataract, who cannot detect the existence of a gas jet or a candle in a dark room, are not fit subjects for operation, as the existence of trouble

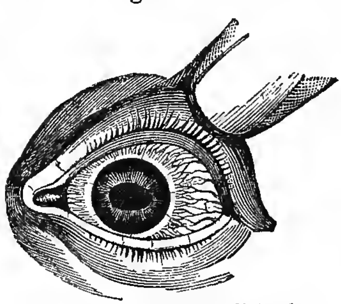

FIG. 41.—Showing the radiate character of the overloaded blood-vessels in iritis, and also the irregular pupil.

[1] See the experiments of Mosso, quoted by Michael Foster.

[2] Watson, op. cit.

behind the lens may safely be surmised; since the periphery of the lens seldom becomes opaque to such an extent as to prevent the perception of light by the retina, even if the outline of objects cannot be perceived.

It is a fact well known among oculists, and one which often helps them materially in diagnosis, that the defects of vision, occasioned by impairment in the power of the muscles which control the eyeball, cause the patients unconsciously to assume a *position of the head*[1] which tends to assist them in the use of the affected eye. So diagnostic are some of the attitudes assumed by this class of afflicted people that the condition which exists may be told at a glance as the patient enters a room, by one thoroughly familiar with the diseases of this important organ. The explanation of this tendency on the part of this class of patients, lies in the fact that any loss of power in the ocular muscles immediately shows itself in the perception of every object, as it were doubled; and it is to overcome these *double images* that patients almost instantaneously discover their ability to get rid of the annoyance by some special attitude which, of course, depends upon the muscle which is weakened or paralyzed.

It will be necessary, in order to make you clearly understand the mechanism of this peculiarity, that the separate action of the six muscle which directly act upon the globe of the eye be considered.

The action of each of the ocular muscles may be given, then, as follows, with the proviso that many of the motions of the eye are not the result of the contraction of any single muscle, but often of a number acting either in unison or successively.

The *superior oblique* muscle turns the eye downward and outward.

The *inferior oblique* muscle turns the eye upward and outward.

The *superior rectus* muscle turns the eye upward and inward.

The *inferior rectus* muscle turns the eye downward and inward.

The *internal rectus* muscle turns the eye directly inward.

The *external rectus* muscle turns the eye directly outward.

This statement as to the above muscles reveals nothing which would not be immediately suggested by the insertion of each, with the exception of the superior and inferior recti muscles, which, besides the action their situation would naturally suggest, tend also to *draw the eyeball inward,* on account of the obliquity of the axis of the orbit and the same obliquity of the muscles, since they arise at the apex of the orbit. The action of the oblique muscles is, as any one familiar with their origin and insertion would naturally surmise, to control the oblique movements of the eyeball.

Now, as soon as any one of these six muscles beomes pressed upon

[1] An extract from the author's late work, The Applied Anatomy of the Nervous System. New York, 1881.

and weakened by the presence of tumors, inflammatory exudation, syphilis, or other causes, the patient at once *perceives double images*, and in order to get his eye into such a relative position with that of the healthy side as to enable them both to focus upon the same object in a natural manner, the patient soon learns to so move his head as to compel the two eyes to look in parallel directions.

A very simple rule can be suggested by which the reader may be enabled, not only to tell in what direction a patient will move his head in case any special muscle be rendered weak or utterly useless, but also to diagnose the muscle affected, when you look at the patient, without any knowledge of his history. The rule may be thus stated :

In paresis of any of the ocular muscles, the head is so deflected from its normal position that the chin is carried in a direction corresponding to the action of the affected muscle.

Thus, in paresis of the external rectus,[1] the chin would be carried outward toward the injured muscle, while in paresis of the internal rectus muscle the head would be turned away from the side on which the muscle fails to act. In case the superior oblique muscle is impaired, the chin would be carried downward and outward, while in the case of the inferior oblique muscle the chin would have to be moved upward and outward to benefit the vision of the patient. The superior and inferior recti muscles, when impaired by disease or other causes, would likewise create a deflection of the head in a line corresponding to that of their respective actions.

When a congenital, zonular cataract exists, the child will give evidence of its presence by the peculiar method employed to obtain a clear perception of any given object which is held in the hand: instead of looking at it in the ordinary manner, the child moves the object constantly before the eyes so as to obtain a view of the object, as it were by sections, since light can only enter the chamber of the eye through the periphery of the lens. This act is so characteristic as to be considered as almost pathognomonic of this congenital defect. These patients also frequently carry the head with the chin depressed so as to admit light through the periphery of the lens, and thus to gain the aid of distinct vision in their movements.

Children suffering from glioma of the retina will often exhibit a yellowish or reddish metallic lustre, which apparently comes from the depth of the eye.

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[1] While this statement would be absolutely true in theory in all cases, we must acknowledge, as a clinical fact, that patients learn to *utterly disregard* the image in the affected eye when the *internal* or *external rectus* is the seat of paresis, and to use the normal eye only for the purposes of vision, thus rendering this attitude of the head less diagnostic than when the oblique muscles are affected.

A person suffering from chronic trachoma (granular eyelid) will manifest the diseased condition by a peculiar drooping of the upper lid, which gives a somewhat sleepy expression to the face. In some of the pictures of Shakespeare, this type of countenance is markedly depicted.

In ptosis, the upper lid falls over the eye, in proportion to the degree of the paralysis, giving the eye a more or less closed appearance. When the upper lid falls so that its margin reaches the limit of the pupil, the patient will often throw the head backward when endeavoring to perceive an object directly in front of him.

One of the peculiarities of cataract, especially if it be nuclear or not fully mature, may be noticed in the attitude of the head as the patient enters the consulting room, since the chin will frequently be depressed in order to admit light above the opacity in the lens. This is in marked contrast to the attitude assumed by patients suffering from atrophy of the optic nerve, who do not depress the chin, but exhibit the blank, unmeaning stare which is so typical of that condition.

An exceedingly peculiar expression of countenance is observed in those patients suffering from epicanthus, since the palpebral fissure is smaller than normal and the canthus is brought closer to the limits of the cornea than in health. If the condition be bilateral and confined to the inner canthus, the eyes have the appearance of being too widely separated.

In glaucoma, the eyes have a peculiarly dull appearance, which is largely the result of a corneal opacity, while a greenish discoloration of the eye will be perceived in the advanced stages accompanied by an engorgement of the veins of the sclerotic. The eye will also be unnaturally hard and resistant to the touch.

A dislocation of the lens into the anterior chamber of the eye will usually be manifested by a bright zone near to the junction of the cornea with the sclerotic. This is due to the direct reflection of light from the periphery of the dislocated lens.

In locomotor ataxia (provided that the cilio-spinal centre be affected by the sclerosis), a peculiarity of the pupil may often be recognized, since it will be small in size and will not respond to light. On careful examination, however, it will be perceived that a certain amount of movement in the pupil occurs when the patient is directed to accommodate the vision to some near object. The methods employed in the examination of such patients may be found by a reference to most of the later text-books on nervous diseases, as this condition is now considered a valuable diagnostic point when locomotor ataxia is suspected.

The dilated pupil, which results from paralysis of the motor oculi nerve, is not so wide as that resulting from the use of atropine, and is associated with external strabismus and occasionally a slight protrusion of the eye as the result of a relaxation of its muscles.

When the tears flow constantly over the cheek, some defect or strictures of the nasal duct may be suspected, provided that the puncta lachrymalia are not turned away from the globe of the eye from any cause.

"The countenance of chronic hydrocephalus is, perhaps, the most typical of any of the conditions to which the attention of the physician or surgeon is directed. In it the frontal bone is tilted forward, so that the forehead, instead of slanting a little backward, rises perpendicularly or even juts out at its upper part and overhangs the brow. The parietal bones bulge above toward the sides, the occiput is pushed backward, and the head becomes long, broad, and deep, but flattened on the top. This, at least, is the most ordinary result. In some instances, however, the skull rises up in a conical form like a sugar-loaf. Not infrequently the

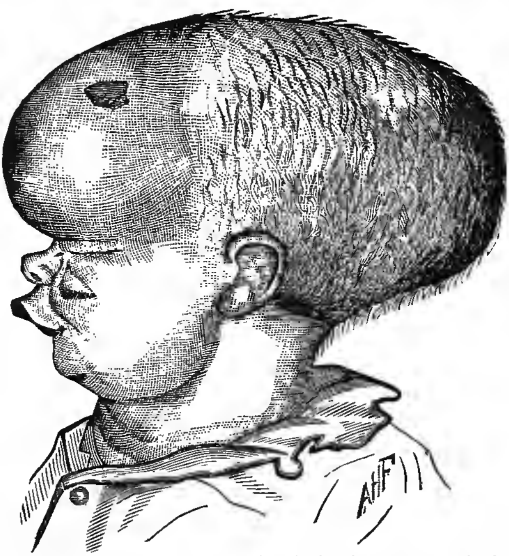

Fig. 42.—Deformity from compression of head, simulating that of hydrocephalus.

whole head is irregularly deformed, the two sides being unsymmetrical. Some of these rarer varieties of form are fixed and connate, others are owing, probably, to the kind of external pressure to which the head has been subjected."[1] While the skull may be rapidly enlarging, the bones of the face grow no faster than usual, perhaps not even so fast, and the disproportion that results gives an odd and peculiar physiognomy to the unhappy subjects of this calamity. They have not the usual round or oval face of childhood. The forehead is broad, and the outline of the features tapers toward the chin. The visage is triangular. The great disproportion in size between the head and the face is diagnostic of the disease, and would serve to distinguish the skull of the hydrocephalic child from that of a giant. In acute cerebral diseases, the countenance is either wild and excited or lethargic and expressionless.[2]

[1] Watson, op. cit. [2] Sir Charles Bell, op. cit.

Thoracic affections are all accompanied by more or less change in the color of the face; whereas the alteration in the natural hue of the features is so slight in abdominal diseases, that both the intellect and complexion remain unaltered up to the final struggle, though the pinched and dragged features express the acute sufferings of the patient. "In pneumonia, the countenance is inanimate; the cheek, of a dusky hue, with a tinge of red; the eyelid droops over the globe; the brow is overhanging; the lips are dry, herpetic, and of a faint claret color; the chest is comparatively motionless, but the abdomen exhibits evidences of activity; the skin is hot; and the respiratory acts are usually about double the normal number, while the pulse is markedly accelerated. In cases where dyspnœa is extreme, the patient, entirely regardless of what is going on about him, seems wholly occupied in respiring; is unable to lie down, and can scarcely speak; and the face becomes expressive of the greatest anxiety, while the expanded nostrils and their incessant movement indicate pulmonary distress." [1]

FIG. 43.—The hydrocephalic head (different views).

In emphysema, the face is not only dusky but anæmic; the eyes are wide open, as the patient gazes at you; the dusky redness of the lips bespeaks the lack of proper oxygenation of the blood; the neck is thrown backward, and the mouth is slightly open, while the cheek is puffed out during the expiratory act; the distended nostril and the elevated brow stamp the case as one of dyspnœa; while the coldness of the skin shows that no acute inflammatory condition is present. If we see, in addition to these facial evidences of disease, the deformity of the chest which has been termed the "barrel-shaped" thorax, the shrugged shoulders, and the absence of that expansive movement so well marked in normal respiration, auscultation and percussion can hardly make the diagnosis more positive.

There are certain facial conditions, which so clearly tell, to the student of physiognomy, of the existence of that most prominent sign of many pulmonary and cardiac diseases, *dyspnœa*, that it may be well to

[1] Watson, op. cit.

enumerate the alterations from the normal countenance which chiefly indicate this condition. In all cases where excessive dyspnœa is present, the brows will usually be found to be raised; the eyes will be full, staring, and clear; the nostril will be dilated, and often it may be seen to move with each respiratory act;[1] the mouth will commonly stand partly open, while its angles will be drawn outward and upward; the upper lip will be elevated, so as to show the margins of the teeth; and the utterance of the patient will be monosyllabic, as the rapidity of breathing renders the utterance of long sentences a matter of extreme difficulty. When we add to these symptoms those of imperfect oxygenation of the

FIG. 44.—Countenance of Emphysema. (Modified from Corfe.)

blood, as is met with in all conditions where the free entrance of air is in any way interfered with, we can better understand how the clear eye becomes stupid, as coma approaches, from the carbonic-acid poisoning, and the face cyanotic from the venous tinge of the blood. It thus becomes possible for the reader to picture to himself the countenance which must exist in such conditions as acute laryngitis, spasmodic and true croup, thoracic tumors (which cause pressure upon the lungs or

[1] Lavater, op. cit.; Sir Charles Bell: Anatomy of Expression. London, 1824.

trachea), and the various conditions of the lung itself, which impede the entrance of air to the organ, but are not of inflammatory origin, and have, for that reason, no distinctive physiognomy.

In cases where renal dropsy has stamped its characteristic marks upon the countenance, we may perceive the signs of dyspnœa, due to the accompanying œdema of the lungs, in the corrugated forehead, the raised eyebrow, the dilated and waving nostrils; the corners of the mouth will be found to be drawn downward and outward, expressive of some disease of the abdominal cavity; the eye will be full and anxious, indicative of suffering long-continued and borne with patient calmness;[1] the conjunctiva may present that pellucid and bleb-like condition so often

FIG. 45.—Cardiac Dyspnœa. (Modified from Corfe.)

seen in this type of disease, and an œdema of the eye may greatly alter its appearance; finally, the waxy pallor of the complexion and the pasty and bloated cheeks show the profound anæmia of the patient.

"Chronic diseases of the abdominal cavity are usually characterized by a languor of the eye and an absence of that flash of alarm so peculiar to the acute forms of abdominal trouble;"[1] and, if attended with steadily increasing danger to life, the corrugated brow and eyelid, the retraction of the cheek, the dragged and elongated nostrils, the depressed angles of the mouth, the protruded chin, and the parted lips, with the teeth firmly clinched behind them, still further proclaim the seat of the disease.[2]

[1] Corfe, op. cit.
[2] M. Louis, quoted by Marshall Hall, op. cit.

The pale face, stamped with the signs of anxiety and distress; the head raised upon two or three pillows, and the trunk similarly supported; the knitted brow, which bespeaks the cerebral disturbance; the nostrils, waving to and fro with each breath; and the jugulars which, as they lie exposed in the throat, show by their pulsation or unusual distention that the valves of the heart are acting imperfectly; all may be found in endocardial or pericardial inflammations, or in conditions of the heart dependent upon chronic valvular disease.[1]

The countenance of each of the continued fevers is liable to receive a modification from the existence of a complication, usually with some morbid affection of the head, the viscera of the thorax, or of the abdo-

Fig. 46.—Face of a Patient with Obstruction at the Pyloric Orifice.

men; the dejection produced by the latter of which is among the most important objects in the clinical study of these diseases.[2] In scurvy, the dirty ashy hue of the skin and its characteristic dryness; the blue and bleeding gums; the emaciation and the frequent indurations of the intermuscular tissue of the cheeks; the sunken eyes, surrounded by a blue ring; and the livid tinge of the lips, make the diagnosis positive at once.

In Graves's or Basedow's disease, a peculiarity of the eye is produced, due to its partial protrusion from the orbit, probably from an increase of the intra-orbital fat, which stamps the disease beyond a possibility of error in diagnosis. In many cases, the inability to approximate the lids,

[1] Corvisart: Diseases of the Heart, Gates's translation. Boston, 1812.

[2] Marshall Hall, op. cit.

and an absence of power to move the eye, on account of the paralysis of the muscles from the stretching which they have undergone, furnish evidence also of disease of that organ which enhances the facial deformity.

In Asiatic cholera, and in children during attacks of profuse diarrhœa, the eyeballs sink into the orbit, a dark ecchymosis appears in the region of the eyes, the lower eyelid forms a prominent fold in the region of its attachment to the cheek, the nose is pointed and sharp, and the lips, normally ruddy and full, become thin and sharply outlined. These changes are chiefly dependent upon a rapid emaciation, which follows the withdrawal of a large proportion of the water from the tissues.[1]

FIG. 47.—Cancer of the Abdominal Cavity. (Modified from Corfe.)

In chronic atrophy, the entire absence of adipose tissue in the subcutaneous structures causes the skin to become loose and corrugated; while various muscles become prominent from contraction (chiefly the frontalis, the corrugator supercilii, and the levator labii superioris).[2] Thus the so-called "senile face" or "Voltairean countenance" is produced, which is seldom to be mistaken in the child.[1]

Among the diseases of the nervous system, there are certain types of physiognomy which are so characteristic as to be of the most positive value in diagnosis. Thus, in the attacks of epilepsy, "the neck at first

[1] Vogel, op. cit. [2] Marshall Hall, op. cit.

becomes twisted, the chin raised, and brought round by a series of jerks toward one shoulder. The features are greatly distorted. The brow is knit; the eyes are sometimes fixed and staring, at other times rolling about in the orbit, and again turned up beneath the eyelid, so that the cornea is covered and only the white sclerotic is to be seen; the mouth is twisted to one side and distorted; the tongue is thrust between the teeth, and, caught by the violent closure of the jaws, is bitten, often severely:

FIG. 48.—Countenance of melancholia.

FIG. 49.—Countenance of dementia.

and the foam which issues from the mouth is reddened with blood. The turgescence of the face indicates obstruction of the venous circulation; the cheeks become purplish and livid, and the veins of the neck are visibly distended."[1]

The expressions of the countenance which are produced by paralysis of any of the special nerves of the face have striking peculiarities which enable the skilful anatomist to easily detect the nerve affected. It is important to remember that, if paralysis of any nerve be the result of any form of external injury, a danger is presented in the form of tetanus, which should be guarded against by a quick comprehension of the existing malady and by all known precautions, applied with judgment based on the anatomical course and relations of the nerve affected. It is also well to bear in mind the fact, that any form of severe external violence about the face may, by causing a fracture of the bones through transmission of the force applied, cause injury to some special nerve whose course may lie far distant from the apparent seat of injury. It is not infrequent to find a fracture of the superior maxillary bone followed by symptoms indicative of a foreign body within the cavity of the antrum; and symptoms of

FIG. 50.—Countenance of paresis.

[1] Watson, op. cit.

irritation of the nasal mucous membrane, or neuralgia of some of the principal nerve-trunks distributed to the face, may likewise follow such an accident. Violence to the vault of the skull may produce not only cerebral lesions and their subsequent evidences in the face and body, but also types of local paralysis,[1] produced by injury to some of the more important nerve-trunks at their point of escape from the skull, in case the base of the skull has been injured.[2]

"A slight tremor of the lips; a hesitation of utterance; a partial loss of power over the lips and tongue, which seem to have lost their grip, as it were, over the consonants; a characteristic stillness of all the muscles of expression; and a slight disparity in the pupils are the predominant features of the early stage of development of the general paralysis of the insane."[3] In those rare cases where the facial nerve of both sides is impaired, symptoms similar to those mentioned above exist, except the tongue has its normal capabilities of movement, save in the perfect articulation of the labial consonants only, and that a complete absence of facial expression is present. "An open mouth; a loss of control over the saliva, which constantly dribbles; an awkwardly moving or motionless tongue; and an indistinct articulation render the labio-glosso-laryngeal paralysis of Trousseau and Duchenne easy of detection."[4] In the so-called Bell's paralysis,[5] which has been described in previous pages of this article, the patient cannot laugh, weep, or frown, or express any feeling or emotion with one side of the face; while the features of the other may be in full play. "One-half of the aspect is that of a sleeping or dead person; while the other is alive and merry. This incongruity would be ludicrously droll, were it not so frightful and distressing."

When, in the human subject, the hypo-glossal nerve is impaired, either as a special type of paralysis or during an attack of hemiplegia, the power of protrusion of the tongue from the mouth in a *straight line* is lost, and that member becomes deflected toward the side which is paralyzed, since the genio-hyo-glossus muscle is unopposed. A disease of rather rare occurrence, in which the hypo-glossal nerves of both sides are paralyzed, and, in addition, the orbicular muscle of the mouth, and, not infrequently, the intrinsic muscle of the larynx, is described by Duchenne;[6] and it has since been written upon, by most of the later authors, under the names of glosso-labio-laryngeal paralysis, glossoplegia, etc. In this type of disease, the tongue lies motionless and trembling in the floor

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[1] Holden, op. cit.

[2] The reader is referred by the author to his late treatise: The Applied Anatomy of the Nervous System. N. Y., 1881.

[3] W. H. Gairdner, Article on Medical Physiognomy, in Finlayson's Clinical Diagnosis.

[4] Finlayson, op. cit. [5] Sir Charles Bell, op. cit.

[5] De l'électrisation localisée. Paris, 1861.

of the mouth, if all power of motion be paralyzed; but, if paresis only exists, it can be imperfectly protruded with difficulty, and is tremblingly and slowly retracted. If one side be affected, the sound side becomes full and prominent, in comparison with the affected side, when called into action. The peculiar trembling character of the movement of the tongue, in bilateral paresis, is observed in every motion which the patient attempts to perform with that organ, and all the motions are slowly and imperfectly accomplished.

The most important effects of the paralytic state of the muscles are shown in attempts at *mastication* and *speech*. The food is no longer properly placed between the teeth; is with great difficulty carried to the back part of the mouth; and frequently regurgitates into the mouth, when attempts are made to swallow. The saliva is secreted in large quantities, and swallowed with extreme difficulty, so that the patient is constantly obliged to expectorate.

During the fit of exacerbation, in an attack of tetanus, the aspect of the sufferer is sometimes frightful. The forehead is corrugated and the brow knit, thus expressing the most severe type of bodily suffering; the orbicularis muscle of the eye is rigid, and the eye itself staring and motionless; the nostril is widely dilated, indicating extreme dyspnœa; the corners of the mouth are drawn back, exposing the teeth, which are firmly clinched together; and the features, as a whole, have a fixed and ghastly grin—the so-called "risus sardonicus." During such paroxysms, as in those of epilepsy, the tongue is liable to become protruded between the teeth and be severely bitten.

In chorea, the facial muscles participate in the general eccentricity of movement. Watson [1] thus describes the peculiarities of this strange affection: "The voluntary muscles are moved in that capricious and fantastic way in which we might fancy they would be moved, if some invisible mischievous being, some Puck or Robin Goodfellow, were behind the patient and prompted the discordant gestures. With all this, the articulation is impeded: there is the same perverse interference with the muscles concerned in the utterance of the voice. By a strong figure of speech, the disorder might be called 'insanity of the muscles.'"

In catalepsy, the patient lies often with eyes open and staring, yet without expression indicative of life; more like a wax figure or a corpse than like a living subject. The features may be made to assume any expression, no matter how absurd, as the tissues have their normal pliability; and they will remain so placed until again mechanically altered. This same peculiarity is also present in the muscles of the extremities, and forms one of the distinguishing tests of the disease. The mental faculties are in abeyance, and all power of voluntary motion is lost. The sensibility of the body seems also to be lost.

[1] Op. cit.

The deformities of face and intellect which seem to be the result of residence in special atmospheric conditions, or certain well-defined localities, are illustrated in that race of people found in Valais and the adjoining cantons of Switzerland, called "cretins." Many of these wretches are incapable of articulate speech; some are blind, some are deaf, and some suffer from all of these privations. "They are mostly dwarfish in stature, with large heads, wide vacant features, goggle eyes, short crooked limbs, and swollen bellies. The worst of them are insensible to the decencies of Nature, and in no class of mortals is the impress of humanity so pitiably defaced. They are usually the descendants of parents afflicted with goître."[1]

Fig. 51.—Partial Paralysis of the Facial Nerve from Disease near the Pons Varolii. (Modified from Corfe.)

In that long list of pathological conditions in which the brain may be subjected to more or less compression of its substance, there are certain signs of positive value in diagnosis which may often assist the medical practitioner to locate the disease. Thus, in depressed fracture of the inner tablet of the skull, where the signs of external injury are absent; in abscess within the cranial cavity; during the course of meningeal inflammations; in apoplexy; in the development of intra-cranial tumors, etc.,

[1] Watson, op. cit.

the eyelids will usually be closed and immovable; the pupils generally dilated or irregular, and always sluggish and less sensitive to light than in health; the breathing will be slow and stertorous if coma exists; the special senses will be in abeyance; and the temperature will be either normal or increased. The evidences of a paralyzed condition of certain of the cranial nerves may also exist, and thus afford an additional means of determining the exact seat of the disease. A rigidity of certain muscles, if present, usually denotes some special irritation of the nerves which supply them, and it is, therefore, seldom present in cerebral softening, but frequently so in those cases where paralysis is produced by pressure upon nerve-centres, or when descending sclerosis affects individual nerve-fibres arising from the seat of the lesion. In cases where the fifth cranial nerve has been impaired by pressure, injury, or disease, the prominent symptoms are a redness of the conjunctiva on the side of the face supplied by the affected nerve; insensibility of the cornea, nostril, and tongue on the same side; a dulness of hearing; a partial or complete loss of smell, sight, and occasionally of taste also in the anterior two-thirds of the lateral half of the tongue; and a diseased state of the gums, similar to that observed in scurvy.

A paralysis of *one side of the face*, if associated with a hemiplegia of the opposite side of the body (crossed paralysis), is one of the most valuable signs of a lesion in the upper part of the pons Varolii. The facial paralysis may be confined to the motor oculi, trigeminus, or facial nerves.

While many typical varieties of countenance, which are of value to the diagnostician, have been omitted, since the limits of a single chapter have possibly been already over-stepped, still it is to be hoped that the facts mentioned, although they are but fragmentary jottings, may tend to kindle among the medical profession a renewed interest in a subject which is rapidly being lost sight of, and the value of which is often ignored. It is not to be expected that sight alone can guide the medical attendant to unerring diagnosis; but that it may prove of the greatest value *as an aid*, cannot, I think, be disputed. It is to be remembered, however, that a direct perceptive faculty, like that of touch, hearing, or smell, *grows with use*, and is capable of unlimited development. As with the musician, an instrument which at first produced discords becomes, under skilful hands, one of melody; so the enlightened and accomplished practitioner may often see at a glance what, to one unaccustomed to note facial changes or to interpret their meaning, would escape detection, unless a special effort be made to note and record systematically the peculiarities of each particular feature and anatomical region of the face, and the records afterward studied, as the mariner studies his chart before he attempts to direct his vessel through channels with which he is not perfectly familiar.

CHAPTER III.

THE BLOOD-VESSELS OF THE HEAD.

THE blood-vessels of the head require, possibly excepting those of the neck, more constant study on the part of the surgeon than those of any other region. They are in such intimate relation with nerves and important organs that surgical interference, unless scientifically performed, is especially dangerous, and may be followed by most disastrous results.

In addition to this source of anxiety, a large proportion of the wounds received, which are apt to create injury to neighboring vessels, are situated about the head; and cancerous tumors, or those of a malignant type which are liable to be associated with hemorrhage during their ulcerative stage, are especially common about the face.

Cirsoid aneurisms of the scalp, vascular tumors of the orbit, or injury to the meningeal or cerebral vessels from depressed fracture of the cranial bones, also require, when present, the best practical anatomical knowledge for their successful treatment, and they are not infrequently met with by the surgeon.

It is my plan, therefore, to take up, as has been done with the bony points of interest, those vessels which are most frequently brought to the notice of the medical practitioner, requiring some steps of relief; and to show, so far as the limits of a small work will allow, the points pertaining to each, which are of practical value or which afford useful information.

One difficulty arises, at this point, from the attempt to place the neck where it properly belongs, viz., with the trunk, of which it is, anatomically, a part. Some of the vessels which are distributed to the head arise from the carotid arteries within this region, although the distance through which the vessel passes, in the neck, may often be very short, and, in many cases, of no practical importance. To give a clear description, however, of the lingual, facial, occipital, and ascending pharyngeal arteries, their *points of origin* must be mentioned, and their *course* traced hastily, until the region of the head is reached, when all important details pertaining to each will be carefully reviewed. To fail to do so would be liable to leave the reader in doubt as to some points pertaining to these vessels; while to attempt to consider, in the description of the neck, only a minor portion of some important vessel, when the rest was treated of elsewhere, would certainly thwart the aim of the author, and embarrass the reader. The slight encroachments, therefore, upon the neck as an anatomical region, which may be noticed in the pages of this chapter, is not an evidence of a lack of systematic arrangement, but a step that seems demanded in order to insure perspicuity. In fact, the head may, in some senses, be held to include all those parts above the level of the hyoid bone, since the structures above that point are properly its own.

THE LINGUAL ARTERY.

This vessel may be wounded, in cases of cut throat, near to its point of origin. It is a frequent source of hemorrhage in ulcerations about the

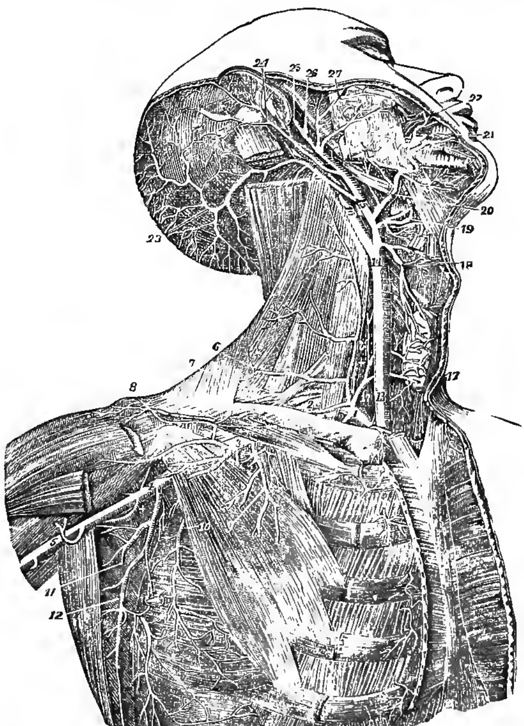

Fig. 52.—Deep view of the carotid, subclavian, and axillary arteries and their branches; the large muscles in the front of the neck and chest having been divided or removed; 1, vertebral artery; 2, subclavian artery; 3, 4, axillary artery; 5, commencement of the brachial artery; 6, 7, 8, branches going to the shoulder; 9, branch going to the pectoral muscle; 10, long thoracic artery; 11, 12, subscapular artery; 13, 14, common carotid artery; 15, external carotid artery; 16, internal carotid artery; 17, 17, thyroid axis and thyroid gland; 18, superior thyroid artery; 19, *lingual* artery; 20, *facial* artery; 21, *inferior labial* artery; 22, *coronary* artery; 23, *occipital* artery; 24, *posterior auricular* artery; 25, *superficial temporal* artery; 25, *internal maxillary* artery; 27, *transverse facial* artery.

tongue. It may be also involved in punctured wounds of the floor of the mouth or the lateral aspect of the tongue.

Its *ranine branch* is very superficial, and may often be seen as a tortuous pulsating vessel, running from the base toward the apex of the tongue, on its lateral border, near to the floor of the mouth. The lingual artery is tied to relieve hemorrhage of any of its branches, and as a palliative measure in case of some tumors of the tongue, in order to check the progress of the disease. It has been tied as a preparatory step to removal of the tongue.[1] The *guide* to the artery is the *greater cornu of the hyoid bone.*

In division of the *frænum of the tongue* in children, serious hemorrhage is liable to occur if the *ranine* vessels, which almost meet at this point, be severed. It is, therefore, of importance to remember that, in surgical interference in this locality, the tissue *should be torn* rather than cut, except in dividing the mucous membrane, which should be done with care and with scissors directed away from the tongue and made blunt-pointed.

Operation for Ligation.

The steps of the operation for the ligation of this vessel are rendered difficult, first, by occasional irregularity of its point of origin; second, by the yielding nature of the tissues upon which it rests; third, by its depth from the surface, and, fourth, by its relations to important structures. The operation, however, possesses great advantages over that of ligating the external carotid or the common carotid trunk; which is too often practised, not only for tumors of the tongue, but also in cases of uncontrollable hemorrhage from the tongue or wounds in the mouth.

A *straight* incision should either be made obliquely downward and backward, extending from a point *one inch anterior to the greater cornu of the hyoid bone* for a distance of about two and a half inches; or a *double incision* is preferred by some, the second lying in the line from the tragus of the ear to the sterno-clavicular articulation. This should be one and a half inches in length, and its centre should correspond to the level of the greater cornu of the hyoid bone; while the first incision should meet the second, and extend along the upper border of the hyoid bone.

The skin and platysma being carefully dissected, and the *underlying veins* avoided, the artery will be found contained within the *lingual triangle,* whose boundaries are as follows: *above,* the digastric muscle; *below,* the hyoid bone, and, *externally,* the external carotid artery.

The *hypo-glossal nerve,* as it crosses the external carotid artery, lies just *above* the lingual's point of origin; and the *thyro-hyoid branch* of this nerve crosses the lingual artery on its way to the muscle of the same name.

The artery will, in the large majority of cases, be found in close relation to the hyoid bone among the loose areolar tissue at the bottom of the wound.

Care must be taken, in applying the ligature to the vessel, that the

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[1] See report of J. W. Howe in Med. Record, Sept. 10th, 1881.

pharynx be not opened, as its walls form the floor upon which the artery rests.

The veins met with in this operation are often a source of serious embarrassment to the operator. They may include either the internal jugular or its lingual and facial branches.

THE FACIAL ARTERY.

This vessel arises most frequently at a point about *one inch* from the bifurcation of the common carotid. Its point of origin is, therefore, *above* that of the lingual artery, from which it is usually separated by about one-quarter of an inch.

It is usually the *largest* branch of the external carotid artery. Its course may be divided into a *cervical* and a *facial* portion, for convenience of description. The cervical portion, starting from the point of origin of the facial, passes obliquely forward and upward beneath the body of the lower jaw to the *submaxillary gland,* in which it lies, imbedded in a groove upon its superior and posterior border.

The facial portion begins at the submaxillary gland, the artery curving upward over the body of the jaw at the *anterior inferior angle* of the *masseter* muscle, ascending forward and upward across the cheek to the angle of the mouth, then passing up the side of the nose, and, finally, terminating at the internal canthus of the eye under the name of the "angular artery."

The facial artery, in both its cervical and facial portion, is remarkable for its *tortuosity.* This is evidently demanded in order to permit of the muscular movements required in the performance of the *acts of deglutition, mastication, articulation,* and *expression,* without incurring a danger of compression or stretching of the supplying vessels.

Relations of the Facial Artery.

In the *cervical portion* the artery is at first superficially situated, being covered only by the integument, fascia, and platysma muscle, but it soon passes underneath the stylo-hyoid and digastric muscles, and becomes partially imbedded in the submaxillary gland.

In its *facial* portion, it can at first be easily perceived by its pulsation, where it passes over the body of the lower jaw, since it lies very superficially, being covered only by the integument and the platysma muscle. It is at this point, therefore, that *compression* of this vessel can be most effectually made, in case of hemorrhage from any of its branches upon the face. During its course across the cheek, it is covered by the integument and a deposit of fat, until it reaches the angle of the mouth, when it receives the platysma and zygomatic muscles as additional coverings. It rests, in its passage to the angle of the mouth, upon the buccinator, the levator anguli oris, and the levator labii superioris muscles.

During its entire course, the *facial vein* accompanies it, but, unlike the artery, it is not tortuous; upon the face, it is separated from it by a considerable interval, and lies to the outer side of the artery.

The branches of the *facial nerve,* distributed to the various muscles of the face, cross the artery; and the *infra-orbital* nerve (a terminal branch from the fifth cranial nerve) lies beneath it, being separated from it by the fibres of the levator labii superioris muscle.

Peculiarities of the Facial Artery and its Branches.

The facial artery, in about twenty-five per cent of all subjects,[1] arises

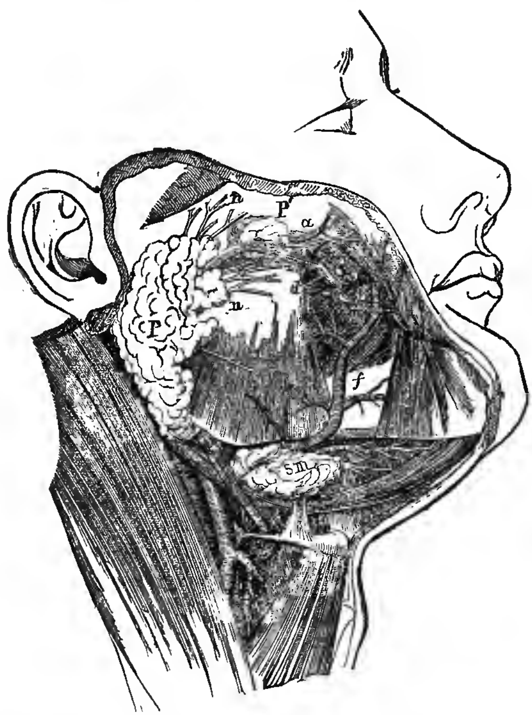

FIG. 53.—Diagram showing the facial artery and the position and size of the parotid and submaxillary glands (two-fifths the natural size); *p*, the larger part of the parotid gland; *p'*, the small part which lies alongside the duct on the masseter muscle; *d*, the duct of Steno before it perforates the buccinator muscle; *a*, transverse facial artery; *n*, *n*, branches of the facial nerve emerging from the gland; *f*, the facial artery passing out of a groove in the submaxillary gland and ascending on the face; *sm*, superficial larger portion of the submaxillary gland lying over the posterior part of the mylo-hyoid muscle.

by a trunk in common with the lingual. It occasionally also arises in common with both the lingual and the superior thyroid arteries.

It varies in its *point of origin,* being often raised above its normal

[1] Wyeth: Essays on Surgical Anatomy. New York, 1879.

level, when it is thus forced to descend to reach the angle of the lower jaw. This latter variation exists in nearly one-third of the cases, although the artery may not necessarily be markedly displaced.

The facial artery varies also in its *size*. As a rule, however, it is the largest of the branches of the external carotid.

Variations in the extent of its *distribution* are also not infrequently

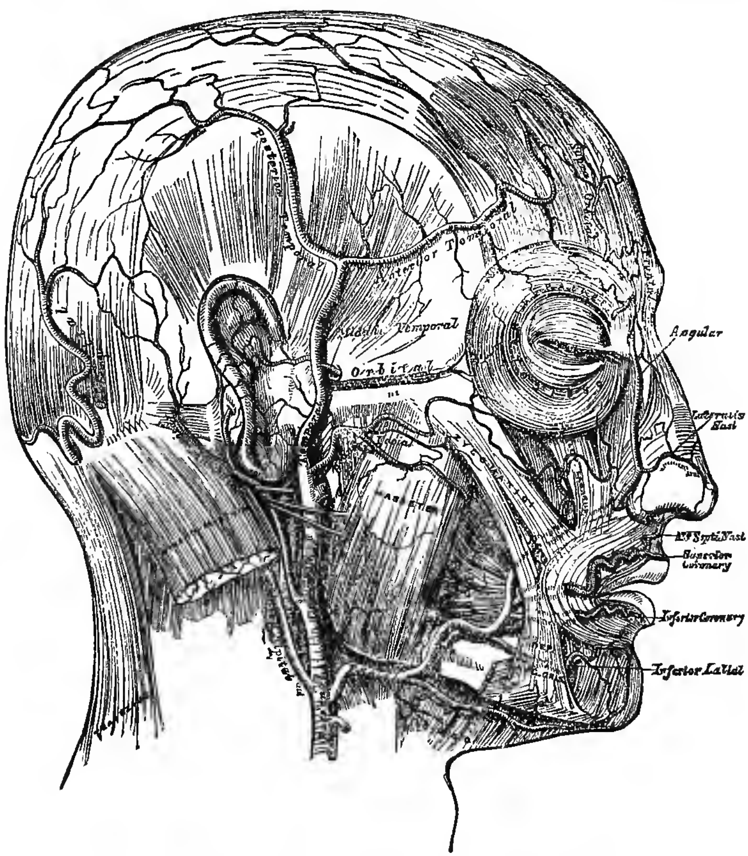

FIG. 54.—The arteries of the face and scalp (After Gray.)

present. Thus, the facial artery, in rare cases, is absent upon the face, having its point of termination at its submental branch. In cases of greater frequency, it is arrested upon the face before it reaches its normal point of termination. In both of these conditions, the *ophthalmic arteries* are proportionally developed, as a rule, upon the corresponding side of the nose and in the orbit; and the transverse facial and the internal maxillary arteries are also frequently enlarged.

The *branches* of the facial artery exhibit occasional peculiarities.

The *ascending palatine* branch may be transferred to the external carotid, or may be of too small size to supply the soft palate, in which case the ascending pharyngeal artery is usually excessively developed.

The *tonsillar* branch may be altogether wanting. The *submental* branch occasionally arises from the lingual, and, in infrequent cases, the facial artery sends branches of supply to the sublingual gland in place of the lingual artery.

Surgical Anatomy.

In cases of severe wounds of the lip causing serious hemorrhage, the *results of pressure* upon the facial of the wounded side, where it crosses the body of the lower jaw, are *unsatisfactory*, and, in a short time, *unavailing*. This is due to the remarkably free anastomosis existing between its branches with other sources of vascular supply.

It is always advisable in such cases, therefore, to firmly *evert the lip*, compressing it between the fingers, and to apply a ligature to the bleeding point, if practicable. In operations for the removal of growths about the mouth or lips, it is customary to use firm compression of the *wounded part* between the fingers as a means of controlling hemorrhage, rather than to resort to pressure over the main trunk during the process of excision of the diseased part.

The situation of the vessels of the lips (being nearest to its *mucous surface*), and the necessity of perforation of the orbicularis oris muscle by the vessel, in order to reach that situation, furnishes us an important practical point in arresting hemorrhage in wounds of the lip requiring sutures. In this class of cases, the sutures should always be passed *nearly through the entire thickness* of the lip, extending nearly, if not quite, to the mucous surface, since, by so doing, the vessels are subsequently partially compressed by the sutures, and the cut surfaces are more closely and neatly adapted to each other.

The *angular artery* (the terminal branch of the facial) has a point of practical surgical interest connected with it from its *distribution to the lachrymal sac,* since it passes along the inner border of the orbit to reach it; in cases of operation for lachrymal fistula, the sac should, therefore, be opened upon its *external portion,* in order to avoid wounding this vessel.

Operation for Ligation.

The facial artery may be ligated at its point of crossing over the body of the jaw (the anterior edge of the masseter muscle), if wounded upon the face, or, if the step be demanded, as a surgical procedure for the relief of a tumor of the face, deriving its nutrition from the facial artery. If, however, the tumor or wound implicate the cervical portion of the vessel, the artery must be tied at or near its point of origin from the carotid. If the former operation be performed, the seat of the artery can easily be detected by its pulsation; and, as it lies extremely superficially, it requires but an incision made along the body of the jaw, the skin of the neck being first drawn upward to bring the cicatrix in the neck, the division of the platysma fibres, and the encircling of the artery by a ligature.

If the artery is to be tied near to its point of origin, an incision along the line of the carotid should be made with its centre corresponding to a point *one-quarter of an inch above the level of the hyoid bone.* The posterior belly of the digastric muscle will be exposed, after dividing the integument, fascia, and the platysma, and the veins which lie in close but varying relations to the vessel at its point of origin must be carefully avoided. This muscle (the digastric) lies *above* the *facial artery,* at its origin, but soon crosses it; while the *hypo-glossal nerve* lies below it, and in close relation to its point of origin. The ligature is best passed from *below upward,* to avoid the nerve and the veins which lie anterior to the artery.

Anastomosis of the Facial Artery.

The facial artery, through its numerous branches, anastomoses with the following vessels:

(1) The *opposite* facial, through branches reaching the median line of the body.

(2) The *internal maxillary,* through its $\left\{\begin{array}{l}\text{infra-orbital}\\ \text{nasal}\\ \text{inferior dental}\\ \text{post. palatine}\end{array}\right\}$ branches.

(3) The *lingual,* through its sublingual branch.

(4) The *internal carotid,* through its ophthalmic branch.

(5) The *temporal,* through its transverse facial branch.

(6) The *ascending pharyngeal,* in the pharynx and soft palate.

By means of the fourth anastomosis, the *internal* and *external carotids* have a free point of collateral circulation; while the second group of anastomosis serves to establish a free communication between the *superficial* and *deep branches* of the external carotid artery.

THE OCCIPITAL ARTERY.

This vessel arises at a point on the posterior aspect of the external carotid, nearly *opposite* to the point of origin of the *facial artery* or about one inch distant from the bifurcation of the common carotid trunk. Its point of origin corresponds, therefore, nearly to the *lower border of the digastric muscle.* Near its origin, as it dips downward, it becomes covered by the stylo-hyoid muscle and the posterior belly of the digastric. The posterior portion of the parotid gland also covers it in this locality, and the *hypo-glossal nerve winds around it,* passing in a direction from behind forward. The course of this artery is long and winding, passing, at first, anterior to transverse processes of the cervical vertebræ, in a direction nearly perpendicular, then turning sharply in the interval between the transverse process of the atlas and the mastoid process of the temporal bone, and passing in a horizontal direction along the outer part of the base of the skull, till it reaches the occiput, where it becomes again directed upward and ramifies beneath the integument. Its calibre is, on the average, the *sixth* in point of size, as compared with the eight branches of the external carotid artery. On its way upward, after passing underneath the parotid gland, this artery *crosses* the internal carotid, the internal jugular vein, and the spinal accessory and pneumogastric nerves.

In its *horizontal* portion, it is covered by the sterno-mastoid, digastric, splenius, and trachelo-mastoid muscles, and rests upon the complexus, superior oblique, and the rectus capitis posticus major muscles. Injuries to this portion are, therefore, infrequent.

As it ascends upon the occiput, it passes through the cranial attachment of the trapezius muscle, and follows a tortuous course over the occiput as high as the vertex, where it divides into numerous small branches. This artery is the main source of hemorrhage in wounds of the scalp, in the posterior portion of the skull.

Peculiarities.

The occipital artery, though usually arising opposite the facial, is sometimes given off from the external carotid, above or below that point. The extreme limits of origin vary, between one inch and three-eighths, and one-quarter of an inch above the bifurcation of the common carotid.

It is occasionally derived from the *internal carotid,* and, in rare cases, it may arise from the *inferior thyroid* artery (a branch of the subclavian). It also arises often in common with the ascending pharyngeal and the posterior auricular arteries. The occipital artery sometimes passes *over* the trachelo-mastoid muscle instead of beneath it, but, in the rarest instances, does it ever pass external to the sterno-mastoid muscle.

The posterior auricular artery and some pharyngeal arteries are occasionally derived from the occipital.

Surgical Anatomy.

The occipital artery bears a most constant relation to the *hypo-glossal nerve,* which winds around it at about the point of origin of its sterno-mastoid branch, and is then carried forward to its distribution within the substance of the tongue.

This has been explained as a possible effort on the part of Nature *to protect this nerve from tension during the protrusion of the tongue,* since it is forced to descend from the anterior condyloid foramen before becoming looped around the vessel, and thus ample opportunity for great latitude of motion is afforded and a proportionate ability to endure strain from the elasticity of the artery, which would be absent were it wound around a bony prominence.

The artery may be ligated underneath the scalp where it is superficial, or, if necessity demands it, near its point of origin, or beneath the margin of the digastric muscle. The operation differs little from that required to ligate the facial,[1] in case the artery requires to be tied within the neck.

In cases of pulsating or vascular tumors of the scalp, attempts at ligation of the supplying vessels often are associated with great difficulty from the density of the tissues which invest them.

THE POSTERIOR AURICULAR ARTERY.

This is a vessel of small size, which arises from the posterior aspect of the external carotid in the vicinity of the apex of the styloid process; this point being nearly *two inches* from the centre of bifurcation of the common carotid artery.

It ascends along the styloid process of the temporal bone, in close relation with the parotid gland, till it reaches the point of junction between the cartilage of the ear and the mastoid process[2] of the temporal bone. At about this point, the artery is *crossed by the facial nerve,* and the *spinal accesory nerve passes behind it,* at about the same point. It then divides into two branches, an anterior and a posterior, the former of which anastomoses with the posterior division of the temporal artery, and the latter communicating with the occipital artery.

The *stylo-mastoid*[3] branch of the posterior auricular artery enters the foramen of that name in the temporal bone when it bears the closest relation to the *facial nerve* as it escapes at that foramen after passing through the aquæductus Fallopii. This vessel in young subjects gives off a small branch which, after passing through the Glasserian fissure, joins with the tympanic branch of the internal maxillary artery and forms a *vascular circle around the external auditory meatus,* from which vessels ramify upon the membrana tympani. These may be a source of hemorrhage in wounds of that important part of the ear mechanism.

Peculiarities.—The posterior auricular artery is frequently very small in size, and sometimes gives off no auricular branch. It is occasionally also a branch of the occipital artery.

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[1] See page 77 of this volume.

[2] One of the arteries which is liable to be injured in wounds of the mastoid region. See page 17.

[3] For the special importance of this trunk, see the vascular supply of the ear.

THE ASCENDING PHARYNGEAL ARTERY.

This vessel arises from the external carotid at a point situated, on the average, about *six-tenths* of an inch from the centre of bifurcation of the common carotid. It is a long, slender vessel of small size placed near its point of origin, deeply in the neck and on a plane posterior to the branches of the external carotid previously mentioned. It is given off from the *posterior surface* of the external carotid artery and ascends nearly vertically *between the internal carotid and the lateral wall of the pharynx* till it reaches the base of the skull (lying upon the rectus capitis anticus major muscle.)

It divides into three sets of branches of distribution, as follows:

1st. Those distributed to *muscles* and *nerves* and directed outward.

2d. Those distributed to the *pharynx,* which pass toward the median line of the body.

3d. Those distributed to the *meninges of the brain,* which pass vertically upward till they enter the cavity of the cranium.

The *external* set of branches are numerous small vessels, some of which supply the hypo-glossal nerve, the pneumogastric nerve, the first cervical ganglion of the sympathetic, and the lymphatic glands of that region.

The *internal set* of branches ramify between the superior and middle constrictor muscles of the pharynx which they supply, and are distributed also to the stylo-pharyngeal muscle and the mucous membrane of the pharynx. The largest of the pharyngeal branches passes inward, running upon the superior constrictor muscle of the pharynx and sends ramifications to the Eustachian tube, tonsils, and soft palate. This vessel frequently is abnormally developed in case of small size or the absence of the ascending palatine branch of the facial artery.

The arrangement of the branches of this ascending pharyngeal artery in the soft palate is as follows: After passing the superior constrictor muscle, the palatine branch divides into two twigs, one of which arches over the *upper margin* of the soft palate on its anterior surface and just beneath its mucous membrane, while the other arches over the *inferior border* of the palate in the same relative position, and thus the branches of the two sides complete two *arterial arches.*

The *meningeal* branches are the terminal branches of the ascending pharyngeal artery. They consist of several small vessels which enter the cavity of the cranium through foramina in the base of the skull.

One, the *posterior meningeal branch,* passes through the jugular foramen (foramen lacerum posterius) in company with the jugular vein and the spinal accessory, pneumogastric, and glosso-pharyngeal nerves which escape through the same foramen, and also with the *inferior* *meningeal branch* of the occipital artery, which enters the skull at the same point.

A second branch passes through the *foramen basis cranii* (foramen lacerum medium) in company with the internal carotid artery, the large petrosal nerve, and some veins, although the foramen is largely filled with cartilage.

A third branch occasionally is found to pass through the *anterior condyloid foramen,* in company with the hypo-glossal nerve which escapes through the same foramen.

These branches, after their entrance to the cavity of the skull, are all distributed to the dura mater. They may, therefore, prove a source of hemorrhage in depressed fracture of the skull, or in the operation of trephining.

Peculiarities.

The aseending pharyngeal artery varies considerably in its place of origin from the external carotid. It occasionally arises at the immediate point of bifurcation of the common carotid, or it may, in *extreme* limits, arise from a point varying from one inch to one inch and a half distant from that point. It is a most constant branch of the external carotid, but in about eight per cent of cases,[1] it is either a branch from a trunk in common with the occipital or derived from some other source, as the occipital or internal carotid arteries.

In rare cases,[2] two pharyngeal arteries have been observed, arising from the external carotid.

Surgical Anatomy.

The *ascending* pharyngeal artery is occasionally wounded in operations about the tonsils or the posterior wall of the pharynx, although its small size seldom renders the hemorrhage severe. One reported case of fatal hemorrhage is, however, on record.

THE TEMPORAL ARTERY.

This vessel is the smaller of the two terminal branches of the external carotid artery, and having a direction similar to that vessel, it seems to be its apparent continuation upon the external surface of the skull. It usually arises at a point slightly *below the condyle of the lower jaw,* and passes upward: while, at this point also, the other terminal branch of the external carotid artery (the internal maxillary) sinks under the inferior maxillary bone. This point of origin is, however, imbedded within the substance of the parotid gland, and contained in an interspace between the *neck of the condyle of the lower jaw* and the *external auditory meatus.*

As the artery is continued upward upon the face, it soon reaches the

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[1] Wyeth, op. cit.

[2] Gray: Anat. Descriptive and Surgical.

cutaneous surface of the zygoma (near to its root), where it may be easily compressed. About *two inches* above the zygomatic arch, it divides into two terminal branches, the anterior and posterior temporal arteries, which again divide and subdivide and ramify beneath the integument on the side and upper part of the head.

As it crosses the zygoma, it is covered by the attrahens auris muscle and a dense fascia which is given off from the parotid gland.

Peculiarities.

The temporal artery is frequently *tortuous.* This is most marked, however, in the aged. It occasionally gives off a branch of large size which runs to the upper part of the orbital arch. By joining with the ophthalmic, it may furnish large *frontal arteries* which ramify over the forehead.

The *branches* of the temporal, especially the transverse facial branch, often present certain peculiarities of origin and distribution. Thus the *transverse facial* artery *sometimes supplies the place of the facial.* It occasionally arises from the external carotid. It presents marked variations in its size, and is especially liable to be large if the facial artery be defective or absent.

The parotid branches vary also in their number, size, and situation of origin.

Surgical Anatomy.

In cases of excessive vascular supply to the orbit, eye, or meninges, ligature of the temporal has sometimes been performed, although the *anterior temporal* is usually the branch selected.

The relations of the temporal artery as it *passes over the zygomotic arch* are important to remember. It is here covered by the *temporal fascia,* which is extremely dense and inelastic, and is crossed by one or two veins. It is also closely related to *two large nerves,* the facial, and auriculo-temporal. It is on account of the temporal fascia that bleeding from the temporal artery should not be performed, since it not only prevents a free escape of blood, but also, from its inelasticity, renders the stoppage of the flow of blood difficult if compression only be used.

Again, *puncture of one of the veins* lying above the artery is liable to generate either a *varicose vein,* an *aneurismal varix,* or a *varicose aneurism.*[1] Injury to one of the neighboring nerves would result either in paralysis of the facial muscles or in severe neuralgic pains, if the auriculo-temporal nerve was not perfectly severed or its structure completely destroyed.

The *anterior temporal* artery, on the contrary, is subcutaneous and

[1] For points of differential diagnosis between these affections, see my work on Surgical Diagnosis. N. Y., 1880.

free from many of the objections associated with the main trunk in case ligation is demanded. It is a vessel of large size and should be selected for ligature, or the operation for bleeding, in preference to the main trunk.

The pulsation of the vessel should be the guide to the incision made to expose it, recollecting that the anterior temporal passes from a point nearly *two inches* above the *root of the zygoma* toward the forehead, in a *direction nearly horizontal,* for the first portion of its course.

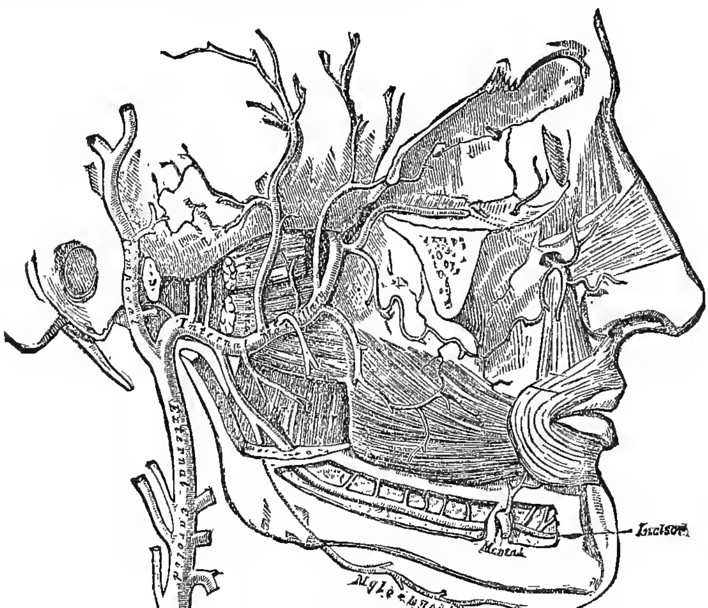

FIG. 55.—The internal maxillary artery, and its branches. (After Gray.)

THE INTERNAL MAXILLARY ARTERY.

This vessel is the *deep terminal branch* of the external carotid, and which, in point of size, if not in direction, is a continuation of that vessel.

It pursues a winding course under cover of the *ramus of the inferior maxillary bone* from its point of origin, where it is concealed by the parotid gland, until it reaches the spheno-maxillary fossa, where it furnishes its terminal branches. It may be considered physiologically as the *artery of mastication,*[1] since it supplies the structures pertaining to that act.

For the sake of greater facility in describing and arranging the

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[1] Hilton: Rest and Pain. N. Y., 1879.

numerous branches which this vessel gives off, and to present in a clearer form the general course of the vessel, it has long been customary with anatomists to divide this artery into three portions, as follows:

1st. The *maxillary* portion. 2d. The *pterygoid* portion. 3d. The *spheno-maxillary* portion.

The *maxillary* portion extends from its point of origin in the *parotid gland* to the anterior border of the *internal lateral ligament* of the lower jaw. In this portion, the artery lies horizontally, and is situated between the internal lateral ligament of the jaw and the ramus of the jaw. The artery here lies parallel with the auriculo-temporal nerve, and crosses the inferior dental nerve (both branches of the inferior maxillary division of the fifth pair), and is situated beneath the narrow portion of the external pterygoid muscle.

The *second* or *pterygoid* portion of the artery is defined by the *connection of the vessel to muscles* through its muscular branches. In this division, the artery rests upon the outer surface of the external pterygoid muscle, and is covered partially by the ramus of the jaw and the lower part of the temporal muscle. The direction of this portion of the artery is obliquely forward and upward.

The *third* or *spheno-maxillary* portion is again in close connection with the *superior maxilla;* and is contained in a fossa which that bone helps to form, termed the spheno-maxillary fossa. The artery enters this fossa through an interval between the *two heads* of the *external pterygoid muscle,* at which point it lies in close relation to *Meckel's ganglion,* and it is in this fossa that its six terminal branches are given off.

This artery possesses less surgical interest than those situated more superficially, as it is protected from injury by the base of the skull and the bones of the face.

Its *middle meningeal* branch, however, is of surgical importance, since it may be injured in fractures of the skull or in the operation of trephining.

Peculiarities.

The *place* of *origin* of the internal maxillary artery is very constant, except in those cases where the external carotid presents either an increase of or decrease from its normal length.

In rare instances, however, it has been seen to arise from the facial artery.

The *course* of the artery often differs from that described as the normal one. It may pass *between the two pterygoid* muscles, or *perforate* the *external pterygoid* at its centre; or it may be bound to the posterior margin of the external pterygoid plate of the sphenoid bone, in which case either a notch or foramen for the artery can be detected.

In cases, when the internal carotid artery has been found to be absent, large branches from the internal maxillary have been detected which have passed through the foramen rotundum and the foramen ovale and thus supplied its place. In such an abnormality, ligation of this artery, or of the external carotid would greatly decrease the *blood-supply of the brain.*

The *middle meningeal* branch occasionally gives off a *lachrymal* branch, but otherwise the branches present few peculiarities worthy of special mention.

Surgical Anatomy.

The cavity of the orbit may sometimes become the seat of suppurative inflammation, either as the result of traumatism or the extension of inflammation from the eye or its appendages, or from the antrum or the temporal or parotid regions, by means of the blood-vessels passing through the zygomatic fossa. Such a condition is liable to produce death by extension of the inflammation to the brain or the cavernous sinus. Such remarkable cases as that reported by Blandin, where a fracture of the neck of the condyle of the lower jaw was followed by a protrusion of the eye and rapid death can easily be explained by the remarkable anastomosis which exists between the vessels of the zygomatic fossa and those of the orbit, while that type of wound which results in hemorrhage from the internal maxillary artery or some of its branches is seldom arrested by even a ligature of the common carotid trunk, on account of the extent of the collateral circulation in this vicinity. In wounds of the hard palate which is chiefly supplied by this artery, it is frequently difficult to control hemorrhage on account of the density of the tissues in which the vessels are imbedded. It was for this reason that Dupuytren urged cauterization of bleeding points in the roof of the mouth in preference to attempts at ligation. Within the cavity of the mouth the soft palate hangs loosely at its posterior portion, and was undoubtedly designed by Nature to act chiefly as a valve to close the posterior nares and upper portion of the pharynx. It not infrequently happens, however, that the soft palate has to be divided in order to remove large polypi of the throat or nasal cavity. This operation is, however, associated with little hemorrhage and the damage is easily repaired, thanks to Roux and Graefe, by the steps of staphylorrhaphy.

In amputating an elongated or hypertrophied uvula, little hemorrhage is experienced, thus further showing the limited blood-supply of the soft palate.

THE INTERNAL CAROTID ARTERY.

This vessel which supplies the eye and brain, is remarkable for the *number of curvatures* that it presents in the different portions of its course. These curvatures are explained as an effort on the part of Nature to offer a *mechanical obstruction* to a *rapid current of blood* entering the brain, since increased friction is thus produced and much of the danger to rupture of the cerebral capillaries from excessive heart's action is thus obviated.

The artery is usually studied, as to its course and relations, by dividing it into four distinct portions. First, the *cervical portion,* including all of the artery below the carotid canal; second, the *petrous portion,* including that part of the artery which lies within the carotid canal; third, the *cavernous portion,* which includes that portion of the artery lying within the cavernous sinus; and, fourth, the *cerebral portion,* or the balance of the artery before it divides into its terminal branches.

The internal carotid artery, as before stated, is distributed to the brain, and also to the eye and its appendages, hence its surgical importance. In point of calibre it equals that of the external carotid artery.

Cervical portion. This portion of the artery varies much in its length, being dependent, not only upon the point of bifurcation of the common carotid artery which sometimes varies, but also upon the stature of the individual. At its point of origin this vessel is easily accessible, being superficially placed within the superior carotid triangle and lying on the same level with but behind the external carotid.

Petrous portion. The internal carotid artery within the petrous portion of the temporal bone, ascends perpendicularly for a short distance, then inclines forward and inward near to the inner side of the Eustachian tube, and again ascends as it passes from the carotid canal into the cavity of the skull. In this portion the *cavity of the middle ear* is in the closest relation, being separated from the artery only by a thin lamella of bone, which, in the young subject, is cribriform, and, in old age, is often nearly deficient from absorption; it can therefore be wounded by puncture through the ear. The artery is separated from contact with the bony walls of the carotid canal by an investing tubular process of the dura mater; but it has, in direct contact with it, the carotid plexus of nerves, which are derived from the sympathetic system. Fracture of the petrous portion of the temporal bone seldom involves the artery on account of its protective sheath derived from the dura mater.

Cavernous portion. On passing out of the carotid canal, the internal carotid artery, which has now entered the interior of the skull, ascends a short distance to reach the body of the sphenoid bone where it enters the *cavernous sinus,*[1] having first perforated the layer of dura mater which forms the outer boundary of that venous channel.

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[1] Within this sinus the following relations are important and may be shown by the following diagram:

Internally.	*Externally.*
Internal carotid artery.	Third cranial nerve.
Sixth cranial nerve.	Fourth " "
Carotid plexus of nerves.	Ophthalmic division of the fifth cranial nerve.

Within this sinus the artery has relations with the third, fourth, fifth, and sixth cranial nerves and is invested by the lining membrane constituting the sinus. It remains within this venous cavity, till the anterior clinoid process of the sphenoid bone is reached, when the course of the artery is suddenly deflected upward. Perforating the layer of dura mater forming the upper or *cerebral wall* of the cavernous sinus, it is then received into a sheath of the arachnoid membrane, and from this point its fourth anatomical division may be said to commence.

Cerebral portion. This portion of the internal carotid artery lies to *the outer* side of the optic nerve, having the third cranial nerve (motor oculi) external to it, and extends to the inner extremity of the fissure of Sylvius, which separates the frontal and temporal lobes of the cerebrum. It may be said to commence at that point where the artery pierces the cerebral wall of the cavernous sinus.

I have entered thus into detail as to the course of this artery, from the point at which it entered the carotid canal, as its relations may have a practical bearing upon fractures of the base of the skull (see page 20), and, in cases of carious disease of the petrous portion of the temporal bone, the artery may possibly become involved.

Peculiarities.

The internal carotid varies in its *length* on account of abnormalities of the common carotid, and also from variations in the length of the neck. It also takes its *origin* occasionally from the *aortic arch,* and, in rare instances, it has been observed to lie nearer the median line of the body at its point of origin than the external carotid.

This vessel may be extremely *tortuous* instead of straight, for the greater portion of its length; and cases are on record where the *absence* of this artery has been discovered. In one of these cases the internal maxillary artery supplied its place with two abnormal branches which passed through the foramen rotundum and the foramen ovale.

The internal carotid artery may also occasionally give off branches in its *cervical* portion.

Surgical Anatomy.

Hemorrhage may occur from wounds involving the internal carotid artery. These wounds usually occur from a stab received in the neck, or gun-shot wounds involving the deeper structures of the neck. It may also be wounded by deep penetrating wounds received *within the mouth,* as of falling upon a pipe, pencil, etc., when held in the mouth; from a thrust of a foil or pointed weapon; or from a bullet wound received within the mouth. In cases of operations about the tonsil, as during its removal, incision for abscess, etc., the internal carotid may possibly be wounded and fatal hemorrhage ensue.

Cases of death from ulceration into this vessel in severe attacks of suppurative tonsillitis are on record.[1]

The *ophthalmic artery* arises from the internal carotid, near the anterior clinoid process of the sphenoid bone, and passes forward to supply the eye, the orbit, and portions of the face.

It escapes from the cavity of the skull through the *optic foramen*, and is here placed below and to the outer side of the optic nerve, which also enters the orbit by the same foramen.

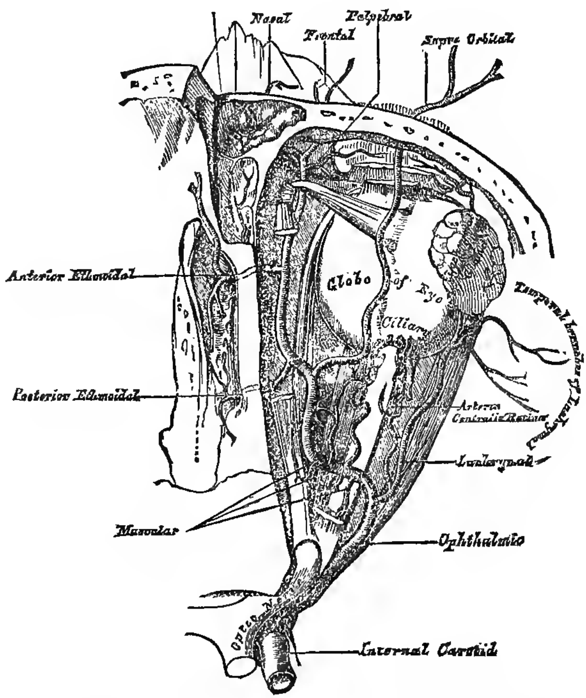

FIG. 56.—The ophthalmic artery and its branches, the roof of the orbit having been removed. (After Gray.)

Within the orbit, this vessel passes *across the nerve*, and thus reaches the inner side of the same. It then runs horizontally forward to the inner angle of the eye, passing, on its way to this point, under the lower border of the superior oblique muscle, and divides, at the internal angle of the eye, into two terminal branches: the *frontal* and the *nasal*, which are distributed upon the face.

In its course, it gives off numerous branches, which are destined to

[1] Blandin, op. cit.

supply the eye and its appendages. These branches are usually divided, for convenience of description, into an orbital and an ocular group, the former sending its blood only to the parts forming the orbit, while the latter is distributed to the globe of the eye and its muscles.

The *lachrymal* branch is the first, and, perhaps, the largest of the branches of the ophthalmic artery.

It is given off in the immediate vicinity of the optic foramen and not infrequently before the ophthalmic artery enters the orbit.

It is a long branch, and passes forward beneath the periosteum of the roof of the orbit until the external rectus muscle is reached. It then accompanies the lachrymal nerve along the upper border of the external rectus muscle, and, guided by it, reaches the *lachrymal gland*, to which it is distributed by numerous branches.

Terminal branches afterward escape from this gland, and are distributed to the conjunctiva and upper eyelid.

The lachrymal artery anastomoses with

(1) The *deep temporal* artery by a malar branch which passes through a foramen in the malar bone.

(2) The *transverse facial* artery through a malar branch which also perforates the malar bone and escapes upon the cheek.

(3) The *middle meningeal* artery, through a branch passing backward through the sphenoidal fissure, being distributed upon the dura mater.

(4) The *palpebral* arteries, through its terminal branches in the upper eyelid.

Peculiarities.—The lachrymal is occasionally derived from the middle meningeal artery, or from one of its anterior branches.

The *supra-orbital branch* of the ophthalmic artery arises from that vessel at a point where the artery lies immediately *above* the optic nerve. It rapidly rises to the roof of the orbit, thus lying above all the muscles, and, in company with the *frontal nerve*, passes forward, between the periosteum and the levator palpebræ, to the *supra-orbital foramen*, where both the artery and nerve escape.

After its exit, the artery divides into a superficial and a deep branch, which supply the pericranium, the muscles, and the integument of the forehead.

The *ethmoidal arteries* are two in number: a *posterior* and an *anterior*. The former, which is of small size, passes through the posterior ethmoidal foramen in the inner wall of the orbit, and, after giving some small branches to the posterior ethmoidal cells, enters the skull. After supplying the dura mater by its meningeal branches, it here sends its terminal filaments (nasal branches) through the foramina of the cribriform plate of the ethmoid bone, in company with filaments of the olfactory nerve, into the nasal fossæ. Thus, hemorrhage from the nose may deplete both the meninges and the orbit.

The *anterior* ethmoidal artery passes through the anterior ethmoidal foramen, in company with the nasal division of the ophthalmic nerve, and, after supplying the *anterior ethmoidal cells* and the *frontal sinuses,* it then enters the cranium. Within the skull, this artery, like the posterior artery, gives off a *meningeal* branch to the dura mater of the anterior fossa of the skull, and a *nasal* branch, which escapes at the cribriform plate of the ethmoid bone into the cavity of the nose.

The *palpebral arteries* are two in number: a superior and an inferior, since they correspond to the lids which they are destined to supply.

They usually arise by a common trunk in the neighborhood of the pulley of the superior oblique muscle, but both arteries may have a direct point of origin from the ophthalmic artery.

They *encircle the eyelids* near their free margins, forming a superior and an inferior arch, which lie between the tarsal cartilages and the orbicularis palpebrarum muscle.

The superior palpebral artery anastomoses at the *outer side* of the orbit with the orbital branch of the temporal artery, while the inferior palpebral artery anastomoses at the *inner side* of the orbit with the orbital branch of the infra-orbital artery (a branch of the internal maxillary). From this last anastomosis a branch is given off, which supplies the mucous membrane of the nasal duct as far as its inferior meatus.

The *frontal artery,* one of the terminal branches of the ophthalmic, passes from the orbit at its inner angle, and, ascending upon the forehead, supplies its pericranium and the muscles and integument of that region.

The *nasal* artery, the other terminal branch of the ophthalmic, takes its course forward above the tendon of the orbicularis muscle, to the root of the nose, where it ramifies and anastomoses freely with the nasal and angular branches of the facial artery.

The *ciliary arteries* are divisible into three sets: the *short, long,* and *anterior* ciliary branches.

The *short* ciliary vessels vary from twelve to fifteen in number, and, as they pass forward to reach the posterior part of the sclerotic coat of the eye, almost completely *inclose the optic nerve.* They pierce the sclerotic at the posterior portion of the globe of the eye, about one or two lines from the circumference of the optic nerve, and are distributed to the choroid coat and the ciliary processes of that organ.

The *long ciliary arteries,* two in number, also enter at the back part of the eye, but pass forward between the sclerotic and the choroid coats, one on each side of the eyeball, till they reach the ciliary ligament, where they divide into branches. These branches form *two arterial circles,* one around the circumference, and the other around the free margin of the iris, which are connected by intermediate branches of communication, passing through the substance of the iris.

The *anterior ciliary arteries* are often derived from some of the muscular branches of the ophthalmic artery. They form an *arterial circle* around the fore-part of the eyeball, within a line or two of the circumference of the cornea.

All of these arteries anastomose within the eyeball.

The *arteria centralis retinæ* is one of the smallest branches of the ophthalmic artery. It pierces the sheath and substance of the optic nerve, and runs imbedded within it until it reaches the retina, where it ramifies, its branches extending forward until the ciliary processes are reached.

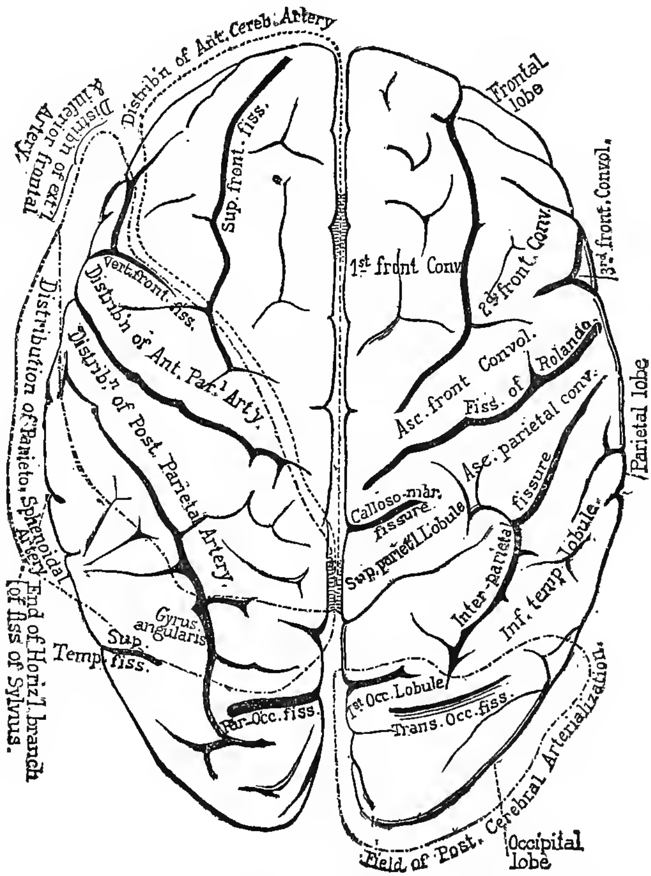

FIG. 57.—Vascular territories of the superior cerebral surface. (After Duret.) The dotted lines indicate the territories of the anterior, middle, and posterior cerebral arteries.

In the fœtus, a small vessel passes directly through the vitreous humor, within the posterior chamber of the eye, and is distributed to the posterior surface of the capsule of the crystalline lens.

The CEREBRAL branches of the internal carotid artery are four in number, viz., the anterior cerebral, the middle cerebral, the posterior communicating, and the anterior choroid arteries.

The *anterior cerebral* artery arises from the internal carotid, at the inner extremity of the fissure of Sylvius. It passes forward, in company with its fellow of the opposite side, in the longitudinal fissure which separates the two hemispheres of the cerebrum, and gives off, soon after its origin, a communicating branch, two lines in length, which connects the two arteries, called the *anterior communicating artery.*[1] This branch forms the anterior boundary of the circle of Willis.

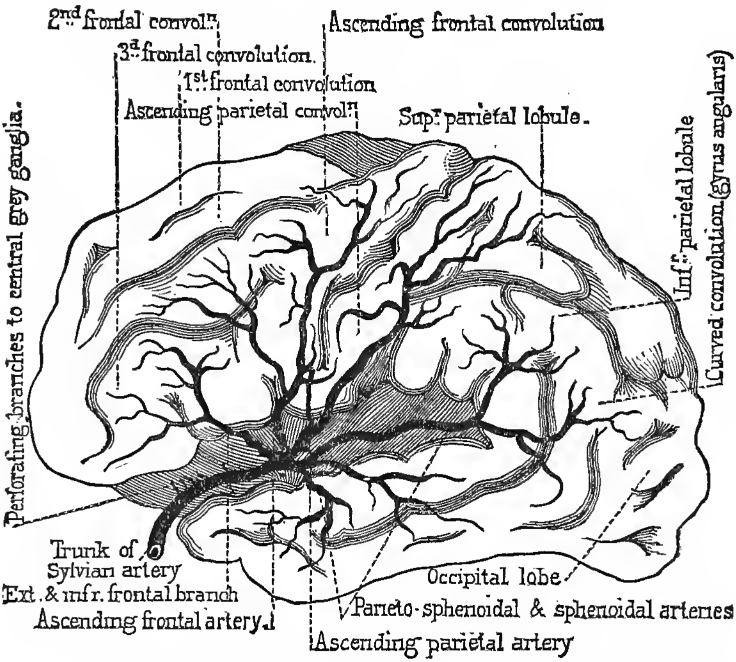

FIG. 58.—Distribution of the middle cerebral artery—*partially schematic.* (After Charcot.)

The anterior cerebral arteries, after curving around the anterior part of the corpus callosum (the great transverse commissure of the brain), ramify upon its inner surface, and anastomose at the bottom of the central part of the longitudinal fissure with the posterior cerebral arteries. By these vessels are supplied the following parts from behind forward: (1) the third ventricle; (2) the upper surface of the frontal lobes of the brain; (3) the anterior perforated space, and, through it, the corpus stri-

[1] For relation of this portion of the circle of Willis to the optic nerve and its effect on vision, the reader is referred to the author's late work: The Applied Anatomy of the Nervous System. New York, 1881.

atum; (4) the optic and olfactory nerves; (5) the inferior surface of the frontal lobes of the hemispheres, and (6) the corpus callosum.[1]

The *middle cerebral artery* is the largest branch given off from the internal carotid, and is in a direct axis of continuation with the main trunk of that vessel. It is contained in the fissure of Sylvius (which separates the frontal and parietal lobes and the parietal and temporo-sphenoidal lobes of the cerebrum), and within it, this artery divides into three branches: an *anterior* branch, which supplies the pia mater investing the frontal lobe; a *posterior* branch, which supplies the pia mater investing the parietal lobe, and a *middle* branch, which is distributed to the Island of Reil (a collection of gray matter, called the *central lobe*, within the fissure of Sylvius). This vessel gives off a few branches also which, after penetrating the anterior perforated space, are distributed to the corpus striatum.

Surgical Anatomy.

The middle cerebral artery, especially that of the left side, is, by far, the most common seat of *embolic obstruction*, since the upward current of blood finds a nearly straight channel from the aortic arch to this vessel. The left side is the more frequently affected, since the common carotid of that side arises from the arch of the aorta at such an angle as to favor the entrance of foreign bodies floating in the blood-current; while the innominate artery, on the right side, leaves the aorta at an angle directed away from the main current, and, for that reason, frequently escapes the entrance of foreign bodies, in spite of its large calibre.

The symptoms produced by the *entrance of an embolus* into the middle cerebral artery, or one of its branches, are chiefly dependent upon impairment of nutrition in the parts to which that artery distributes its blood. Thus we usually have sudden paralysis (most frequently of the *right* side of the body, since the left middle cerebral artery is most commonly affected). *Aphasia* is also a prominent diagnostic symptom, since the nutrition to the *Island of Reil* and the *third frontal convolution* is impaired.[2] *Consciousness* is often retained, since no compression of nerve-centres is produced; and, from *collateral circulation*, the paralysis may show a marked improvement soon after the attack. If recovery from the paralysis takes place, it usually indicates an absorption of the embolus through a process of fatty degeneration.[3]

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[1] See functions of these parts and their bearings on diagnosis in the chapter on the Brain in the author's late work: The Applied Anatomy of the Nervous System.

[2] For the location of the centre of articulate speech, and the clinical types of aphasia, the reader is referred to the late work by the author: The Applied Anatomy of the Nervous System.

[3] See my work on Surgical Diagnosis. New York, 1880.

The *distinctive* symptoms between embolism and apoplexy, provided the attack is not immediately fatal, are best grouped as a differential diagnosis

Apoplexy.	*Embolism.*
The attack, if serious, but not immediately fatal, is accompanied by coma and insensibility.	Under the same conditions, consciousness is liable to be present during the attack.
The indications of cerebral compression are present, as shown by the following symptoms:	The indications of cerebral anæmia exist, as shown by the following symptoms:
The breathing is stertorous.	The respirations are normal (as a rule).
The face is flushed.	The face is pale.
The pulse is full and slow.	The pulse is rapid and feeble.
The pupils are irregular.	The pupils are uniform.
No aphasia exists (as a rule).	Aphasia is diagnostic.
The paralysis is slow in improvement.	The paralysis usually improves slightly within twenty-four hours.
The arteries are often felt to be atheromatous.	The arteries are normal.
No cardiac lesion exists if the attack be uncomplicated,	The aortic and mitral valves are usually found to be abnormal.
A history of previous high living is usually present.	A history of previous rheumatism and endocardial inflammation is generally detected.

Both may have been preceded by similar attacks; but in each a recurrence is liable to take place, even should no previous history of a former attack exist.

The *posterior communicating artery* arises from the back part of the internal carotid, and serves to join it with the posterior cerebral branch of the basilar artery. This artery completes, by this anastomosis, the arterial circle at the base of the brain termed the "circle of Willis." The size of this artery not only varies in different subjects, but is frequently larger upon one side of the body than upon the other. It may, in some cases, present itself as a small branch of the internal carotid, while, in others, it may be of such large dimensions as to give the appearance of an abnormal origin of the posterior cerebral artery from the internal carotid trunk.

Hemorrhage within the cavity of the cranium may occur in one of three situations: (1) between the bones and the internal periosteum; (2) between the dura mater and the parietal layer of the arachnoid, and (3) into the brain tissue or upon its surface.

VERTEBRAL ARTERY.

The point of origin of the vertebral artery has a direct surgical importance, since upon its proximity to a ligature placed around the first portion of the subclavian, depend, to a great extent, the chances of recovery. In dissections made by Dr. John A. Wyeth,[1] of New York, upon an equal number of males and females, the average distance of the origin of the vertebral was about *one-third* of an inch from the inner border of the scalenus anticus muscle toward the median line, upon the *right* side of the body, while upon the *left* side it was almost invariably present at the point of abrupt change in the course of the subclavian as it arches over the first rib, which, however, corresponds to nearly the same relative point. The left vertebral artery is usually the larger in calibre, and at its point of origin its axis lies more nearly in the direct line of the current of blood than that of the right side, which perhaps accounts for the increased size of the left vertebral artery.

This artery, after its escape from the subclavian artery, ascends through a foramen in the transverse process of each cervical vertebra, and, after pursuing a winding course, enters the skull through the foramen magnum, and terminates in front of the medulla oblongata, by uniting with its fellow of the opposite side to form the basilar artery. The singular course of this vessel, which has been thus generally indicated, requires a more precise description.

The artery first enters a foramen in the base of the transverse process of the sixth cervical vertebra, and subsequently passes directly upward through a foramen similarly situated in each of the cervical vertebræ until the axis is reached. It here inclines outward, in consequence of the greater width of the atlas, to reach the foramen in the transverse process of that bone. It then passes through this last-named foramen, and, winding backward behind the articular process of the atlas, runs along in a deep groove on the upper surface of the posterior arch of that bone, and, piercing the occipito-atloid ligament and the dura mater, enters the skull through the foramen magnum of the occipital bone.

This artery, previous to its entrance to the skull, is contained within a *triangular space,* which is bounded by the rectus capitis posticus major internally, the obliquus capitis superior externally, and the obliquus capitis inferior below.

While within the canal formed by the transverse processes of the vertebræ, this artery is accompanied by a plexus of sympathetic nerves and the vertebral *vein,* which lies in front of the artery. The cervical nerves arising from the spinal cord and escaping from the intervertebral foramina, lie behind the artery, so that, at these points of escape for the nerves, the artery is placed between the vertebral vein and the cervical branches of the cerebro-spinal system. As the artery passes through the triangle just named and bounded, it is covered in by the rectus capitis posticus major and the complexus muscles.

Within the cavity of the skull, as the artery winds around the medulla

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[1] Surgical Essays. New York, 1879.

oblongata, it is located between the hypo-glossal nerve and the anterior branch of the sub-occipital nerve.

Branches.—The branches of the vertebral artery may be divided into two sets: (1) Those given off within the neck, and (2) those given off within the cranium.

Cervical Branches.	*Cranial Branches.*
Lateral spinal.	Posterior meningeal.
Muscular.	Anterior spinal.
	Posterior spinal.
	Inferior cerebellar.

The *lateral spinal* branches enter the cavity of the spinal axis by passing through the intervertebral foramina. They chiefly pass along the side of the spinal cord, close to the roots of the spinal nerves, and supply the meninges of the cord, but some branches are distributed directly to the posterior surface of the *bodies* of the cervical vertebræ.

The *muscular* branches are given off near the articular process of the atlas, and supply the deeply seated muscles of the cervical region and anastomose with the occipital and deep cervical arteries.

The *posterior spinal* arises at an obtuse angle from the vertebral artery after its entrance to the cavity of the cranium. It passes backward around the medulla oblongata to reach the posterior portion of the spinal cord, where it descends and inosculates with small vessels, accompanying the cervical and dorsal nerves through the intervertebral foramina. It can be traced as low down as the cauda equina at the second lumbar vertebra. This artery, at its commencement, gives off an ascending branch, which extends to the side of the fourth ventricle of the brain.

The *anterior spinal* artery is larger than the preceding branch of the vertebral. It descends obliquely in front of the medulla till it reaches the border of the foramen magnum, where it unites with the artery of the opposite side to form a common trunk. This single vessel then descends along the front of the spinal cord for a *short* distance only, since the small artery, called the *anterior median artery* (see Fig. No. 59), which apparently runs from one end of the spinal cord to the other, is, in reality, formed by a series of small vessels, which enter the spinal canal through the inter-vertebral foramina at the different regions of the spinal column.

These anastomosing branches are derived as follows:

(1) From the *vertebral* and *ascending cervical* arteries in the neck.

(2) " " intercostal arteries in the dorsal region.

(3) " " $\left\{\begin{array}{l}\text{lumbar}\\\text{ilio-lumbar}\\\text{lateral sacral}\end{array}\right\}$ arteries, in the lumbar region.

This chain of anastomosing vessels is placed beneath the pia mater of the spinal cord and along the anterior median fissure. Its numerous branches supply the pia mater and the substance of the cord, and send branches to the cauda equina.

The *posterior meningeal artery* (occasionally two branches) is given off from the vertebral near to the foramen magnum. It supplies the falx cerebelli, and ramifies between the dura mater and the bone in the posterior fossa of the skull.

The *inferior cerebellar artery* is the largest branch of the vertebral (although occasionally a branch from the basilar), and arises near to the pons Varolii. It passes first between the hypo-glossal and pneumo-gastric nerves, then crosses the restiform bodies, and reaches the under surface of the cerebellum. Here two branches are given off, one of which passes in through the notch between the two hemispheres of the cerebellum, while the other ramifies over the inferior surface of that portion of the brain, and at its edge anastomoses with the superior cerebellar arteries which supply its upper surface.

This artery, by means of small branches, supplies blood to the *choroid plexus* within the substance of the brain, in the vicinity of its fourth ventricle.

THE BASILAR ARTERY.

A single trunk, formed by the union of the two vertebrals in the median line, is so called from its lying upon the basilar process of the occipital bone. It extends from the posterior to the anterior border of the pons Varolii, lying underneath the arachnoid, and is, therefore, in its length equal to the breadth of the pons.

Branches.—It divides at its anterior termination into two branches: the *posterior cerebral* arteries, and in its course gives off the *anterior cerebellar,* the *posterior cerebellar,* and *transverse* branches. It also gives unnamed branches to the substance of the pons Varolii.

The *transverse* branches of the basilar artery are several in number; one of these accompanies the auditory nerve within the internal auditory canal, and is called the *auditory artery.* It is subsequently distributed to the labyrinth of the ear. Other of the transverse branches are distributed to adjacent portions of the brain. A large transverse branch receives also a special name, being called the *anterior inferior cerebellar artery.* It is distributed to the anterior part of the under surface of the cerebellum.

The *superior cerebellar artery* arises from a point near to the termination of the basilar artery, in fact, so close to the point of bifurcation that many anatomists describe the basilar artery as dividing into four terminal branches instead of two.

Each superior artery of the cerebellum turns, immediately after its origin, behind the third nerve, then enters the groove between the pons Varolii and the crus cerebri, then winds around the crus, opposite the origin of the fourth nerve, to reach the upper border of the cerebellum, where it divides into its branches, and is distributed to the upper surface of that division of the brain.

Branches are given off from this artery also to the *pineal gland* and *velum interpositum.*

The *posterior cerebral* artery is larger than the preceding branch of the basilar, and is separated from it by the *third nerve,* which lies between the two arteries at their point of origin. It turns backward, at first parallel with the last-named vessel, and then runs outward and upward upon the under surface of the posterior lobe of the cerebrum, till it nearly reaches the posterior extremity of the corpus callosum. This artery divides into numerous branches and anastomoses with the anterior and middle cerebral vessels.

Near its point of origin, it receives the *posterior communicating* branch of the internal carotid, and the two posterior cerebral arteries thus form portion of the circle of Willis, which will be described in subsequent pages of this work.

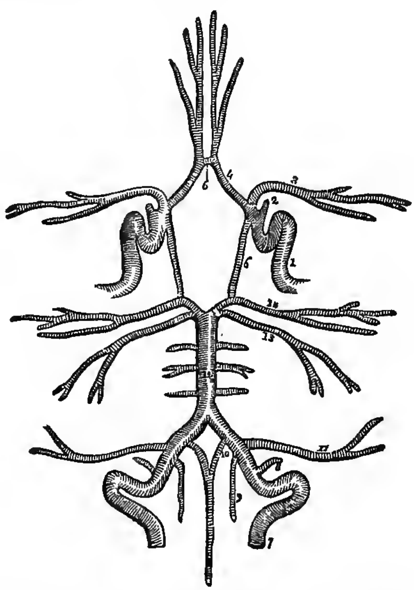

FIG. 59.—A diagram of the circle of Willis. (After Wilson.) 1, carotid artery; 2, the ophthalmic artery divided across; 3, the middle cerebral artery; 4, the anterior cerebral artery; 5, the anterior communicating artery; 6, the posterior communicating artery; 7, the vertebral artery; 8, posterior meningeal artery; 9, posterior spinal artery; 10, the two anterior spinal branches, uniting to form a single vessel; 11, the inferior cerebellar artery; 12, the basilar artery, giving off transverse branches to either side.

The posterior cerebral artery gives off a *posterior choroid* branch, which, like the anterior choroid branch of the internal carotid, is distributed to the interior of the brain. It sends filaments to the velum interpositum and the choroid plexus.

CIRCLE OF WILLIS.

A remarkable anastomosis exists between the vessels at the base of the brain, by which the circulation, not only of the brain, but also of all the structures entering into the formation of the head and neck, may, to a great extent, *be equalized,* and any obliteration of one or even two of the larger vessels may be speedily remedied by a corresponding enlargement of the others. This anastomosis, which is known as the "*circle of Willis,*" results from a series of communications between the following branches: (1) The two *anterior cerebral* arteries are connected by the anterior communicating branch. (2) The *internal carotid* arteries of either side are united to the posterior cerebral arteries by the posterior

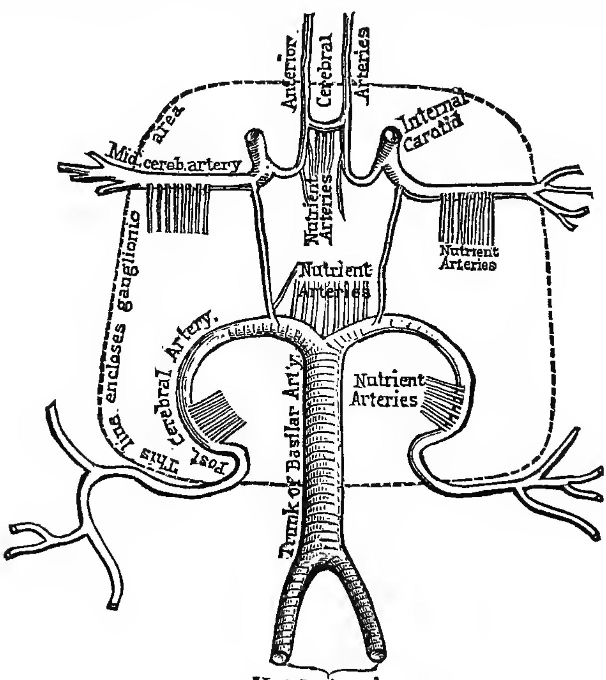

FIG. 60.—Scheme of arterial circulation at the base of the encephalon, intended to show the origin of the nutrient arteries which arise from the circle of Willis. (After Charcot.)

communicating branches. (3) The *posterior cerebral* arteries themselves arise from a single trunk, viz.: the basilar artery, and (4) the *anterior cerebral* arteries are direct branches of the internal carotids. Thus from before backward we perceive the anterior communicating artery, next the two anterior cerebrals, next the internal carotid trunks, next the two posterior communicating arteries, next the two posterior cerebral arteries, and finally the basilar artery, where the last-mentioned vessels converge.[1]

[1] For a discussion of the bearings of the circle of Willis upon defects in vision,

ARTERIAL SUPPLY OF SPECIAL REGIONS OF THE HEAD.

In recapitulation of the arteries derived from the principal vascular trunks of the head, it may be of service to the surgeon or the medical practitioner to recall in a tabulated form the *various sources* of vascular supply to special structures which have at times great surgical interest and importance.

The MENINGES OF THE BRAIN AND SPINAL CORD receive arterial blood from the following sources:[1]

(1) The *anterior* meningeal artery (a branch of the internal carotid).
(2) The *middle* " " (" " internal maxillary).
(3) The *small* " " (" " internal maxillary).
(4) The *posterior* " " (" " vertebral artery).
(5) The *inferior* " " (" " occipital artery).
(6) Small branches which are not specially named, but still distributed to the meninges. Among these, the more important ones are:
 (*a*) Branches to the meninges from the ascending pharyngeal.
 (*b*) " " " " " lachrymal.
 (*c*) " " " " " posterior ethmoidal.
 (*d*) " " " " " anterior ethmoidal.
 (*e*) " " spinal meninges from the vertebral artery.

Of these branches, the anterior meningeal artery and the meningeal branches of the two ethmoidal and lachrymal arteries supply the anterior fossa of the skull, the middle and small meningeal, and some branches of the ascending pharyngeal, which enter the skull at the foramen basis cranii, supply the middle fossa, while

The TYMPANUM[2] receives its blood chiefly from the following sources;

(1) The tympanic branch of the internal maxillary which enters at the *Glasserian fissure.*
(2) The tympanic branch of the internal carotid which enters through a *small foramen within the carotid canal.*
(3) The stylo-mastoid artery (a branch of the posterior auricular) which enters the aquæductus Fallopii through the *stylo-mastoid* foramen.
(4) The Vidian artery (a branch of the internal maxillary, which passes through the Vidian canal and accompanies the large petrosal nerve through the hiatus Fallopii.
(5) The petrosal branch of the middle meningeal artery, which enters at the hiatus Fallopii.
(6) Branches from the ascending pharyngeal artery, which enters along the Eustachian tube.

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see chapter on Optic Nerve, in the Author's late work: The Applied Anatomy of the Nervous System. N. Y., 1881.

[1] Darling and Ranney: Essentials of Anatomy. New York, 1880.

[2] Darling and Ranney, op. cit.

HEMORRHAGE.

To die of repeated hemorrhages, while perhaps the most painless of deaths, is the most awful. With each succeeding hemorrhage, dissolution is so distinctly intimated, and the patient so conscious that his strength is fast ebbing, that he clings to life. The most resolute are overcome with an anxiety which they cannot conceal, and look around for some one to delay, at least, the fatal moment.

But if there be a *sudden* hemorrhage from a vessel opened in an operation, or from an aneurism, or from some wound, the arteries of which cannot be discovered, there is *immediate* danger of death to the patient even while in the hands of the surgeon. Those who have witnessed the agitation of such scenes can best judge of the importance of this subject.

John Bell,[1] in his essay on hemorrhage, though undoubtedly influenced by the defective means of arrest then existing, closes a paragraph with these words: "Were this *one* danger removed, would not the young surgeon go forward in his profession almost without fear?"

I question if even our present enlightenment has entirely dispersed this element of anxiety.

Hemorrhage is usually classed into three distinct varieties: 1st. *Arterial,* as indicated by a bright-red color of the blood and an intermitting flow; 2d. *Venous,* as indicated by a continued flow and darker color; 3d. *Parenchymatous,* as indicated by a *general* oozing from the capillaries of an injured surface.

Causes primarily modifying Hemorrhage.

The amount of hemorrhage is *modified,* at first, by the number of vessels wounded, and by the smoothness of the *cut* surface.

This latter element is especially important in vessels of large calibre, since an injury with a dull instrument, or the rending of a vessel from violence, leaves the mouth in a condition to offer more or less resistance in itself to the rapid escape of blood, independent of the changes which occur in the coats of the wounded vessel subsequent to its injury.

Causes tending to prolong Hemorrhage.

There are, however, other causes which may modify hemorrhage *later on,* and, by *prolonging* it, tend to greatly increase the danger to life. Under this head I would mention:

1st. *Gravity.*

2d. *High temperature,* whether in the wound or surrounding atmosphere, by delaying coagulation.

3d. *Muscular expiratory efforts,* especially in wounds of the neck.

4th. *Obstruction to a free venous return.*

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[1] Treatise on Surgery. London, 1821.

5th. *Obstructed or delayed contraction of vessels,* as occurs in hepatic hemorrhage; from the teeth; from the nutrient artery of bone; from disease of the vessel; and from atony of a vessel.

6th. *Diseases of blood,* preventing coagulation or assisting exudation, as in *vicarious hemorrhage,* purpura, yellow fever, etc.

7th. *Congenital anatomical defects* in the construction of vessels. Wilson's case,[1] coats only one-half normal thickness. Blagden's case,[2] transparent coats—died from the pulling of a tooth. Wachsmuth's case —death from a ruptured hymen.

Symptoms due to hemorrhage.—When a patient suffers from the impetuous bleeding of some large artery, from a ruptured aneurism or wounded viscera, the face at once becomes deadly pale, a dark circle around the eyes is perceived, the lips change to a blackish hue, and the extremities become rapidly cold. The patient faints, revives but to be conscious of his danger, and faints again. The voice is lost; there is an anxious and incessant tossing of the arms, with that restlessness which is the sign of the approaching end. The head is suddenly raised, gasping as it were for breath, with inexpressible anxiety depicted on the countenance. The tossing of the limbs continues; convulsive sighs are drawn; the pulse flutters, intermits from time to time, and the patient often expires suddenly.

The countenance is not of a transparent paleness, but of that clayey and leaden color which the painter represents in assassinations and battles; and this tossing of the limbs, which is commonly represented as the sign of a fatal wound, is indeed so infallible a sign of death, that I have never known any one to recover who had fallen into this condition.

Treatment.—In the early centuries, when hemorrhage was with difficulty controlled, and the percentage of mortality from this source enormous, superstition frequently accompanied the defective surgical means at that time in vogue. Thus we find Wolffius Sennertus, Michael Mercates, and Gottfried Moebius, in the sixteenth century, extolling the application of TOADS behind the ear and in the arm-pits, as a means of arresting hemorrhage.

Plunging bleeding members into the abdomen of a living fowl had its adherents. The use of hot magnetic ore, boiling oil of turpentine, vitriol, and corrosive sublimate were also among the cruel practices of the day. The actual cautery can be found described as early as Galen. Albucasis, in his work on surgery, devotes fifty-eight chapters to the cautery and its uses. All possible designs and shapes were wrought from iron to meet the various emergencies, and plates of them published, and the special advantages of each extolled. Red-hot knives were first suggested by "Fabricius Ab Aquapendente" as a valuable improvement on former customs for the *immediate* arrest of hemorrhages during amputation.

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[1] Lancet, 1840.

[2] Med. Chir. Trans., vol. viii., p. 224.

In the reign of Henry IV., Ambrose Paré first advocated ligature, with rules and directions not unlike those of the present day; but for a century it was used with great caution, and met with much disfavor.

Petit, in 1730, urged a compress and bandage at the stump to modify the *shape of the clot,* and invented the tourniquet, known by his name. In 1732, Petit's experiments of the effect of astringents on mutton were made in his endeavor to discover artificial means to *harden* the clot within a stump by local applications.

Pouteau, soon after, advocated the ligature of *nerves* with the vessel to stimulate the swelling of tissues, and thus cause compression of the vessel. Subsequently torsion became developed by Amussat, Velpeau, and Thierry. Ligature and its mechanism have been fully explained by Jones. Tourniquets have been modified and improved by Signorini, Skey, and hosts of others, and the study of collateral circulation investigated to a high degree of perfection by Mannoir, Porta, and Stilling.

Transfusion has also been added, of the literature of which Blundell's essay probably best deserves mention. Acupressure, devised by Simpson in 1859, has proved also a valuable contribution to this branch of surgical investigation.

I close the subject of hemorrhage by enumerating certain general rules of treatment, which seem to me to meet all possible indications.

1st. Always *ligate* the bleeding vessel, in moderate hemorrhage, when convenient to do so; the form of ligature used depending on the choice of the operator.

2d. Use compression over the wound or on the *main trunk,* in moderate hemorrhage, when ligature of the wounded artery is inconvenient.

3d. In *violent* hemorrhage enlarge the wound and tie the artery.

4th. As a *rule,* never attempt ligation except when bleeding *actually exists.*

> The exceptions to this rule are: 1. In *exposed* vessels of large calibre demanding ligature as a safety measure. 2. In delirium tremens following an injury. 3. When necessity for transportation exists.

5th. Ligature should, as a rule, be applied *at the bleeding point,* and not remote from it.

> The reasons for this general statement being: 1. That collateral circulation may otherwise keep up the hemorrhage. 2. The bleeding vessel may not be the main trunk. 3. There exists in certain localities additional danger as you approach the heart. 4. Gangrene is liable to occur, in case subsequent ligature of the wound shall be required.

6th. Use the *external wound* as a *guide* to your incision to reach the vessel—except when the wound exists on the side opposite to the vessel injured, when a probe may be cut down upon.

7th. Always use the greatest precaution to avoid needless loss of blood in reaching the vessel, until the finger can compress it.

8th. The artery, when found, should be tied above and below the wounded portion, and at a bifurcation THREE ligatures should be used.

In case the lower end cannot be discovered, use *compression* in the wound as a substitute for ligature.

9th. A ligature should not be placed close below a large branch, since a clot may not form and secondary hemorrhage occur.

10th. In *recurring* hemorrhages the treatment should depend on the *coor* of the blood and the severity of the hemorrhage.

If the hemorrhage springs from the proximal end of the artery: 1. Tie, if possible. 2. Amputate, if necessary. 3. Use styptics and compression, if both are impossible.

FIG. 61.—The superficial veins of the head and neck. 1, sterno-mastoid muscle; *a*, facial vein; *b*, anterior temporal vein; *c*, transverse facial vein; *d*, posterior auricular vein; *e*, internal maxillary vein; *f*, external jugular vein; *g*, posterior external jugular vein; *h*, anterior jugular; *k*, internal jugular vein. Many of these veins will be more apparent to the reader by consulting the succeeding figures.

11th. *Amputation* is preferable to ligature: 1. When great swelling of the limb renders ligation difficult. 2. When exhaustion of the patient forbids further search for the vessel. 3. When *competent assistance* is needed and not attainable.

12th. In case a large vessel is injured, without actual hemorrhage, heat and flannels to the limb are indicated as a *preventive* measure.

13th. In case an aneurism is the seat of hemorrhage—provided the aneurism is *traumatic* in its origin—it should be treated on the same principles as if it were a wounded artery.

VEINS OF THE HEAD.

The veins of the head may be divided into two sets, viz., the superficial veins, comprising those of the cranium and face; and the internal or cerebral veins. The latter include (1) the cerebral veins proper, (2) those channels formed by the dura mater (the cerebral sinuses), and (3) the veins of the diploë or middle tablet of the skull-cap; while the former correspond in their name and general direction with the arteries which have been described in previous pages.

The Cerebral Sinuses. Many points of interest pertaining to the cerebral sinuses and the veins of the diploë have already been mentioned in connection with certain bony points on the exterior aspect of the skull,[1]

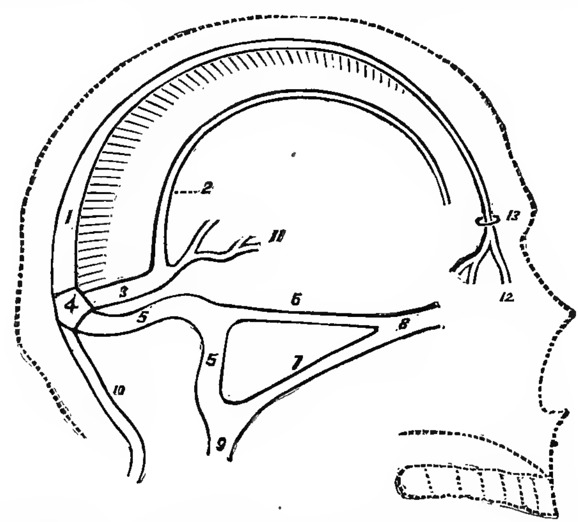

FIG. 62.—A diagram of the venous sinuses of the dura mater, as seen on a vertical section through the cranium.

1, The *superior longitudinal sinus* (single). 2, The *inferior longitudinal sinus*, formed by the under border of the falx cerebri (single). 3, The *straight sinus*, connecting the two longitudinal sinuses and receiving the venæ Galeni of the brain (single). 4, The *torcular Herophili* (wine cup) where the sinuses of the dura mater converge. 5, The *lateral sinuses*, showing the curve which is made by the sinus of each side. 6, The *superior petrosal sinus*, connecting the cavernous and the lateral sinuses of the same side. 7, The *inferior petrosal sinus*, assisting the lateral sinus of the same side to form the jugular. 8, The *cavernous sinus*, communicating with the two petrosal sinuses of the same side and with the ophthalmic vein, anteriorly. 9, The *jugular vein*, formed by the lateral and the petrosal sinuses. 10, The *occipital sinus*, passing downward to the foramen magnum. 11, The *venæ Galeni*, of the velum interpositum. 12, The vein which passes through the *foramen cæcum*, and thus allows of communication between the nose and the superior longitudinal sinus.

which need not be repeated, as they can easily be found by reference to the first chapter of this volume, or to the index, in case any special point needs to be referred to; but the general situation of the cerebral sinuses has not been, as yet, discussed in all its practical bearings.

The cerebral sinuses are channels formed by the *separation of the dura*

[1] Pages 5 and 7.

mater, for the transmission of the venous blood from the supplying vessels of the brain and its coverings. They are fifteen in number, and may be divided into five single and five pairs of sinuses. The two diagrammatic drawings will help to show the relative situation of each far better than a long description.

In this second drawing, the sinuses which are situated at the base of the skull only are shown, and the points of communication between them are also made evident. Two of the five *single sinuses* are shown to be situated in the middle of the base of the skull, while the remaining three

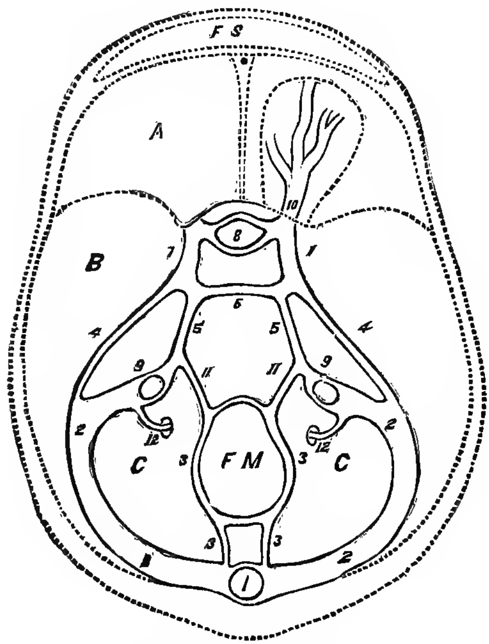

FIG. 63.—A diagram of the venus sinuses of the dura mater, as seen on a horizontal section through the cranium.

1, The *torcular Herophili*, where six sinuses join. 2, The *lateral sinuses*. 3, The *occipital sinuses*, passing downward to the foramen magnum. 4, The *superior petrosal sinuses*, running along the upper border of the petrous portion of the temporal bone. 5, The *inferior petrosal sinus*, running along the posterior border of the petrous portion of the temporal bone. 6, The *transverse sinus*, connecting the petrosal sinuses (single). 7, The *cavernous sinuses*. 8, The *circular sinus*, connecting the two cavernous sinuses (single). 9, The commencement of the *internal jugular vein*. 10, The *ophthalmic vein*, communicating with the cavernous sinus of the same side. 11, A *small vein* joining the occipital and the inferior petrosal sinuses of the same side. 12, A *vein* passing through the *anterior condyloid foramen* to join the lateral sinus. A, The *anterior fossa* of the skull. B, The *middle fossa* of the skull. C, The *posterior fossa* of the skull. FM, The *foramen magnum*. FS, The *frontal sinus*.

have already been shown in the preceding diagram. The five *double sinuses* are shown upon both charts, and thus their relative position to each other and to adjacent parts can be better understood than if only one diagram was used.

It will be perceived, by reference to the above diagrams, that the sphenoid bone is in close relation with *both* of the *cavernous sinuses,* and also with the *circular sinus* which invests the margins of the "sella turcica" or "pituitary fossa;" hence the liability of injury to some of these venous channels in fracture at the base of the skull.[1] The temporal bone

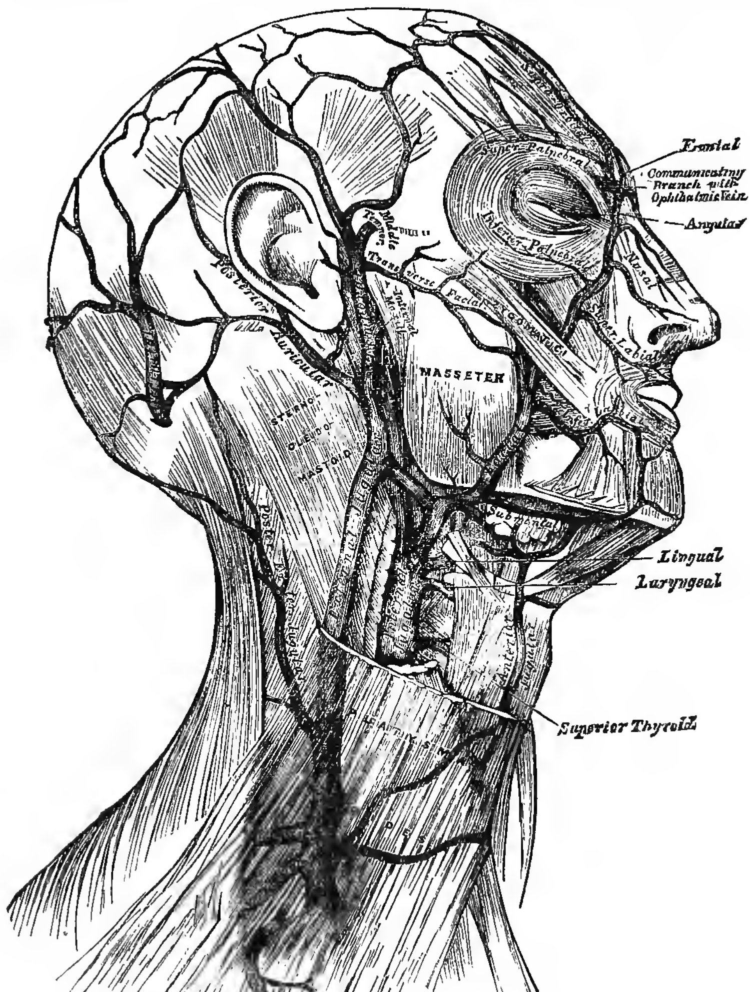

FIG. 64.—The veins of the head and neck. (After Gray.)

also, which is frequently fractured by transmitted force (for reasons mentioned on page 26), lies in relation with the *petrosal sinuses* and a *part of the lateral sinus;* while the parietal bones are each in contact with the

[1] See page 20 of this volume.

superior longitudinal sinuses at their upper border, and the occipital bone, with *both lateral* and *both occipital sinuses,* and a *portion* of the *superior longitudinal sinus.*

The Veins of the Exterior of the Skull.

The veins of the face and cranium are six in number, viz., the facial, temporal, internal maxillary, temporo-maxillary, posterior auricular, and occipital.

The *facial vein* passes obliquely downward across the side of the face, in a line extending from the inner angle of the orbit to the anterior margin of the masseter muscle. It lies to the *outer side* of the facial artery and is less tortuous than that vessel.

It commences at the angle of the eye, being formed at that point by the junction of two vessels, called the *angular* and *frontal veins;* it terminates in the neck, beneath the cervical fascia and the platysma muscle, by uniting with a branch of the temporo-maxillary vein, to form a large trunk, which empties into the internal jugular vein.

It collects blood, during the upper half of its course, from the soft tissues of the anterior portion of the face, and, below the jaw, from the tonsil, soft palate, submaxillary gland, and the tongue.

The *temporal vein* corresponds, in respect to the course of its tributaries, to the branches of the artery of the same name. Its main trunk accompanies the artery, and eventually unites with the vein accompanying the internal maxillary artery, to form the temporo-maxillary vein. It collects blood from the scalp, the temporal muscle, parotid gland, the ear, and the side of the face (through the transverse facial vein).

The *internal maxillary vein* is of large size, and receives, as tributaries, veins corresponding to the branches of the arteries of the same name, viz.: the middle meningeal, deep temporal, pterygoid, buccal, palatine, and inferior dental veins. It passes *behind the angle of the lower jaw,* and unites with the temporal vein to form the temporo-maxillary vein.

The *temporo-maxillary vein* divides into two branches in or below the substance of the parotid gland, one of which joins the facial vein, and the other is continuous with the external jugular. It receives, near its point of division, the posterior auricular vein.

The *posterior auricular vein* commences from a plexus at the side of the cranium, passes behind the ear, and empties into the *temporo-maxillary* vein. It receives the stylo-mastoid vein, whose surgical importance depends upon its carrying blood from the aquæductus Fallopii.

The *occipital vein* commences at the back part of the vertex of the skull, from a plexus of small veins, and follows the course of the occipital artery. It usually terminates, on account of the depth to which it passes in the neck, in the internal jugular. As it passes over the mastoid process, it receives the mastoid vein, whose surgical importance has been already mentioned on page 7.

The *veins of the head* have one very important surgical aspect, which has not, as yet, been mentioned; and the same remarks are also equally applicable to those of the *neck* and the *axilla.* I refer to the entrance of air into the veins, and its transmission to the heart. This distressing accident has never, to my knowledge, occurred, except in operations in one of these three surgical regions.

The dangers liable to result from thrombosis of the veins of the head, especially those of the diploë, have been already discussed on page 5 of this volume.

The extension of facial erysipelas to the meninges of the brain probably takes place by means of the communication between the veins of the scalp, through the diploë and sutures of the skull, and those of the face by means of the ophthalmic vein, which traverses the orbit.

In ligation of arteries, the veins frequently embarrass the operator by their over-distention. They can be made to collapse by pressure over the distal portion of the vein; and too much care cannot be taken in avoiding cutting a large vein, in this region, unless it be previously tied in two places and cut between the ligatures.

As the return of blood, through the veins of the head, is assisted, to a great extent, by gravity, the valves within them are less frequent than in those of the extremities, where gravity tends to retard the circulation in the veins.[1] Even those valves which exist in the veins of the head are imperfect, since it is possible to make a satisfactory injection of them, through the superior vena cava, which would be impossible, were the valves capable of occluding their entire calibre.

The emissary veins, described by Santorini, are probably one of the most frequent means by which inflammations upon the exterior surface of the skull are transmitted to the meninges; and it is to these veins alone that Béclard attributes the escape of blood from the ear in case of fracture at the base of the skull, involving the petrous portion of the temporal bone. Cambournac, Blandin, and others have also laid great stress upon the emissary veins, as the anatomical explanation of the production of meningeal or cerebral hemorrhage by wounds of the skull not resulting in fracture.

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[1] Struthers: Jugular Venesection.

CHAPTER IV.

SPECIAL REGIONS OF THE HEAD.

THERE are certain *practical points* pertaining to the anatomy of the head which can be given, in detail, only by considering special regions whose anatomical construction brings them constantly to the notice of the physician.

It has been the custom with almost all authors upon topographical anatomy to follow some special plan as to the division of the head into regions, based either upon those landmarks which Nature has herself de-

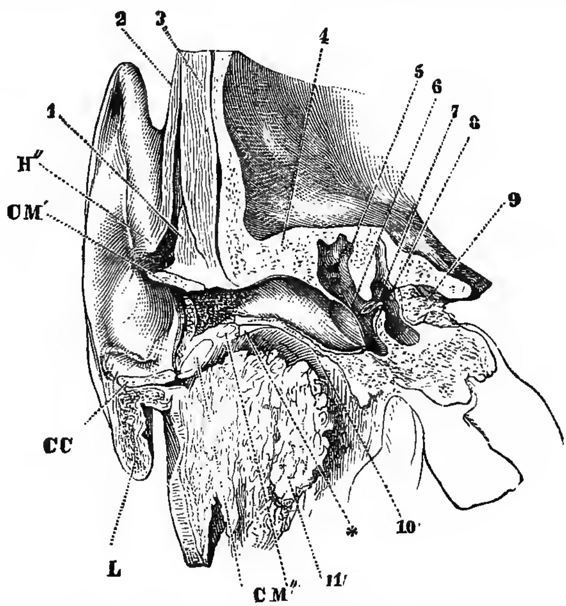

FIG. 65.—Section through the external meatus and the ear at the point of junction of the cartiage of the auricle, CC, with that of the auditory canal. (After Henle.) A small portion of the upper wall of the latter remains as a narrow band, CM ; CM , lower wall of the cartilage of the external meatus; H , spine of the helix; L, lobe of the ear; *, fibrous lip of the border of the osseous meatus; 1, epicranius temporalis muscle; 2, levator auricularis; 3, temporal muscle; 4, upper wall of the osseous canal; 5, cavity of the tympanum; 6, membrana tympani; 7, stapes bone; 8, vestibule; 9, meatus auditorius internus and acoustic nerve; 10, lower wall of the osseous meatus; 11, parotid gland.

fined, or upon a physiological connection between the various structures. To follow in detail such a chart as Blandin recommends would increase the scope of this volume beyond its proper limits, while it would conflict in many ways with the general plan of its construction. I shall, therefore, call attention, under this heading, only to such practical points as pertain to the temporal, orbital, nasal, and buccal regions, since other portions of the head have been treated of in previous pages.

TEMPORAL REGION.

In the temporal region, the ear often presents numerous anomalies. The pinna may be flattened or some of its prominences excessively developed. The lobule may be absent or adherent to the skin, while the auditory passage may be abnormally short or narrow, and, in some

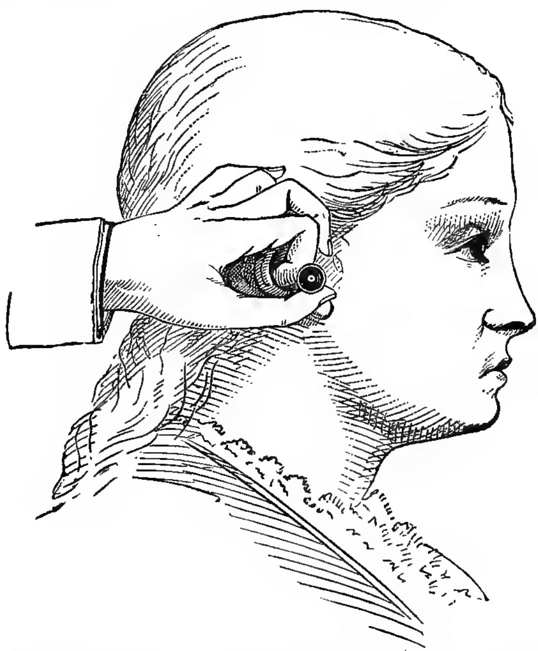

FIG. 66.—Method of holding the ear speculum in position. (After Roosa.)

cases, entirely obliterated. The ancients, deceived by the false idea that the cartilage of the ear was endowed with excessive sensibility, considered injuries to the pinna to be extremely serious; and some have even spoken of fracture of this portion, evidently mistaking an incised wound of the cartilage for such an accident.

The follicles of the external canal may, if morbidly developed, result in small encysted tumors; and inflammation of the external ear or of the auditory canal is rendered extremely painful by the close adhesion of the skin to the subjacent parts. If the external ear be removed, the hearing is markedly impaired, but is not entirely lost.

The curve of the auditory canal explains the necessity of *drawing the* *pinna upward* when we wish to examine it, since we thus remove the curve, which does not extend to the osseous portion of the canal. In removal of foreign bodies by instruments, it should be borne in mind that, if the instrument has only one blade, it must be carried down upon the *lower wall* of the canal, since we can thus introduce it more deeply before arriving at the membrana tympani, as this portion of the canal is the longer; but, if the instrument has two blades, one should be introduced below and the other above, as the vertical diameter of the canal is longer than the transverse, and the foreign body will be, for this reason, less pressed upon, and a greater space for the instruments will be afforded to pass inward and embrace it.

FIG. 67.—Mode of using the aural speculum and reflecting mirror.

Whenever it is desired to remove an insect from the ear, the head of the patient should be inclined to one side, and the meatus filled with any mild oil, which may be retained in the ear a few minutes, simply by keeping the head in the inclined position. The oil thus occupying the tube closes the respiratory pores of the creature, and soon either kills it or causes it to seek the surface to obtain air or escape, when it may be seized or subseqently washed out with a syringe or tepid water. Especially if inflammation exists, this latter mode should be practised, since this condition increases the sensibility of the part and renders the introduction of instruments painful.

If the foreign body should be a hard substance, and one not capable of absorbing water, then the best plan of removing it will be to wash it away by the force of a stream of water thrown in on one side of it, and made to fly outward from the resistance created by the surface of the membrana tympani to the entrance of the water.

Cases have been reported by Sabatier, Blandin, and others, of meningitis having been produced from foreign bodies which have been lodged in the external auditory canal and which have withstood all attempts at removal.

It is a well-recognized fact that foreign bodies in the ear sometimes create symptoms of a cerebral type which may occasion alarm even with those having a large experience in ear diseases. It is always advisable, therefore, to examine the ear for foreign bodies, if any symptoms be referred to that region.

The escape of pus from the auditory passage, which often occurs, may arise from its own lining membrane, or come from the tympanum or the mastoid region. The auditory passage is partly membranous on its posterior wall, and this anatomical fact explains how abscesses of the mastoid or parotid regions sometimes point in this canal.

The membrana tympani is sometimes broken by loud noises, as is not infrequently the case with cannoneers; and perforation may also be produced by the pressure of accumulated and hardened wax in the external auditory canal, and sometimes by the pressure of the handle of the malleus. Artificial puncture of the membrana tympani is sometimes performed (as first suggested by Cooper in 1800) to allow the introduction of air into the cavity of the middle ear when the Eustachian tube is obliterated,[1] or for the purpose of evacuating pus during attacks of suppurative inflammation of the tympanum.

The operation of opening the mastoid process, as a means of relief for that obstinate form of deafness produced by permanent occlusion of the Eustachian tube, was first suggested by Jasser, a Prussian surgeon, who thus hoped to establish a permanent and free entrance of air to the cavity

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[1] The presence of air, having the same density and moisture, on both sides of the membrana tympani is essential to the proper perception of sound, as that membrane thus vibrates freely and accurately records the number of vibrations peculiar to each individual note.

The closure of the Eustachian tube prevents the entrance of air to the middle ear from the mouth; hence the abnormalities in hearing perceived when a catarrhal inflammation creates a tumefaction of its lining membrane, as often occurs during an attack of influenza.

of the middle ear by means of the mastoid cells, and urged, as its chief advantages, the facts that no anatomical difficulties existed to the operation, and that the membrana tympani was left intact. The unfortunate accident of erysipelas in the case of Just Berger (physician to the king of Denmark) brought serious criticism on Köelpin, of Copenhagen, who performed the operation upon that distinguished man, and the operation fell into disrepute.

It is a fact worthy of mention in this connection, that the mastoid cells are absent in childhood, and are not fully developed until middle life.

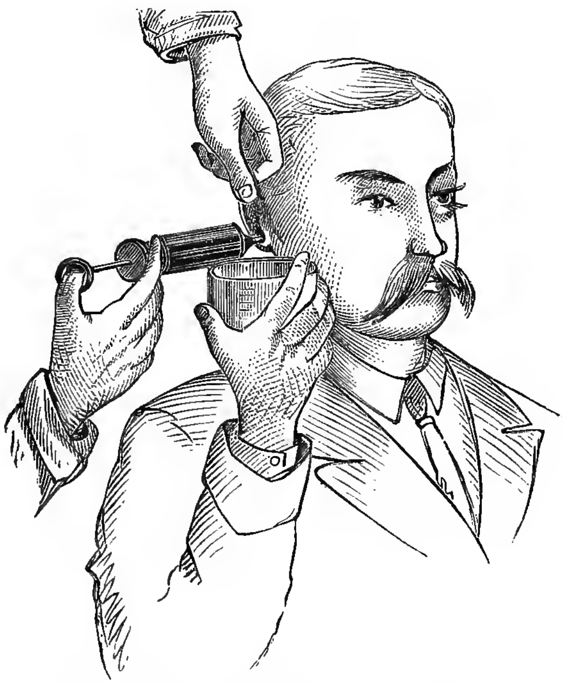

FIG. 68.—Method of syringing the ear. (After Roosa.)

The intense pain which is present in *suppuration of the middle ear* is produced by compression of the sensory nerve filaments, since most of the walls of that cavity are bony; hence we find in those cases an abnormal *outward protrusion* of the *membrana tympani*, which is a symptom of great diagnostic value; and, if not surgically relieved by puncture, spontaneous perforation of the drum is liable to follow, and repair of the damage often becomes difficult.

Pages have been written on most of the aural operations, but with a tendency to confuse and embarrass, rather than encourage the reader. Washing out the internal and external auditory tubes, with perforation of the membrana tympani, or, perhaps, the mastoid cells, really constitutes the greater portion of aural operative surgery, and all are easily executed. For this reason, the steps of catheterizing the Eustachian tube will be found appended in the description of the nasal cavity as a surgical region; while the steps necessary in the operation of opening the mastoid process can easily be ascertained by reference to any work on surgery. The dangers from the surgical relations of this process will be given in full detail later on in this chapter.

Wounds of the temporal region, even if not very deep, may be attended with profuse hemorrhage, especially when they are situated near the auditory passage, and the temporal artery may possibly have to be tied to arrest it.

The whole of the temporal region may be rendered prominent by tumors of the antrum which have perforated its posterior wall, passed through the zygomatic fossa, and thus encroached upon the temple.

Trephining should never be performed in this region unless the case absolutely demands it, since the thickness of the soft parts which cover the bone renders the operation a difficult one, and, because the skull is extremely thin in this portion, the brain is therefore liable to be wounded. The proximity of the *middle meningeal artery* is an additional reason why the operation should not be performed in this region, unless circumstances render it imperative.

In the region of the mastoid process, the *lateral fontanelle* may be abnormally large, or late in closing, and thus a hernia of the encephalon, whether of the cerebrum or cerebellum, may occur through this opening. Such cases, however, are fortunately infrequent. Wounds in the vicinity of the mastoid process may be attended with profuse hemorrhage if the cutting instrument pass either *in front* of or *behind* it, since large vascular trunks are in close relation to it, both anteriorly and posteriorly.

Caries and *necrosis* of the temporal region are frequently the result of syphilis, and *exostoses* may also be developed from the same cause. The occurrence of necrosis usually indicates that the disease has affected the pericranium, and separated it from the bone, thus destroying its nutrition. It is a curious fact that the cranial bones are seldom reproduced after removal of the entire thickness of the skull-cap; and this seems to indicate that the dura mater does not take the place of a true periosteum, since it sends few vessels into the bone, which is chiefly nourished by the pericranium, and, for this reason, the calvaria shows little if any tendency to reproduce bone-tissue.

In trephining over the mastoid process—and the same statement is applicable to other regions of the skull—the liability of injury to some of the *emissary veins*, which pass chiefly through the sutures of the skull, affords a danger of meningeal inflammation; hence all sutures should be looked upon as points of danger in trephining.

The simultaneous escape of blood and cerebro-spinal fluid from the auditory canal may be regarded as a most positive indication that the perous portion of the temporal bone has been fractured (see page 20); although blood alone may exist after an injury without a fracture having occurred.

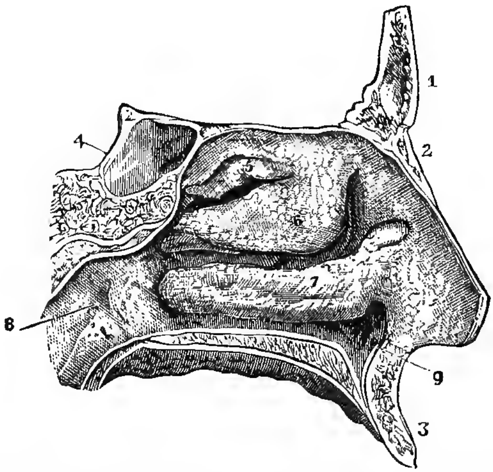

FIG. 69.—Outer wall of the left nasal cavity, covered by the mucous membrane; 1, frontal bone; 2, left nasal bone; 3, upper jaw; 4, body of the sphenoid bone; 5, projection of the membrane covering the upper spongy or turbinated bone; 6, that of the middle; 7, that of the lower; 8, opening of the Eustachian tube going to the middle ear; 9, inferior meatus.

REGION OF THE NOSE.

The cavities of the nostrils are much narrower in the infant and the aged than in middle life. In the infant, this narrowness is due to im-

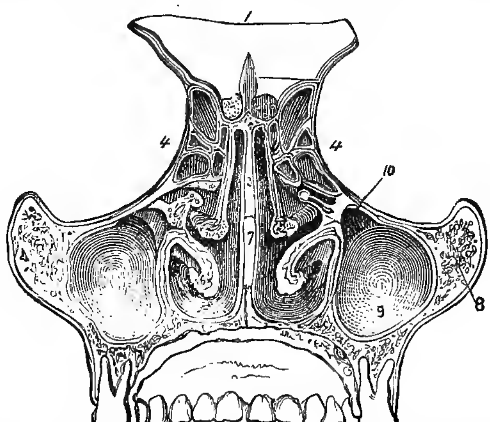

FIG. 70.—Transverse vertical section of the nasal cavities, seen from behind: 1, part of the frontal bone; 2, crista galli; 3, perpendicular plate of the ethmoid bone; between 4 and 4 the ethmoid cells; 5, the right middle spongy or turbinated bone; 6, left lower spongy bone; 7, vomer; 8, malar-bone; 9, maxillary sinus or antrum of Highmore; 10, its opening into the middle meatus or passage.

perfect development of the nasal cavity in the transverse direction; while in the aged, an excessive development of the turbinated bones tends to occlude both the superior, middle, and occasionally the inferior meatus of the nose.

The prominence on the ascending process of the superior maxillary bone may be used as a *guide* for *inserting a probe* into the lower opening of the nasal duct. In performing this operation, a probe which is properly curved is introduced along the floor of the nostril, with its point looking outward. When it has penetrated for the distance of an inch, it is generally withdrawn with the point in close contact to the outer wall of the nasal fossa, until it is arrested by the prominence above mentioned; the probe is then depressed and carried a little inward, and, by a vibratory

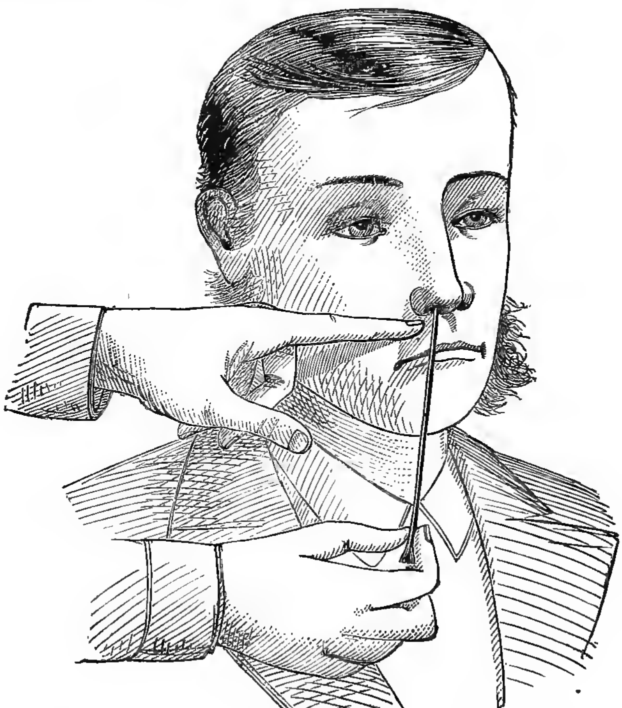

FIG. 71.—Introduction of Eustachian catheter. (After Roosa.)

motion, the instrument is made to penetrate the nasal duct, passing underneath a valve of mucous membrane, which partially occludes its lower orifice. Probing of the nasal duct through the nostril is now seldom resorted to on account of the valve of mucous membrane which occludes its mouth.

The cavities of the nasal fossæ communicate, in the superior meatus, with the sphenoidal sinus and the posterior ethmoidal cells; in the middle meatus, with the frontal sinus, the cavity of the antrum, and the anterior ethmoidal cells; while, into the inferior meatus, the nasal duct opens. The inferior meatus is of importance to the surgeon in the operations of plugging the posterior nares, dilating the nasal duct from below, catheterizing the Eustachian tube, and removal of polypi or foreign bodies.

In plugging the posterior nares, should the surgeon not be able to obtain Bellocq's canula, he may readily carry a ligature through the nostril and mouth by means of a common elastic catheter, the ligature being passed through the eye of the instrument, the latter being withdrawn after the pellet is in position. After the lapse of several hours, the lint in front of the nostril should be removed by the fingers or forceps, and that from

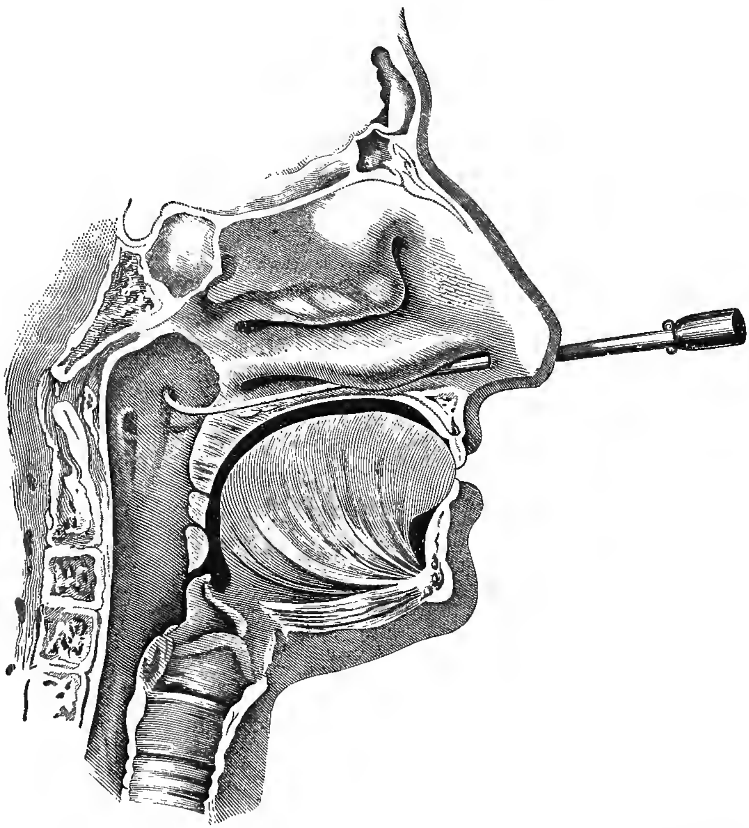

FIG. 72.—A section of the nose, mouth, soft palate, uvula, tonsil, pharynx, upper part of the œsophagus, and trachea, showing the route taken by the Eustachian tube catheter along the inferior meatus and floor of the nostril into the orifice of the Eustachian tube. (After Allen.)

the posterior nares displaced, either by pressing it into the throat by a probe, when it may be drawn out by the thread left attached to it for this purpose, or it may be removed by simply employing the end of the ligature left in the mouth.

When the position of the orifice of the Eustachian tube is recollected, it will be seen that the introduction of a catheter into the mouth of that tube is a simple operation, though the verbiage in which it has often been described tends to create a belief in its being difficult.

The patient is seated with the head thrown slightly backward and firmly supported, while the surgeon takes the catheter in his right hand, and, after oiling it, introduces it into the nostril on the side to be dilated. Then, keeping its point on the floor of the nostril, and its convexity upward and inclined against the septum of the nose, he slides it backward till it reaches the soft palate, as may be readily told by the sense of touch transmitted along the instrument, or by the patient making a slight gulp or effort to swallow. At this moment the surgeon should turn the point of the catheter upward and outward by rotating it a quarter of a circle, and then, by a slight movement forward and backward, he may slip it into the tube with as much, if not more ease, than a catheter can be made to enter the bladder. When the proper position of the instrument is insured, it will at once be known by its steadiness, and also by the sensation of the patient.

Foreign bodies in the nostril may be extracted either from the front, or pushed back into the throat, according to the proximity to one or other of these orifices. As they seldom fill up the entire space of the nose, a curette, or curved probe, or Leroy's instrument for removing fragments of calculi from the urethra, may generally be passed to one side of the article, so as to enable the operator to draw it forward. If jammed between the inferior turbinated bone and the septum, gentle pressure, from above downward, by crowding it upon the floor of the nostril, will facilitate its subsequent removal, either by the instruments above named, or a polypus-forceps, or common dressing-forceps. If, however, the foreign substance should be a piece of ribbon or something similar, which has been stuffed high up in the cavity of the nose, washing out the nostril by a stream of water with a syringe will often dislodge one end, and thus enable the operator to seize and draw it out with the forceps.

During attacks of sneezing, coughing, laughing, or fright, at the time an attempt at deglutition is being made, foreign bodies in the throat may be forcibly driven into the postero-superior part of the nares; and similar instances are recorded during attacks of vomiting, although vomited matters are usually expelled from the nose with little difficulty, in case they chance to enter.

Metallic rings have been forced into the nostril through the pharynx[1] during attacks of sneezing; and cherry pits and other substances have been introduced by attacks of vomiting, and some have remained there undetected, until ozæna caused a careful examination of the nares to be made.[2]

Foreign bodies can also be thus forced into the Eustachian tube, as reported by Fleischmann, where a grain of barley became so lodged, and

[1] Hickman Lowndes. [2] Poulet, op. cit.

created ringing in the ears, a sensation of hair in the fauces, and interference with hearing.

It is well known that horse-flies are particularly prone to deposit their larvæ in the nasal fossæ of animals, and that, after their maturity, the animals which are hatched are often thus enabled to enter some of the air-chambers of the head. In countries where leeches abound, they are occasionally introduced into the pharynx with water drank from pools, and they thus are enabled to crawl upward and lodge themselves in the nasal fossa, where they are often detected only by the epistaxis which they

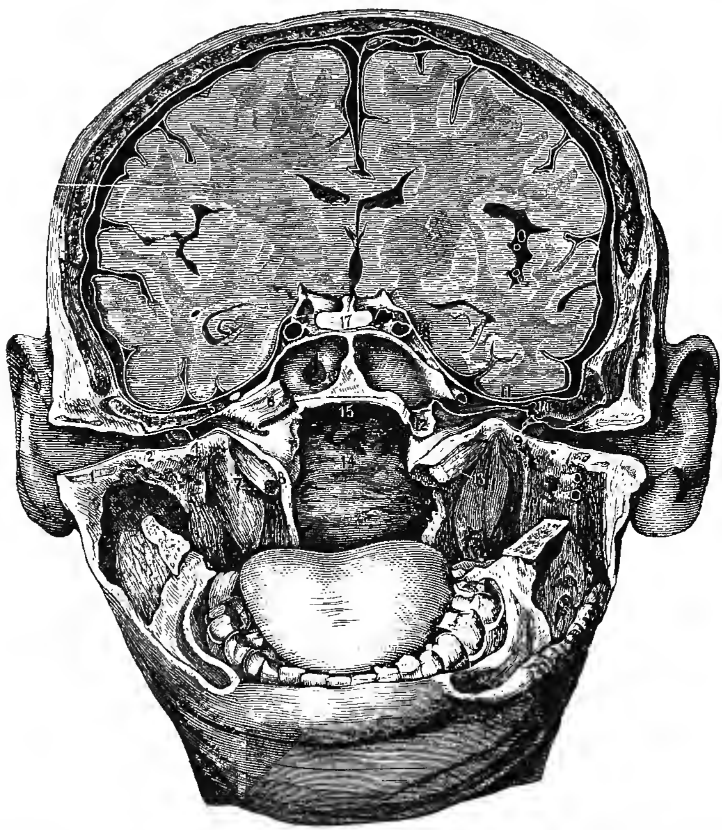

FIG. 73.—Section of the head, showing the divisions of the ear, and the naso-pharyngeal cavity (after a photograph—Rudinger); 1, cartilage of external auditory canal; 2, osseous auditory canal; 3, 4, membranæ tympani; 5, cavity of the tympanum; 6, dilator muscle of the Eustachian tube; 7, levator palati muscle; 8, mucous membrane of the pharyngeal orifice of the tube; 9, left membrana tympani; 10, handle of the malleus and short process; 11, tensor tympani muscle; 12, mucous membrane of the membranous portion of the tube, perforated by a needle; 13, levator veli palati muscle; 14, mucous membrane of the posterior surface of the pharynx; 15, mucous membrane of the pharynx, attached to the lower surface of the body of the sphenoid bone; 16, sphenoidal sinus; 17, hypophysis cerebri and its relations to the cerebral arteries and the cavernous sinus.

create. They are extracted by *salt douches* or medicated injections, which cause them to loosen their hold and drop into the inferior meatus, where they can be reached.

The presence of any form of foreign body in the nose creates a feeling of irritation, which is indicated by an uncontrollable desire to forcibly pass air through the nose and a peculiar stinging pain and sneezing, which the patient seldom becomes deprived of, no matter how long the foreign substance be retained. By its irritation, such an accident may destroy smell, since an offensive ozæna is usually produced if the foreign body be long retained; or, it may occlude the nasal duct by compression, and thus induce symptoms referable to the eye or the lachrymal apparatus, or create necrosis or caries of the bones of the nasal fossa, with the many symptoms dependent upon those conditions.

The subject of foreign bodies of the nasal fossa has much of interest which cannot be here given, and to such as seek for further information the admirable work of Poulet is recommended.[1]

FIG. 74.

FIG. 75.

FIG. 74.—Fibrous polpyus of the nose. (After Hamilton).
FIG. 75.—Deformity of the nose from polypi of large size in both nostrils.

Swelling of the mucous membrane of the nasal cavity may partially or completely occlude its calibre and thus affect the tone of the voice and perhaps occasion dyspnœa; while a similar swelling in the region of the lower orifice of the nasal duct may so occlude that canal as to prevent the escape of the tears through their natural channel and thus cause them to flow over the cheek.

Abnormal growths within the nasal fossa may be either *mucous polypi* which are localized hypertrophies of the mucous membrane or the submucous tissue; *fibrous polypi*, which spring from the periosteum, and

[1] A Treatise on Foreign Bodies in Surgery. New York, 1880.

are composed chiefly of bundles of fibrous tissue; *cartilaginous growths*, which spring chiefly from the septum of the nose and the frontal or ethmoidal cells; *osseous tumors; sarcomata;* and *cancer*.

The mucous type of polypus rarely, if ever, springs from the septum of the nose, but usually arises from the mucous lining of the superior or middle meatus, or the inferior turbinated bone. In rare cases they may arise from the roof of the nasal fossa, or even from the frontal sinus,[1] and may occasionally be so extensive as to hang into the pharynx.

The fibrous type of polypus, on the contrary, may grow from any part of the walls of the nasal fossa, but is most frequently attached to the basilar process at the base of the skull, and, for that reason, is usually found within the upper portion of the pharynx, behind the uvula.

The tissues which invest the turbinated bones may undergo a *genuine hypertrophy* and thus seriously occlude the cavity of the nose. Such cases can be best relieved by removal of the hypertrophied mass by the écraseur, or actual cautery.

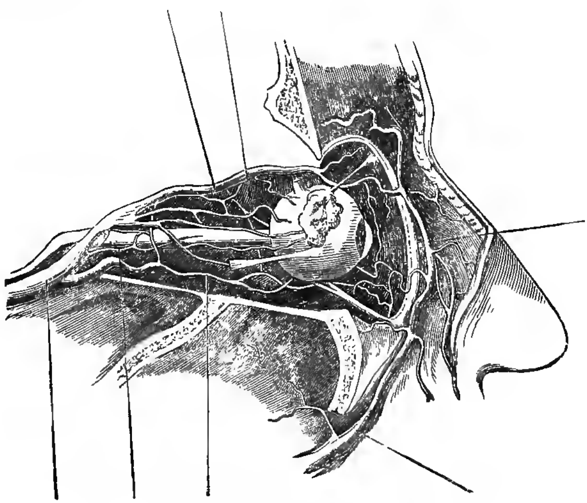

FIG. 76.—Vertical section of right orbit. (After Stellwag.)

REGION OF THE ORBIT.

Injuries in the vicinity of the eyebrow may be regarded as particularly liable to be followed by serious results. Death has resulted in such cases from a fracture at the base of the skull; and an accompanying amaurosis from injury to the optic nerve is frequent in such cases. Besides these two sequelæ, an *emphysematous condition of the forehead* may occur if the frontal sinus be opened, and fistulæ may remain, through which air may be forcibly blown if the nose be held. A case is on record where, after such an accident, the patient could blow out a candle through an opening in the forehead which communicated with the frontal sinus. The supra-or-

[1] Mackenzie: Diseases of the Nasal Cavity. London, 1880.

bital nerve which escapes from the orbit by a foramen underneath the eyebrow may also be pressed upon by fragments of bone and thus become the seat of a tormenting neuralgia, or, by creating reflex symptoms in

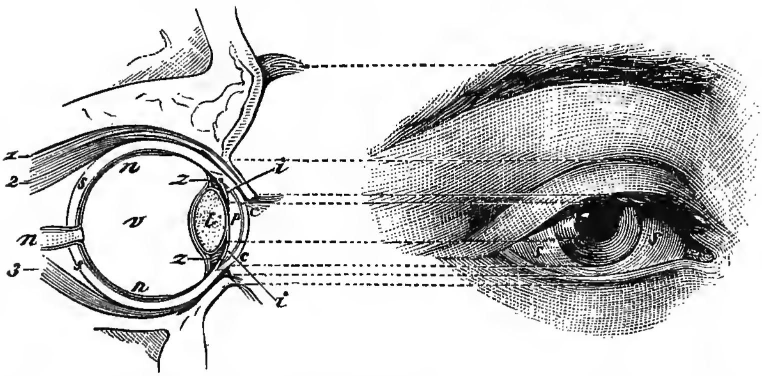

FIG. 77.—Relation of the various parts of the eye. *c*, cornea; *i*, iris; *p*, anterior chamber of eye; *l*, lens of eye; *z*, ciliary muscle; *v*, vitreous humor of eye; *n*, optic nerve entering eye and sending its fibres into the retina; *s*, sclerotic coat of eyeball; 1, 2, 3, muscles which move the eyeball and upper eyelid.

other nerves which communicate with the fifth pair, cause manifestations of a diseased condition of other parts of the head and face.[1]

Penetrating wounds in this region may pass above or below the globe

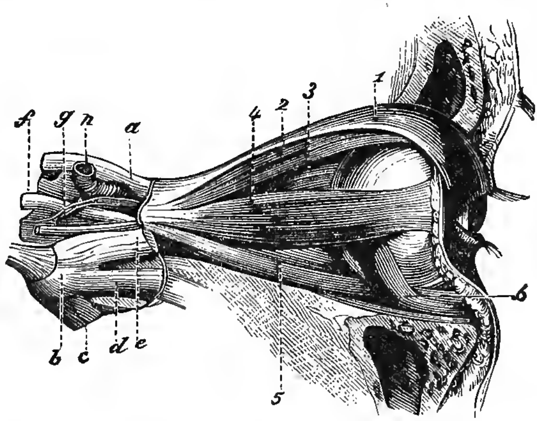

FIG. 78.—Section of the orbit and cranium. 1, 2, 3, 4, 5, 6, muscles which move the globe and upper eyelid; *a*, optic nerve; *b*, *c*, *d*, *e*, the trigeminus nerve and its branches; *f*, motor oculi nerve; *g*, abducens nerve; *h*, ophthalmic artery.

of the eye, or affect the globe itself. If the eye itself be injured, it may be destroyed either as a direct result of the accident or by inflam-

[1] Ranney, Medical Gazette, New York, October 30th, 1880.

mation following it; while, if the eye be not *destroyed*, opacities of the cornea or lens may result, foreign bodies may be deposited within its chambers, the iris may be lacerated, and many other unfortunate conditions ensue which may impair to a greater or less extent the functions of the eye and lead to subsequent changes of a more or less serious character.

Wounds exterior to the globe of the eye are not as serious in their results, except in those cases where the penetrating instrument has passed deeply within the orbit and has injured (1) the orbital arch and the adjacent brain tissue, (2) the internal or external bony walls of the orbit, (3) the important nerves and vessels situated in the sphenoidal fissure, or (4) by penetrating still more deeply, the vessels of the zygomatic fossa. In

Fig. 79.—Cyst in the region of supra-orbital ridge, closing the eye.

this latter region, all wounds are especially serious, for the following reasons: first, because such wounds necessarily presuppose that the piercing instrument, before arriving there, has passed either through the cheek, the temple, the parotid region, or the orbit; secondly, because it is almost impossible for the branches of the internal maxillary artery or its main trunk to escape injury, while Meckel's ganglion and the superior maxillary nerve may also be wounded; and thirdly, because the collateral circulation between the branches of the internal maxillary artery with the surrounding vessels is so extensive that, even if the common carotid artery be tied, the other vessels are liable to produce fatal hemorrhage.

In extirpating the eye, we must guard against plunging the instrument too deeply, in order to avoid injury to the nervous and vascular structures of that region; besides, if roughly introduced, the scissors might be forced into the sphenoidal fissure, or even through some portion of the bony wall of the orbit.

In those cases where amputation of the globe of the eye is performed in preference to extirpation, the globe should be cut behind the ciliary body in such a manner as to prevent the escape of the vitreous humor and cause the formation of a stump adapted for the insertion of an artificial eye.[1]

Elevation of the floor of the orbit by a tumor of the antrum, or the pressure of an abnormal growth or suppuration behind the globe of the eye, may cause a protrusion of the eyeball from its socket—a condition to which the term "exophthalmia" is applied. In case the exciting cause of such a condition be a vascular tumor, ligation of the internal carotid, or even of the primitive carotid, may be demanded.

FIG. 80.—Complete Ptosis.

Within the orbital region, the operations of division of certain branches of the fifth cranial nerve, for the relief of neuralgia, are performed, whose steps in detail will be found given in most of the general treatises on the art of surgery.

The pulley, through which the tendon of the superior oblique muscle of the eye plays, is situated at the upper and inner angle of the orbit, and in close proximity to the internal angular process of the frontal bone. Care should always be taken, in operating in the orbit, that this loop be not severed, as the action of the superior oblique muscle would thus be temporarily destroyed, and its permanent impairment rendered probable.

[1] Blandin, op. cit.

Abnormalities in the condition of the pupil, and deviations from the normal power of vision dependent upon anatomical defects, have previously been considered, as far as anatomy has any direct bearing upon them, in other articles of mine which treat of the second, third, fourth, and sixth cranial nerves.[1]

The lachrymal apparatus, which comprises the lachrymal gland, the lachrymal canals, the lachrymal sac, and the nasal duct, often creates a necessity for surgical interference in the region of the orbit. In those

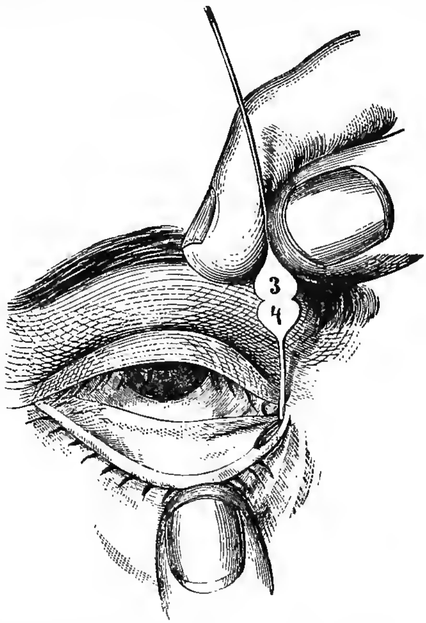

FIG. 81.—Introduction of the lachrymal probe. (After Stellwag.)

cases where the removal of the lachrymal gland is demanded, an incision through the upper lid is usually made, and the gland is then dissected from the surrounding parts. The loss of secretion of the gland is, in a measure, supplied by the *increased action* of the *conjunctiva;* the mucus secreted being generally sufficient to assist the action of the lid over the eyeball.

In contraction of the puncta lachrymalia, the lachrymal canals, or the nasal duct, it occasionally becomes necessary to either dilate them by a probe or to wash them out by means of a syringe. In performing either of these operations, that eyelid, in whose punctum the instrument is to be passed, must first be drawn toward the temple, since by so doing the normal curve of the lachrymal canal is straightened, and the introduction

[1] See New York Medical Gazette, October 16th, 23d, 30th, 1880. A more complete résumé of the subject can be found in a late treatise by the author: The Applied Anatomy of the Nervous System. N. Y., 1881.

of an instrument is thus greatly facilitated. If the canal is simply to be washed out, the nozzle of the syringe (Anel's syringe is perhaps the best) is introduced into the punctum and the fluid forced into the canal with the finger, while the other punctum is compressed to prevent regurgitation. If the fluid does not pass out of the syringe as freely as the orifice should permit, withdraw the point a little, and, by again passing it forward, any duplicature of the lining membrane of the canal may, as a rule, be easily avoided.

In introducing a probe through the lachrymal sac and nasal duct, the instrument should first be introduced with the handle of the probe parallel with the border of the lids, and the point gradually moved toward the inner canthus of the eye till it reaches the lachrymal sac. In some cases incision of the larychmal canal may be required. The handle of the instrument should now be elevated from the horizontal to nearly a perpendicular direction, when, on carrying the handle obliquely forward, the point of the probe will pass readily through the nasal duct and escape at the inferior meatus of the nostril.

It is a somewhat remarkable fact to a novice that a large probe will pass with greater facility than a small one. This is explained by the liability of a reduplication of the mucous lining of the canal, unless it be fully distended.

The intimate nervous communication which exists between the nasal mucous membrane and the lachrymal apparatus explains why irritation of the nose is so frequently followed by an excessive flow of tears; and, for that reason, any excessive action of the lachrymal gland should always suggest to the surgeon a careful examination of the nasal cavity, in case no cause can be discovered in the region of the orbit.

The passage of the third, fourth, ophthalmic branch of the fifth, and sixth cranial nerves through the sphenoidal fissure, and of the optic nerve through its own foramen, explains why any pressure created by abnormal growths within the cavity of the orbit is so liable to be followed by symptoms dependent upon paralysis of some of these nerve-trunks, and, to one familiar with the course of these nerves, such symptoms often indicate the possible situation of the exciting cause.[1]

REGION OF THE MOUTH.

Within the cavity of the mouth, the bones which help to form it, the mucous membrane which lines it, and the nerves and vessels which are distributed to it, have been considered in previous pages and many practical points noted which will require but casual mention here, since they can be referred to under each of these respective heads. The cheeks

[1] For the symptoms created by pressure upon or destruction of these nerves, the reader is referred to the late work of the author: The Applied Anatomy of the Nervous System. N. Y., 1881.

tongue, tonsils, and soft palate, however, present points of interest both to the surgeon and medical practitioner.

In the child, the region of the cheek is particularly liable to gangrenous and ulcerative processes, while, in the adult, tumors are not infrequent in this region. Its physiological functions, in the acts of respiration, mastication, blowing, and sucking, are seriously impaired by any cause which tends to create interference with the conducting power of the facial nerve.

The situation of *Steno's duct* gives to wounds of the cheek a surgical importance, since, if that duct be wounded, the escape of saliva between the edges of the wound may create a salivary fistula upon the face, and prove a source, not only of disfigurement and annoyance to the patient, but one which it is often difficult for the surgeon to relieve.

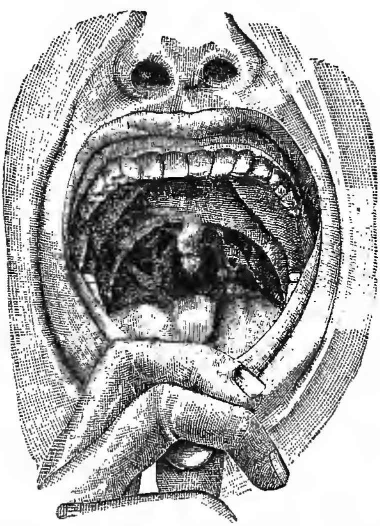

FIG. 82.—The soft palate and tonsils, as seen from the mouth.

The tongue may present conditions of increase in its size as the result of hypertrophy or tumors, which sometimes prevent mastication, and in rare cases may so completely fill the mouth as to render breathing difficult. Its excessive vascularity renders wounds of the tongue a source of serious hemorrhage, which frequently requires ligation of the lingual artery; hence the caution given by surgical authors to inexperienced operators in performing the trivial operation of the division of the frænum of the tongue in children. A peculiar condition of the tongue, in which a *furring* of its *lateral half* is detected, may often be a point of great diagnostic value, since it indicates irritation of some of the branches of the fifth cranial nerve or the glosso-pharyngeal nerve. Thus, Hilton reports a case where furring of the posterior portion of the lateral half of the tongue followed an attack of tonsillitis from irritation of the glosso-pharyngeal nerves; and another where the removal of a decayed molar tooth caused the disappearance of a similar condition affecting the anterior half of the lateral part of the tongue, which had for a long time withstood all other methods of treatment, since the irritation of the fifth nerve had not been relieved. Bransby Cooper reports a case where the furred tongue persistently remained upon one side after fracture of the

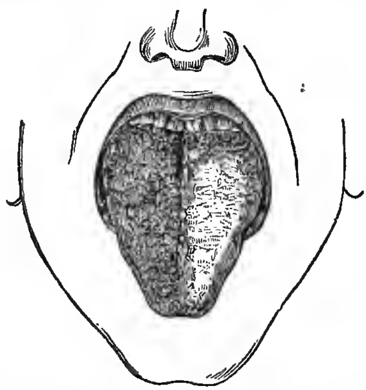

FIG. 83.—Sketch of a tongue furred only on the left side, resulting from a decayed and painful second molar tooth in the upper jaw on the same side of the head. (After Hilton)

base of the skull involving the foramen rotundum; and a similar case recorded by Hilton was produced by disease of the Gasserian ganglion, which was detected at the autopsy. Such cases as these cannot fail to

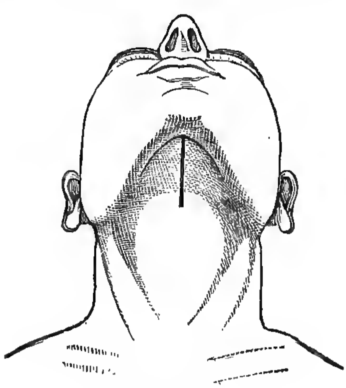

FIG. 84.

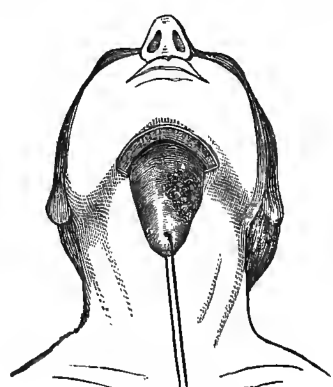

FIG. 85.

FIG. 84.—Incisions in Regnoli's operation. (After Hamilton.)
FIG. 85.—Tongue drawn out. (After Hamilton.)

excite interest in the reader and to impress the importance of the bearings of nervous distribution as an aid in diagnosis.[1]

In operations for the removal of tumors of the tongue, if situated

[1] Ranney, New York Medical Gazette, October and November, 1880.

near to its base, an incision through the soft tissues forming the floor of the mouth is sometimes required in order to permit the tongue to be drawn below the chin and thus be more completely exposed. Care should, however, be exercised, after the soft tissues have been divided, to prevent the tongue falling or being drawn backward over the superior opening of the larynx. This can be easily accomplished by passing a loop of silk through the tip of the organ, by which its movements can be easily controlled.

If we look beneath the tongue at the attachment of its frænum, the openings of the ducts of the sublingual glands can be perceived, and the orifices of the submaxillary glands (ducts of Wharton) can be detected as two small papillæ on the anterior margin of the frænum. A swelling is often produced underneath the tongue by occlusion of the sublingual ducts, to which the term "ranula" is applied, since such a tumor is normal in the frog. The saliva also sometimes deposits sabulous matter, and gives rise to concretions, which are usually situated in the ducts themselves.

The palate is composed of two portions, the hard or bony structure formed by the palate-plates of the superior maxillary and palate bones, and the soft palate, which is composed of mucous membrane and muscles. The soft palate extends across the back of the mouth from side to side, being attached to the posterior margin of the hard palate above, while its inferior or free margin presents, at its centre, the projecting uvula, which is from half to three-quarters of an inch long in the healthy state.

The physiological action of the soft palate is chiefly confined to its valve-like obstruction to the upper portion of the pharynx during the act of deglutition, which thus prevents the regurgitation of food, and especially that of liquids, into the posterior nares during the contraction of the constrictor muscles of the pharnyx. It also modifies to some extent the intonation of the voice, as is demonstrated in those cases where it is congenitally defective. It is abundantly supplied with mucous follicles, which afford an anatomical explanation of the peculiar appearance which that portion presents when inflamed, since it is then covered by an excessive secretion of mucus, which frequently gives it a whitish color. The muscles of the palate play an important part in its movements, and, in the various operations for fissure of the palate, a close *study of the action of these muscles* is essential to a successful result; since, frequently, some of them have to be divided in order to insure a close approximation of the edges of the wound by suture.

The palate may be the seat of *hypertrophy,* as occurs chiefly in elongation of the tonsil; of *ulceration,* as is particularly liable to occur during the first stages of secondary syphilis, and in scarlet fever and small-pox; and of *tumors,* both of the benign and malignant character. It may be made to *bulge forward* into the mouth by nasal polypi which protrude into the pharnyx, by fungoid growths from the neighboring regions, or by retro-pharyngeal abscess, which is usually dependent upon caries of the cervical vertebræ. Perforation of the soft palate is liable to create considerable difficulty in the swallowing of liquids, in case the abnormal opening be of appreciable size. Most of the movements of the soft palate are produced by means of the glosso-pharyngeal nerve, or branches from Meckel's and the otic ganglion. Paralysis of the soft palate is therefore sometimes associated with paralysis of the pharyngeal, lingual, and labial muscles; hence, deglutition and articulation often become simultaneously embarrassed.

Many points of interest pertaining to the hard palate have been already given in connection with the bones,[1] and need not be repeated here.

The tonsils are small bodies situated between the anterior and poste-

FIG. 86.—Complicate hare-lip. (After Buck.)

rior pillars of the fauces upon either side. They contain a central cavity, and are in close relations to some of the large vessels of the neck. During attacks of chronic inflammation, or, repeated attacks of quinsy, sore throat, effusions of lymph into the parenchymatous structure of these glands sometimes produce an induration and permanent enlargement, which may be mistaken for scirrhus. The continuance of such an enlargement being a source of constant irritation, renders these patients extremely liable to inflammation of the throat on the slightest change of temperature; and, to relieve the sensibility, after the failure of all other means, an operation for their removal may become necessary. Suppuration within the tonsil, especially of both sides, if simultaneously attacked, may so close the fauces as to render deglutition impossible and even respiration difficult, unless the accumulated pus be evacuated by incision. The famous case reported by Desault, in which the carotid ar-

[1] See pages 22 and 23 of this volume.

tery was punctured by an incision made into the tonsils, should lead all careful surgeons to remember that, in case extirpation of the tonsil be attempted, only that portion should be excised which *projects beyond the free border* of the stylo-glossus muscle, and that incisions should always be made with extreme care.

The occlusion of the ducts which open into the cavity of the tonsil may sometimes result in the formation of *calculi within the gland,* as was first described by Celsus.

The modifications of the teeth produced by congenital syphilis have been made the subject of careful observation by Jonathan Hutchinson. He writes: It is very common to find all the incisor teeth dwarfed and

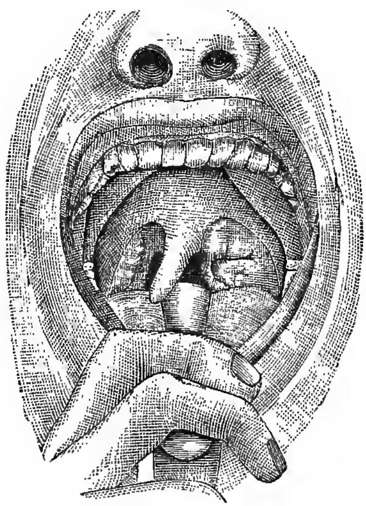

FIG. 87.—Enlarged tonsils and elongated uvula.

malformed. Sometimes the canines are affected also. These teeth are narrow, and rounded, and peg-like; their edges are jagged and notched. Owing to their smallness, their sides do not touch and interspaces are left. It is, however, the upper central incisors which are the most reliable for purposes of diagnosis. When the other teeth are affected, these very rarely escape, and very often they are malformed when all the others are of fairly good shape. The characteristic malformation of the upper central incisors consists in a dwarfing of the tooth, which is usually both narrow and short, and in the atrophy of its middle lobe. This atrophy leaves a single broad notch (vertical) in the edge of the tooth; and sometimes from this notch a shallow furrow passes upward on both anterior and posterior surface nearly to the gum.

This notch is usually symmetrical. It may vary very much in degree in different cases; sometimes the teeth diverge, and at others they slant toward each other. In any case in which this malformation was as marked, I should feel no hesitation in pronouncing the possessor of the teeth to be the subject of inherited syphilis, even in the absence of any other testimony. I have never yet seen such teeth, excepting in patients of this class. In the majority of cases, however, the condition of the teeth is only sufficient to excite suspicion, and not to decide the question.

The removal of portions of the superior maxillary bone, or, in severe cases, of the bone itself, is demanded by the growth of tumors, usually of a fungous or malignant character, and their encroachment on the surrounding bony structure of the mouth. Probably the earliest reference to the removal of this bone which is known to have been recorded is that of Acoluthus, a surgeon of Breslau, who is stated by Gensoul[1] to have removed a portion of the upper jaw on account of a tumor in 1693, although Jourdan, in 1768, removed a portion of the antrum, and Dupuytren, in 1820, a portion of the alveolar process of the bone. This operation may

FIG. 88.—Hypertrophy of lower lip.

be demanded as a means of relief for extensive disease of the antrum which depresses the roof of the mouth; for large polypi of the nose, as is reported by Mott in "Velpeau's Surgery;" and for extensive necrosis or malignant growth. The severity of the operation and the deformity which must ensue if the entire bone be removed, renders it evident that this operation should never be performed except in cases where no other means of relief is possible.

The *lower jaw* may be resected either partially or entire, although the latter operation may justly be regarded by surgeons as a most formidable

[1] Paris, 1833.

one. It was first performed by Graefe and Walther of Bonn, and has since been repeated by Dupuytren, Delpech, Carnochan, and others; but it is still a question whether the evils resulting from the loss of the entire inferior maxilla should not forbid its use.

In those instances where extensive necrosis of the lower jaw has occurred from phosphorus poisoning, or where tumors have so involved portions of the bone as to impair its usefulness or endanger other parts, a partial resection of bone will often accomplish relief with less difficulty to the surgeon than if the entire bone be removed, and with far less evil to the patient.

In consequence of the effect of fissure of the hard palate upon the tone of the voice, as well as upon the enunciation of words, it becomes desirable to attempt its closure by uniting the two halves as soon as the individual is able to assist the operator in the efforts required for its execution; but in those extreme cases where such union is impossible, mechanical appliances can often be made which will, to a certain extent, obviate the annoyances of the deformity.

False anchylosis of the lower jaw, dependent upon cicatrization or contraction of the soft parts, may exist to such an extent as to demand subcutaneous division of the masseter muscle. A case was reported by Dr. Schmidt, in 1841, where a young lady, in consequence of an extensively ulcerated throat when a child, had not been able to open her mouth for a period of twelve years, so that the end of the little finger could be inserted, and where recovery followed the division of the masseter muscle. Dr. Mott, in his edition of "Velpeau's Surgery," treats of this condition for the first time as a special type of disease, and reports seventeen cases where the condition was treated by forcible dilatation by various mechanical devices.

It may be advisable in this connection to call attention to one of the axioms of John Hilton in reference to the nervous association which exists between the joints and the muscles which move them,[1] since by this useful guide some local seat of irritation may possibly be detected in such cases which will account for fixation of the jaw, and, when properly relieved, may be followed by a complete return of mobility without recourse to severer methods. This would, of course, not apply to any form of fixation dependent upon cicatricial tissue.

[1] Every nerve distributed to the muscles which move a joint sends a filament to the joint itself, and supplies the integument over the insertion of each of the muscles which move it.

PART II.

CHAPTER I.

THE TRUNK.

THE bony framework of the trunk serves as a connecting link between that of the upper and lower extremities, while it also serves to support the head. It must be evident also, to any one who studies the design of Nature in the general plan of construction of the human frame, that this part of the body serves many purposes; and there is hardly an isolated portion which is not suggestive of the wonderful adaptability of man to the various acts which he is called upon to perform. This part of the skeleton affords protection to the spinal cord and all of the viscera; the large arterial trunks; the veins which convey the blood from the extremities, the abdominal and pelvic viscera, the head and lungs, to the chambers of the heart; the important nerves which govern the movements necessary to respiration and the functions of the viscera; and the lymphatic vessels, which are concerned in the process of absorption of the nutritive elements of the food. To its numerous surfaces and bony points are attached some of the most important muscles, which are not only designed to act in harmony with the muscles of the extremities in preserving the equilibrium of the body and in the proper performance of locomotion, but also to directly assist in the respiratory act, in parturition, in the act of vomiting, and in the evacuation of the normal secretions, when any obstruction to their free escape exists. The lower portion of the trunk, the bony pelvis, is so modified from the type of the lower animals as to afford support as well as protection to the organs of the abdomen, while the vertebral column is a source of constant wonderment to the anatomist from the beauty of its construction and the simplicity of its arrangement.

In studying the bones of the trunk, the vertebral column will first be considered, then the bones of the thorax, and finally the bones of the pelvis. It will be perceived that the cervical region of the spine, as well as the structures which enter into the formation of the neck, are treated of as portions of the trunk rather than as a separate anatomical region, since many of its organs are properly but parts of the thoracic viscera and the alimentary canal, and since its vessels can be studied to better advantage, in their practical aspects, by grouping them with the larger trunks from which they spring or into which they empty. Furthermore, the nerves of the neck are, in a measure, those also of the trunk, since their most important actions are confined to parts below the superior opening of the thorax, and to treat of only a limited portion of each would tend to create confusion and possibly to impair the general utility of the plan of this work.

After considering the bony frame-work of the neck, thorax, abdomen, and pelvis, those special clinical points pertaining to each of these regions in which anatomy has any special bearing, will be discussed. Thus, the *external landmarks* to all of the important structures will be given: the modifications from the *normal contour* of special regions, which are indicative of disease, and may prove of value to the diagnostician; the *muscles*, and their physiological actions and surgical importance; and the course of the cutaneous nerves, where *pain*, as a symptom, is an anatomical guide to disease of certain well-defined localities.

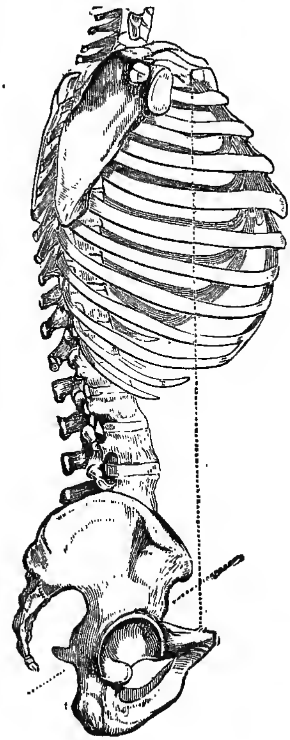

Fig. 89.—Lateral view of the bony skeleton of the trunk.

THE VERTEBRAL COLUMN.

The intermediate link, which serves to connect the head with the bones of the lower extremity, consists of a series of bones called "vertebræ,"[1] since they allow of the bending and turning of the body, and two lateral bones, the ossa innominata, which are interposed between the spinal column and the femur of either side. The vertebræ are so articulated together as to form *three graceful curves*, being bent forward in the region of the neck, backward in the region of the chest, and again forward in the loins. Between each of these bones is interposed a plate of cartilage (the intervertebral disks), whose functions are to act as so many

[1] The number of the vertebræ is given by different authors as twenty-four and twenty-six. If the latter number be taken, the sacrum and coccyx are included, which are properly parts of the pelvis. The twenty-four vertebræ comprise seven cervical, twelve dorsal, and five lumbar. The length of the neck cannot be used as a means of approximately estimating the number of cervical vertebræ in animals, since Flower states, in his work on the Osteology of the Mammalia, that the whale, which apparently has no neck, has the same number as the giraffe.

elastic springs which shall tend to break the force of any shock transmitted to the vertebral column and thus to the head. In the whale, these disks are of extreme size, and are often found upon the seashore of northern countries, having become separated from the vertebræ and thus carried to the beach. Cases are reported where they have been used by shipwrecked sailors as plates.[1] The curves of the vertebral column

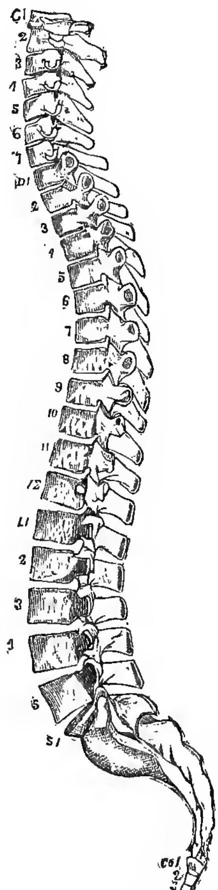

FIG. 90.

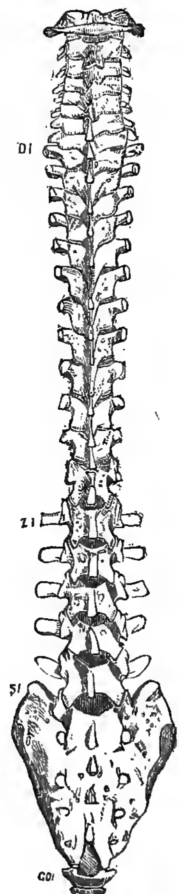

FIG. 91.

FIG. 90.—The spinal column as seen from the left side. C 1 to 7, the seven cervical vertebræ; D 1 to 12, the twelve dorsal vertebræ; L 1 to 5, the five lumbar vertebræ; S 1, the sacrum; Co 1 to 4, the four bones of the coccyx.

FIG. 91.—The spinal column as seen from behind. The same figures and letters of reference as in cut No. 90 are used.

serve the following purposes: (1), they contribute to the wonderful

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[1] Queckett: Lectures on Histology. London, 1852.

strength of the spine,[1] since its curves are alternating; (2), they convert the spine into an *elastic* structure and thus afford a *springy pillar* upon which the head shall rest, rendering the danger of severe jarring of the brain a minimum;[2] (3), the curves are so arranged as to favor the lodgment of organs, since the cavity of the chest is greatly enlarged thereby, and the weight of these organs is still kept within the line of the centre of gravity—a fact to be considered in the arrangement of muscles, as less power is required to preserve the proper balance; (4), the curves are so gradual as to prevent the possibility of compression of the spinal cord, which might occur were there are any abrupt angles to the canal; (5), the curve of the cervical and dorsal regions adds greatly to the beauty of outline of the body, while the cervical curve facilitates the movements of the neck.

The *curves of the vertebral column* are due, in great measure, to the variations in thickness of the intervertebral fibro-cartilages, but partly also to the relative thickness of the bodies of the vertebræ of the different regions, and to the tension exerted by the ligamenta subflava, which connect the laminæ of the different vertebræ together.

The spinal column is capable of movement in one of four directions, viz., *flexion, extension, lateral movement,* and *torsion.* The first two are freest in the neck, least free in the dorsal region, and less free in the loins than in the neck. This is largely due to the fact that the spines of the dorsal vertebræ overlap each other, particularly from the fourth to the eighth, and that the articular processes of the dorsal vertebræ are nearly perpendicular, so that movement is prevented; while, in the cervical region, the articular processes are oblique, the intevertebral disks thick, and the spinous processes of the third, fourth, and fifth are purposely made short and horizontal. The lumbar vertebræ have also thick intervertebral disks, which allow of movement between their spinous processes; and the articular processes are so placed as to allow of a limited movement. Flexion and extension of the spine are freest between the third and sixth cervical vertebræ, between the eleventh dorsal and second lumbar, and again between the last lumbar vertebra and the sacrum.[3] The lateral movements of the spine are very free in the neck, so as to allow of an easy carriage of the head, and in the loins, so as to permit of movement of the trunk. The movement of rotation of the spine is confined almost exclusively to the lumbar region, and it is this power of movement that enables the head to be rotated beyond the

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[1] Rollin and Magendie have mathematically calculated the value of these curves, and estimate the strength of the column as sixteen times that of a straight one.

[2] Holden: Human Osteology. London, 1878.

[3] In cases of tetanus, or in those feats of the acrobat where the body is made to rest upon the head and the heels alone, this point is admirably shown.

ability of movement of the atlas upon the axis, through a participation of the trunk.[1]

The *intervertebral disks* are soft and of a pulpy consistence in the central portion, but firm at the edges, and they thus tend to form a ball-and-socket joint which permits of a certain amount of movement in every direction between the vertebræ which they separate. By the weight of the body they are compressed, so that at night the height of an individual is often diminished some fraction[2] of an inch from the measurement taken after a night's repose.[3]

FIG. 92.—Lateral curvature and rotation. (After Hamilton.)

Upon each side of the spines of the vertebræ may be perceived a *deep groove*[4] for the strong muscles of the back. If we look at the spinal column from the front, we can perceive that the transverse processes of the atlas are very long, so that the muscles which *rotate the head* can gain additional leverage. An enlargement of the column can be detected at the lower part of the cervical region, so as to form an expanded base for the neck, and a diminution in the width of the column can be detected in the dorsal region in order to afford more room for the lungs. A slight *lateral curvature* in the dorsal region may often be perceived, which is attributed by some authors to the excessive use of the right arm, since its concavity is usually toward the left side. This point should be remembered as a frequent and natural deformity, when diagnosing a lateral curvature as the result of disease.

Along the entire length of the spinal column, on its posterior aspect, the spinous processes form a prominent bony ridge, which may be felt through the skin of the back even in the fattest people, and which is occa-

[1] Holden suggests an admirable way to demonstrate this point: "Sit upright, with your head and shoulders well applied to the back of a chair; the head and neck can be rotated to the extent of 70°. Lean forward, so as to let the lumbar vertebræ come into play; you can then turn your head and neck 30° more."

[2] This diminution in the height may vary from a scarcely perceptible shrinkage to one-third, or even one-half of an inch.

[3] A habit of leaning toward one side may make a *permanent deformity* by destroying the elasticity of these cartilages. Thus, a distortion of the spine may not always indicate disease.

[4] This groove is narrowest at the junction of the last dorsal and first lumbar vertebræ (the weakest part of the back), and widest at the sacrum.

sionally prominent during life. It will be noticed that the spine cannot be felt in the cervical as distinctly as in the dorsal and lumbar regions, for the following reasons: (1) on account of its curve, (2) on account of the attachment of an elastic ligament (the ligamentum nuchæ) which extends from the head to the last cervical vertebra, and assists the muscles in supporting the head at a right angle to the spine, (3) from the fact that the spines of the third, fourth, and fifth cervical vertebræ are made *shorter than the rest* so as to admit of free extension of the neck, (4) on account of the muscles which tend to render the long spine of the axis less prominent than it would otherwise be. In a muscular subject, the spines of the vertebræ of the dorsal and lumbar regions, instead of being prominent as they are in the skeleton, lie in a *median*

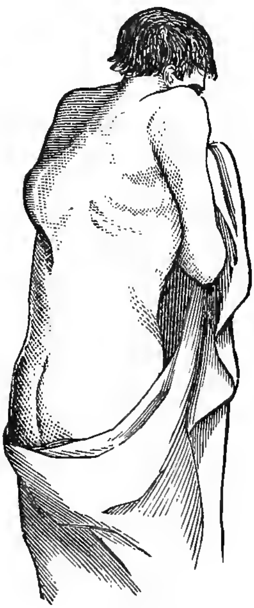


Fig. 93.

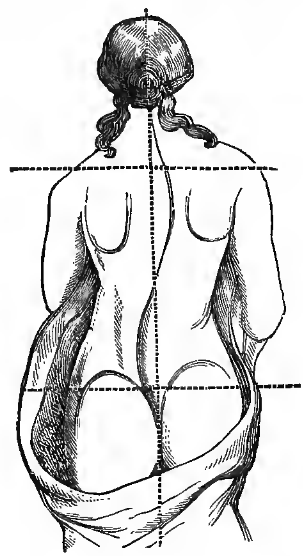


Fig. 94.

Fig. 93.—Fully developed caries. (After Hamilion.)
Fig. 94.—Lateral curvature. (After Hamilton.)

depression or *groove*, which extends the entire length of the back and is caused by the prominence of the erector spinæ muscles upon either side of the spines.

The vertebræ as surgical guides.

It frequently happens that it is desirable to determine the exact situation of some special vertebra, since valuable guides are thus obtained to important structures; this can be done most readily by first applying *sharp friction* along the groove over the spinous processes of the vertebræ, when the points of the spines will be made prominent as small red marks (since they come close to the skin), and can then be readily counted.

There are certain vertebræ which are of special value to the physician, since they stand as landmarks to guide him to the seat of other parts of the body. Thus, the *third cervical vertebra* corresponds to the following parts: (1) the opening of the larynx, (2) the bifurcation of the carotid artery, (3) the point of origin of both the external and internal carotid arteries, (4) the situation of the superior cervical ganglion of the sympathetic nerve. The *fifth cervical vertebra* is a guide to the following parts: (1) the lower opening of the larynx, (2) the beginning of the trachea, (3) the lower end of the pharynx, (4) the upper opening of the œsophagus, (5) the middle cervical ganglion of the sympathetic nerve. Finally, the *second lumbar vertebra* corresponds to the following parts: (1) the termination of the duodenum, (2) the commencement of the jejunum, (3) the lower border of the pancreas, (4) the upper root of the mesentery, (5) the point of origin of the superior mesenteric artery, (6) the commencement of the thoracic duct, (7) the opening of the ductus communis choledochus into the intestine, (8) the commencement of the vena porta, (9) the termination of the spinal cord, (10) the point of origin of the cauda equina, (11) the attachment of the crura of the diaphragm, and (12) the situation of the receptaculum chyli.

In addition to these three vertebræ, which are of special value as guides to more than one part of the body, may be mentioned the *seventh cervical,* whose long spine is a guide to the level of the apex of the lung in the male, since, in the female, it extends higher up; the *third dorsal* at whose level the aorta reaches the spinal column, the trachea bifurcates, and the apex of the lower lobe of the lung is found; the *eighth dorsal,* which indicates the lower level of the heart and that of the central tendon of the diaphragm; the *ninth dorsal,* at which level the upper edge of the spleen is found in health, and where also the œsophagus and vena cava pass through the diaphragm; the *tenth dorsal,* which corresponds to the lower edge of the lung, the spot where the liver comes to the surface posteriorly, and the situation of the cardiac orifice of the stomach; the *eleventh dorsal,* guiding the student to the normal situation of the lower border of the spleen, and to the upper part of the kidney; the *twelfth dorsal,* which marks the lower limit of the pleura, the passage of the aorta through the diaphragm, and the situation of the pyloric end of the stomach; the *first lumbar* where the renal arteries are given off, and where the pelvis of the kidney may be found; the *third lumbar* which corresponds to the level of the umbilicus, and the lower border of the kidney; and, finally, the *fourth lumbar* which marks the point of bifurcation of the abdominal aorta into the two common iliac arteries, and which lies on a level with the highest part of the ilium.

It may be of value to the physician in examining the chest, or endeavoring to locate the exact situation of any particular point upon the chest, to remember that the spine of the *third dorsal* vertebra is on the same level as the commencement of the spine of the scapula; that the spine of the *seventh dorsal* vertebra lies on a level with the inferior angle of that bone; and, finally, that the spine of the *last dorsal* vertebra is on the level with the head of the last rib, which may be used as a guide to certain surgical operations, upon some of the abdominal viscera.

Between the different vertebræ are placed *foramina,* through which the spinal nerves escape from the spinal canal to reach the parts which each is destined to supply. It is often useful to know the vertebræ, opposite to which the nerves of any special region arise from the spinal cord, since the point of origin does not always correspond to the foramina of escape. The following guides may be furnished by the vertebræ, to locate the *seat of lesions of the spinal cord,* which are affecting any special nerves or sets of nerves.

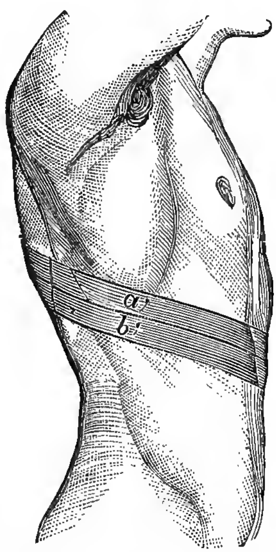
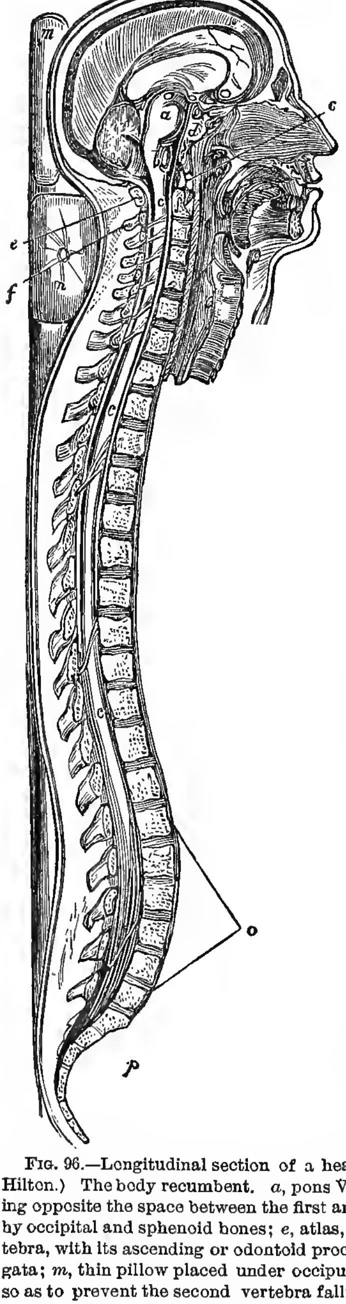


FIG. 95.—Side-view of chest, showing the course of the sixth and seventh dorsal nerves. *a,* course of the sixth nerve; *b,* course of the seventh nerve. (After Hilton.)

The interval between the occiput and the sixth cervical spine, marks the limits of origin of the *eight cervical nerves;* that between the sixth cervical and the fourth dorsal spine,[1] marks the origin of the *first six dorsal nerves;* between the eleventh and twelfth dorsal spines, the *five lumbar nerves* arise as the upper part of the cauda equina; while the origin of the *five sacral nerves* corresponds to a single vertebra, the twelfth dorsal spine.

[1] It should be remembered that the *spines of the vertebræ* are not always in a *precisely straight line,* but that in persons possessing the greatest strength, an occasional deviation of single vertebræ, either to the right or the left, may exist. It is by knowing these natural defects that we can guard ourselves against error in diagnosis.



The *spinal canal* which is inclosed by the vertebræ extends throughout the entire length of the spinal column, and contains the spinal cord, and the lumbar, sacral, and coccygeal nerves, after the spinal cord has terminated in the cauda equina. The vertebræ so overlap each other, posteriorly and at the sides, that it would be extremely difficult for any cutting instrument to injure the spinal cord, except between the occiput and the arch of the atlas, where animals are usually "pithed,"[1] and in the lumbar region, where a cutting instrument might possibly injure the lumbar or sacral nerves. The spinal canal is *larger in the neck* and the *lumbar regions* than in the dorsal, which fact is explained on two grounds: first, because there are two enlargements present on the spinal cord (where the large nerves of the upper and lower extremities arise), which demand increased space, and second, because the dorsal region does not admit of much motion, and therefore the spinal cord requires less room to insure its safety from pressure than in the neck, or lumbar regions, where the movements of the spinal column are more extensive.

The vertebræ are so interlocked, by their spinous and articular processes, as to render the *danger of dislocation* of any bone extremely slight; in fact such an accident would be impossible in the dorsal and lumbar regions without a fracture of the processes having first occurred; but, in the cervical region, such cases have been reported, and specimens of it are

FIG. 96.—Longitudinal section of a head, spine, etc., on right side of the median line. (After Hilton.) The body recumbent. *a*, pons Varolii; *b*, medulla oblongata; *c*, spinal marrow, terminating opposite the space between the first and second lumbar vertebræ; *d*, base of the skull formed by occipital and sphenoid bones; *e*, atlas, or first cervical vertebra; *f*, axis, or second cervical vertebra, with its ascending or odontoid process interposed between the altas and the medulla oblongata; *m*, thin pillow placed under occiput; *n*, thicker pillow, supporting the hollow of the neck, so as to prevent the second vertebra falling backward upon the medulla oblongata; o, six lumbar vertebræ as found in the body dissected; *p*, sacrum.

[1] The deficient bony protection of the medulla oblongata between the occiput

shown in some of the larger collections of osteological curiosities. Sudden and forcible *rotation of the neck* may be followed by such a dislocation, and Boyer reports a case where a lawyer was made the victim to this accident in attempting to see a person entering a door behind his chair.

The excessive length of the *transverse processes* of the *atlas* affords one of the many examples of a provision of Nature to increase the leverage of muscles and thus to add to their power, since the inferior oblique muscles of the neck are thus enabled to *rotate the head* with greater ease than if the transverse processes were of the same length as those of the other cervical vertebræ.

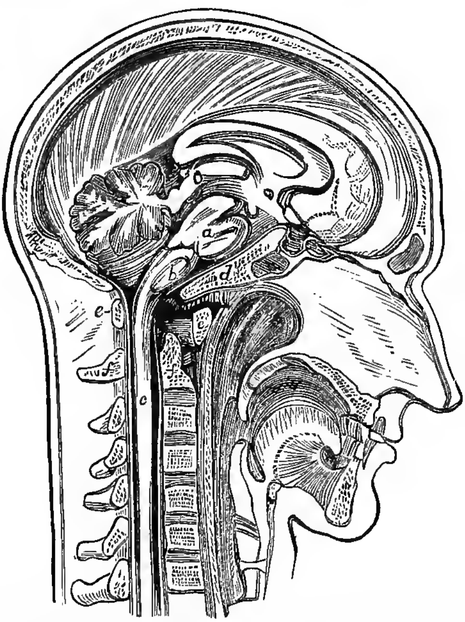


FIG. 97.—Sketch of a dissection, showing the head falling forwards, as happens in some cases of destruction of the ligaments, associated with disease of the joints between the atlas and axis and occipital bones. The head and atlas inclining forward, and leaving the second vertebra in its proper position, crush the medulla oblongata upon the odontoid process of the second vertebra, and so cause sudden or instant death; *a*, pons Varolii; *b*, medulla oblongata; *c*, spinal marrow; *d*, base of skull, formed by occipital and sphenoid bones; *e*, atlas, or first cervical vertebra; *f*, axis, or second cervical vertebra, with its ascending odontoid process. These bones are here shown widely separated, as the result of the division of the ligaments between them. (After Hilton.)

The *transverse ligament*, which serves to retain the odontoid process of the axis in close relation to the atlas, is an important structure, since it protects the medulla oblongata from the pressure upon it which would otherwise be exerted by that process of bone when the head is bent forward; hence the fatal consequence of rupture of that ligament when

and the atlas seems to be known among the criminal classes, as several murders have been perpetrated by forcing an instrument through this interval. (Blandin.)

hanging is scientifically performed upon a criminal. In spite of the strength of this ligament and the deep groove in the odontoid process in which it fits, it occasionally slips out of its place with fatal results to the patient. Such a case is reported by Petit[1] of a child that was killed by being lifted by the head, while Holden[2] reports another, where a lady was carrying her child upon her shoulders, and the child, losing its balance, clung to the mother's neck in falling, and drawing it suddenly backward, caused instantaneous death of the mother from rupture of this ligament. Such displacement is more liable to occur in the child than in the adult, since the ligaments are weak and liable to be more relaxed.[3]

The *seventh cervical vertebra* has, in rare instances, a *cervical rib* developed in connection with it, which is analogous to the cervical ribs found in some animals; such an abnormality has been mistaken for a bony tumor of the vertebral column, as it is not often movable, being frequently attached to the first rib, when present.

In the *sacral region*, the posterior sacral foramina are directly opposite to the anterior openings, so that it is possible for a pointed instrument to enter the cavity of the pelvis and thus wound some of the pelvic viscera; while the spinal canal is also *incomplete posteriorly* in the lower part of that bone, which thus enables the putrid secretions of bed-sores to enter that canal and create symptoms of spinal inflammation.

POINTS OF CLINICAL INTEREST PERTAINING TO THE VERTEBRAL COLUMN.

The number of the cervical vertebræ may, in rare cases, be *decreased to six;* this is one of the numerous evidences which the human frame often shows, of a tendency to return to the type of the lower animals, since only one mammal[4] has more than seven vertebræ. Although the neck may appear to be long, in phthisical subjects, and short in those of a full habit, the variation is due chiefly[5] to the shape of the upper portion of the body, which resembles the condition present after a full inspiration in those where the neck is short, while it is comparable to the condition of the healthy chest after a full expiratory effort in those where the neck is long. It was formerly and still is believed by some that the shortness of the neck indicates an additional danger to the subject from apoplexy in later life; basing this belief on the fact that the

[1] As quoted by Holden and others.

[2] Human Osteology, London, 1878.

[3] In addition to this explanation, Blandin mentions an anatomical fact pertaining to the odontoid process of the axis, which may prove an important factor in this accident; viz., that it is much shorter in the child than in the adult and thus more readily allows the transverse ligament to slip over its apex.

[4] The "*bradyphus tridactylus.*"

[5] It may be also due to an increase in the thickness of the *intervertebral disks* and the *bodies* of the vertebræ themselves.

head is thus brought more closely in relation to the heart, and the capillary vessels of the head are therefore subjected to a greater pressure than if the head were more widely separated from the trunk.

In advanced age, the *movements of the spine* often become seriously impaired, especially in the region of the neck, on account of a rigidity of the muscles which act upon the vertebræ. In the aged and also in the very young, *caries of the cervical region* of the spinal column is not an uncommon affection; and, as pus usually forms at the seat of the carious process, the pharynx is apt to be partially or even completely occluded by the bulging forward of a soft fluctuant tumor, and thus serious dyspnœa may ensue unless the pus be evacuated. It may be safely stated that a large proportion of the so-called "retro-pharyngeal abscess" which is met with in the ordinay practice of the physician, due to this carious process, is confined chiefly to the cancellous tissue of the bodies of the cervical vertebræ.

The spinal column may present *congenital,* as well as *acquired malformations.* Cases have been reported where the upper half of the cervi-

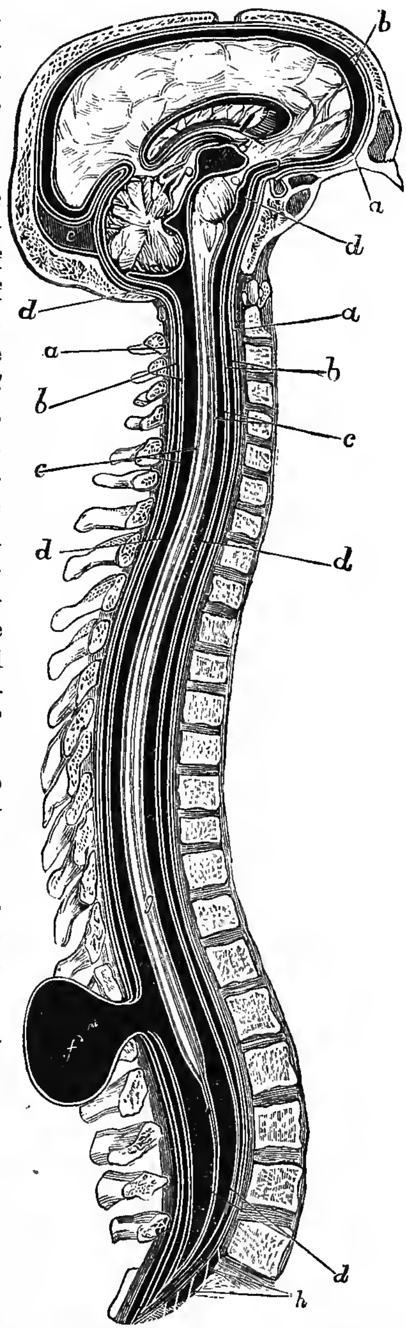


FIG. 98.—The condition of spina bifida. (After Hilton.) *a*, dura mater; *b*, external arachnoid; *c*, internal arachnoid; *d*, space occupied by cerebro-spinal fluid; *e*, torcular Herophili; *f*, spina bifida tumor; *g*, spinal marrow closely invested by pia mater; *h*, separate ligaments fixing the anterior parts of dura mater to the second, third, fourth, and fifth portions of sacrum. (There are other delicate ligaments passing separately from the posterior part of the dura mater to the arches of the sacrum and lumbar vertebræ, not shown in this sketch. The considerable space which exists naturally between the dura mater and the vertebræ, occupied by the rachidian veins and areolar tissue, is also omitted.) *i*, in the transverse section, indicates the position of the spinal nerves entering their dura-matral sheath. The posterior half of the dura mater is accurately represented as much thicker than the anterior half; its structure is more dense and more elastic.

cal region of the spinal column has been found wanting at the time of birth—a condition to which Beclard applies the term "atrachelo-cephalia;" also, where the entire cervical region has been wanting, as well as the upper extremities—a condition called by the same author "abrachiocephalia." The spinous processes of the vertebræ may be deficient at the time of birth—the condition of "spina bifida"—and a tumor, whose size depends upon the extent of the imperfection in the spinal column, will be presented in the median line of the trunk, posteriorly, which will be fluctuant, as a rule, since it will contain the cerebro-spinal fluid. The free communication which the cerebro-spinal fluid has with the *ventricles of the brain*[1] will explain why pressure over these tumors is apt to cause brain symptoms, and why injections of medicinal agents into the cavity of the tumor is certainly a questionable procedure, and one of great danger.

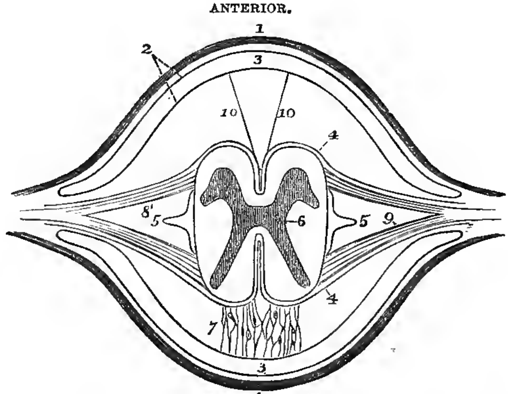


FIG. 99.—This diagram has been introduced to show the arrangement of the different membranes and spaces as they are believed to exist in the spinal column; 1, 1, dura mater passing down to end on the sheath of the nerves; 2, 2, layers of arachnoid forming, 3, cavity of arachnoid; 4, 4, pia mater ending on nerve-sheath; 5, 5, ligamentum denticulatum; 6, gray matter of spinal cord; 7, delicate areolar tissue found in the sub-arachnoid space between the arachnoid and pia mater; 8, anterior and smaller, 9, posterior and larger, roots of spinal nerve; 10, 10, similar tissue to 7. (After Hilton.)

Fractures of the vertebræ may result from direct injuries to the spine, or from a force indirectly applied, as in case of falls upon the feet, knees, pelvis, or head. In the first set of causes, viz., those producing fracture from direct violence, the injury is, of necessity, received upon the back; since the spine is most thoroughly protected in front by the soft tissues.

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[1] The cerebro-spinal fluid performs for the cerebro-spinal axis (the brain and spinal cord) the functions: (1) of diverting the vibratory motions of the bones of the skull from the brain, in case of violence being perceived; (2) it isolates the various nerves passing through the same cranial foramina; and (3) it regulates the internal pressures required to properly counterbalance the blood-pressure in the vessels of the brain and cord, and thus tends to bring back the internal ganglia of the brain to a state of quiescence after their state of vascular activity.

This class of injury, almost without exception, results in a *complicating dislocation* of the vertebræ in addition to the fracture received, since the anterior ligamentous attachments of the bodies to each other are ruptured by the direct force of the blow, which causes an alteration of the spinal curve; while at the same time the spinous processes and the laminæ of the vertebræ are comminuted, on account of the compression exerted in endeavoring to resist such an alteration of the spinal axes.

In the second class, viz., those forms of fracture dependent upon a force applied indirectly to the spinal column, the fracture is found to be situated, as a rule, at a distance from the point where the force was applied. Dislocation of the vertebræ will generally be absent in this class of fracture, but the articular processes will be often comminuted, and the spinous and transverse processes frequently broken. In very severe cases, however, where the force transmitted through the spinal column

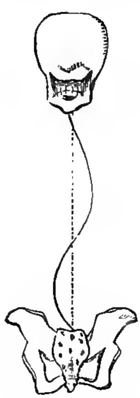

FIG. 100. Double lateral curve. (After Hamilton.

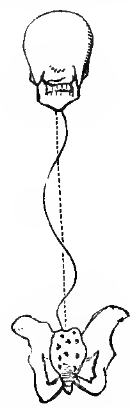

FIG. 101.—Quadruple lateral curve. (After Hamilton.)

is of a violent character, the *bodies* of the vertebræ may be comminuted (although the amount of cancellous tissue in their interior enables them to stand great compression without comminution), and thus a most serious form of displacement may result, which is liable to produce pressure upon the spinal cord and destroy life, if the displacement be above the origin of the phrenic nerves.

The symptoms of fracture of the spine may be either local in character, or referable to compression of, or injury to the spinal cord. The *local symptoms* will probably consist of crepitus, deformity, detached and movable fragments, local ecchymosis, and local pain. The *spinal symptoms* will vary with the seat of fracture and the portion of the cord which has been compressed or otherwise injured. Thus, if above the origin of the phrenic nerve, death may ensue from respiratory paralysis, provided that both of the lateral halves of the spinal cord are simultaneously injured. If above the origin of the lumbar and sacral nerves, symptoms of paralysis of the limbs and pelvic organs will be apparent. The paralysis of the muscles may be of the hemiplegic or the paraplegic type, according as the pressure upon the spinal cord affects one lateral half only, or both lateral halves of the cord; or, possibly, even local paralysis may result, if special spinal nerves be injured, and the spinal cord escape.

In some cases, where dislocation of the vertebræ exists, in connection with fracture of the spine, extension of the vertebral column, by means of the suspension of the patient if practicable, will often reduce the dislocation, and, possibly, an audible click will be heard when the reduction is effected. The results of injury to the spinal column depends more upon the severity of the spinal symptoms, produced by the injury to the spinal cord, than the situation or extent of the fracture.

Carious disease of the dorsal and lumbar regions of the spine is ex-

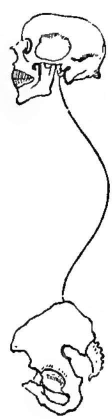

FIG. 102.—Kyphosis. (After Hamilton.)

FIG. 103.—Lordosis. (After Hamilton.)

tremely common in children. As regards the causes which conspire to create this condition, I must personally disagree with many of the distinguished authors on surgery, in the opinion that scrofula is generally found to exist in those so affected. To my mind, we can far more intelligently trace the exciting cause of this affection to *muscular exhaustion*, due to exercise persevered in after fatigue, or to some *slight accident* which is either unacknowledged by the child or overlooked by both the child and its parents. I am inclined to think that no case of spinal disease of an acute or chronic type ever occurred without some form of wrench or strain to the tissues forming the affected joint or joints; not that I am disposed to deny that scrofula probably predisposes to a debility of constitution which favors inflammatory processes, and in this way, and to just that extent, may be regarded as a predisposing cause, but I have never yet met with a case where my conviction as to the traumatic origin of the affection was not strengthened rather than diminished.

Diseases of the spine may begin in the *bodies of the vertebræ* or in the *intervertebral* substance. The traumatic theory of origin seems to favor the latter as the most frequent seat of origin of this type of disease, since it has been found by some of our best observers that all forms of injury to the spinal column tend to create a partial or complete separation of the intervertebral cartilages from the bodies of the vertebræ, and thus to interfere with their nutrition.

The *pain* which is associated with spinal disease is due to an irritation of the spinal nerves which escape from the foramina between the laminæ of the vertebræ, and are therefore placed in close relation both to the bodies of the vertebræ and the intervertebral substances, both of which have been discussed as the most probable points of origin of this affection. It is often possible, by a thorough knowledge of the course and distribution of these spinal nerves, and by a general law, which is given by Hilton, to trace the symptom of localized pain to its exciting cause, and thus to make an early diagnosis of a diseased condition of parts, which may be far removed from the seat of pain, and whose recovery depends upon this recognition in the early stages of the disease. The rule to which I refer may be thus quoted: "In disease of the lower cervical, dorsal, and lumbar regions of the vertebral column, the pain is usually expressed symmetrically; that is, on both sides alike. It is often not so, however, when the disease lies between the occiput and the atlas, or between the first and second cervical vertebræ."[1] As examples of the utility of this guide to the diagnosis of spinal affections by means of symmetrical pain, a constant *pain in the pit of the stomach* is a frequent indicator of disease in the region of the point of origin of the sixth and seventh dorsal nerves from the spinal cord; while *pain in the scalp* covering the *back part of the skull*, in the region of the nape of the neck, is often a guide to disease of the spine between the atlas and the axis, since the great occipital nerve, which supplies that region of the scalp, arises between these vertebræ.

The subject of *pain*, as a guide to the situation of spinal lesions, is one which requires a most thorough knowledge of anatomy to properly appreciate its advantages or to skilfully apply its precepts. It would be out of the province, as well as the scope of a small volume like the present one, to attempt to give to the reader more than a general idea of how the nerves which arise from the spine can be utilized by the physician, not only in making a brilliant diagnosis in some instances, but in skilfully treating and relieving the symptoms of others. Every student of

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[1] The explanation of this peculiarity of the first and second cervical vertebræ, as given by Hilton, rests in the anatomical fact that the number of separate joints between these bones enables the disease to frequently remain *unilateral;* while, in the case of all the other vertebræ, the disease rapidly spreads throughout the *bodies* of those bones, and thus becomes a *bilateral* affection.

medical anatomy should first become most thoroughly familiar with the seat of origin of the spinal nerves and the guides to them, as afforded by the spinous processes of the vertebral column (see page 143). He should next acquire the general course and distribution of those nerves which are distributed to the muscles of the trunk and the integumentary covering of the thorax, and abdomen; and also the general course of those nerves which supply the muscles, joints, and skin of the upper and lower extremities. When this has been mastered, he should learn to regard *pain* as a symptom which can be traced along the well-defined course of the nerve which supplies the region where the pain is perceived, remembering that pain is usually felt at the *peripheral extremity* of the nerve, and not in its central portion, or near its point of origin; and he should always trace the course of the affected nerve, carefully noting the presence or absence of anything along the course of the nerve which might create pain, until the seat of disease is reached. One axiom, which is given by Hilton, cannot be too often repeated to those who hope to use the method which has been described, with success, viz., "*That superficial pains on both sides of the body, which are symmetrical, imply an origin or cause, the seat of which is central or bilateral, and that unilateral pain implies a seat of origin which is one-sided, and, as a rule, on the same side of the body as the pain.*"

We have now considered the results of fractures, dislocations, and diseased conditions of the vertebral column, and the means of diagnosis which are afforded us by anatomy, both in the recognition of the existing condition and in the localization of the disease, as far as this line of study can guide us, without entering into the consideration of the minute structure of the spinal cord and the nerve-centres, and the physiological functions of the various parts. We have seen that *pain* may be used as a guide to the proper recognition of the early stages of disease of the vertebræ; that *deformity* may be produced as the result of fracture or dislocation, and that the seat and the results of a force applied to the spine are capable of being explained on anatomical grounds, when the construction of the vertebral column is mastered; that the effects of pressure upon the spinal cord may be revealed as a *type of paralysis*, either of the lateral half of the body (hemiplegia), of the lower half of the body (paraplegia), or of the lower portion of one lateral half of the body (hemi-paraplegia); and, finally, that the *motor power* of the muscles may be affected, the *sensation* of the parts alone affected, or that *both motion and sensation* may be impaired or destroyed.[1]

The normal curvatures of the spine have been discussed to some

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[1] Pressure on or disease of the posterior part of the spinal cord produces symptoms referable to the *sensation* of the parts to which the paralyzed nerves are distributed; while pressure upon or disease of the anterior portion of the cord interferes chiefly with the motor nerves distributed to the muscles.

some extent in the pages descriptive of the articulations of the vertebræ with each other, as certain points were thus made clear by showing a design on the part of Nature; while the effects of abnormal curvatures upon the intercostal spaces and the general configuration of the thorax will be found mentioned in connection with the bones of that region. These abnormal curvatures are most commonly the result of carious disease of the bodies of the vertebræ, and its attendant suppuration, or of a relaxation of the ligaments and absorption of the intervertebral disks of cartilage. They are met with in children who have been subjected to some severe muscular strain or injury (possibly of so slight a character as to have been forgotten or purposely concealed); also in those who have long assumed a reclining position of the trunk toward one side, as in sitting over a desk; and in the weak and debilitated. The various methods now adopted to support the head and spine in an erect attitude, and the benefits derived from their use, seem to warrant the belief that the causes of the disease are largely mechanical, and that a relief from pressure of the vertebræ upon each other effects a cure.


FIG. 104.—Caries of the spine. (After Hamilton.)

In that condition, called "*Pott's disease,*" the bodies of the lower dorsal and upper lumbar vertebræ undergo carious degeneration, and the pus which forms follows the psoas muscle downward to its point of insertion, and thus escapes at the upper part of the thigh (on its inner aspect), where it forms a fluctuant tumor which may be mistaken for a femoral hernia, and other surgical conditions of that region.[1]

Dislocation of the *last lumbar vertebra* upon the sacrum, in a forward direction, occasionally occurs to such an extent that, while it does not seem to imperil life to any marked degree, an impediment to parturition is produced; because the superior aperture of the true pelvis is shortened in its antero-posterior diameter. In case such a cause of dystocia is suspected, a bony projection can be felt by the finger through the vagina or rectum, which juts out into the pelvic cavty.

When the bones composing the vertebral canal are the seat of *carious degeneration,* and the exact limit of the disease, or even its existence, is involved in doubt, a practical test has been suggested by Rosenthal, by which not only the existence of the affection, when the symptoms are obscure, but also its extent and situation can be determined with an approach

[1] The author would respectfully refer his readers to his treatise on Surgical Diagnosis, N. Y., 1880, for the points of discrimination between this affection and several others which are liable to be confounded with it.

to accuracy. This test consists in passing, along the *sides* of the vertebral column, a pair of electrodes attached to a Faradic battery of considerable power. Under these circumstances, if there be any caries, or inflammation of the vertebræ tending toward caries, the seat and extent of the disease will be at once manifested by a *burning* and *stabbing pain* which will often cause the patient to scream or start, since the passage of the electric current through inflamed bone-tissue is extremely painful. While some of the later authors are not yet willing to concede this symptom as a positive evidence of carious degeneration, still they are agreed, almost unanimously, that the absence of pain on the application of the galvanic current may be regarded as conclusive evidence that no disease of the vertebræ exists.

Dislocations of the spine are of infrequent occurrence, but such an accident may occur either as the result of violence to or disease of the vertebræ, without the presence of a complicating fracture. In two cases, reported by Lassus and Paletta, the *occipital bone* has been displaced from its articulation with the *atlas;* the first of these lived six-hours, having suffered a laceration of the vertebral artery, which lies in extremely close relation with both bones, as it passes between them, while the second survived five days. Dislocations of the *axis* from the *atlas* have been already mentioned as possible, and some remarkable cases have been cited to illustrate the form of accident which is most liable to produce it (see page 146). It has been stated by some authors that cases of this character have been relieved by a reduction of the dislocation, by placing the head of the patient between the hands, and the knees of the surgeon against the shoulders of the sufferer, and thus, by drawing and twisting the head, the odontoid process has been replaced; but such a statement seems to me incredible, since, if the accident had really occurred and the odontoid process had once become displaced, death would inevitably take place before surgical relief could be of benefit. I am inclined, therefore, to believe that these cases are properly those of concussion of the spinal cord with a severe sprain of the neck, injuring its muscles or stretching its ligaments. A rare form of accident is occasionally met with, in which the *transverse process* of some of the cervical vertebræ is displaced, upon one side only; thus causing the head to be turned toward the opposite side and rendered immovable, while marked pain is present at the seat of displacement, and a ridigity of the neck is produced. In such an emergency, forcible extension of the head, and rotation afterward, will tend to reduce the displacement, which will usually be indicated by that peculiar snap with which all dislocations are liable to be associated when replaced.

CHAPTER II.

THE NECK AND ITS STRUCTURES.

THE REGION OF THE NECK, AS A WHOLE.

THE bones of the neck have already been considered as a part of the vertebral column, with the exception of the *hyoid bone,* which serves as a point of attachment for the root of the tongue; the membranous structures which connect it with the larynx; the muscles situated in the anterior portion of the neck; and those which serve to raise the hyoid bone and the larynx, during the second period of the physiological act of deglutition.

In the fœtus and also in the aged,[1] the anterior outline of the neck assumes a curve with its concavity looking toward the spinal column; but, as the parts fill out, the line assumes more nearly a perpendicular direction in childhood and middle life.[2] The *length* of this region varies, not only in individuals, but also with the position of the head; it is more delicate in the female than in the male, and its prominences and depressions are therefore more apparent. The length of the neck is caused to vary by alterations in the thickness of the intervertebral disks of fibro-cartilage; partly by an increase in the thickness of the bodies of the vertebræ themselves; and, finally, by the formation of the upper portion of the chest, since the neck is apparently shortened during each inspiratory act and lengthened during expiration. An actual increase or decrease in its length is therefore produced by those types of thorax which more closely resemble the conditions either of a full inspiration or a full expiration. For this reason, the long neck is most often associated with that type of chest which is flat in the supra-mammary region; where the clavicles are prominent; the upper intercostal spaces widened, and the lower spaces narrow; and where the sternum is depressed (the typical expiratory chest). Such a condition of the chest always denotes a lack of robustness of constitution, and, often, a tuberculous tendency; and, for that reason, long necks are not the best evidence of animal vigor or of long life.

On the other hand, the short neck—while it may most often be found

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[1] Blandin: Anat. Topog. Paris, 1836.

[2] In the male adult, when the pomum Adami is extensively developed and prominent, the line of the anterior portion of the neck is often rather convex than straight; while in those afflicted with goitre (enlargement of the thyroid gland) the same condition is present to an exaggerated degree.

with the typical inspiratory form of chest, and thus probably indicate great vigor and strength of temperament—is thought to render its possessor liable to the danger of apoplexy in later life, on account of the close approximation of the brain to the heart, and the additional strain to the cerebral vessels, due to this fact. That the length of the neck is modified by the position of the head is too well-known by surgeons to need more than a mere mention, since all the operations upon the neck demand that the head be so placed as to assist the operator in rendering certain muscular guides tense, and relaxing other muscles, when additional space is required. The old rule, quoted by Blandin,[1] is valuable to those whose surgical experience is limited: "Place the head so that the part to be operated upon shall be opposed to the motion toward which the whole inclines."

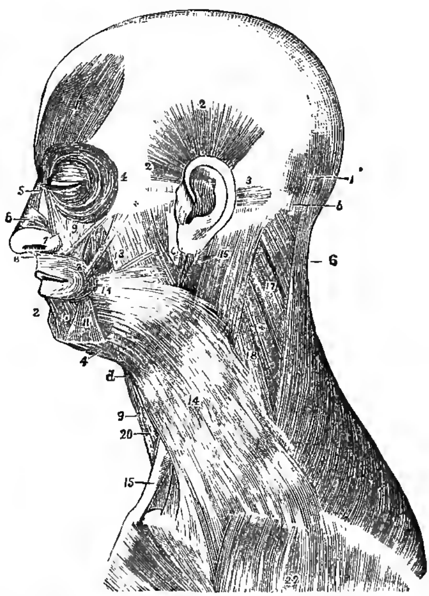

Fig. 105.—Muscles of the head and neck: 1. 1, the two portions of the occipito-frontalis muscle; 2, 2, 3, three muscles (more largely developed in animals) which move the ear; 4, orbicularis palpebrarum, the muscle which closes the eyelids; 5–7, muscles of the nose; 8, orbicularis oris, the muscle which puckers the lips; 13, masseter muscle; 14, platysma myoides, a broad thin muscle which gives motion to the skin overlaying it; 15, sterno-cleido-mastoid muscle; 16, trapezius; 17, 18, muscles which raise the shoulder-blade, or, when it is fixed, draw the head to either side.

The neck is rendered short during an advanced stage of emphysema, since the chest, being forced to contain more than the normal amount of air (inspiration being a labored act as well as expiration), the shoulders are permanently raised and the upper portion of the thorax is rendered prominent, thus shortening the neck. In phthisis, on the contrary, the expansion of the thorax is reduced, to an extent proportionate to the amount of lung-tissue involved; and, in severe cases, the neck therefore

[1] Op. cit.

becomes markedly lengthened on account of the flattening of the supra-mammary region, and the sinking of the bones of the shoulder.

Many of the structures of the neck are of practical interest from a medical point of view. The pharynx, larynx, trachea, œsophagus, and thyroid gland are the seat of medical diseases, in contra-distinction to those which are properly classed as surgical affections; while the various diseases of internal organs are often evidenced by alterations in the arteries, veins, muscles, nerves, glands, and fasciæ of this region.

THE VEINS OF THE NECK AND THEIR POINTS OF INTEREST.

The veins of the neck, which lie superficially and can thus be watched during life, show variations in their size which are of great value to the physician. In the sitting posture, the law of gravity assists to empty these veins, except during the act of expiration, when the sinking of the chest-wall and the pressure exerted upon the mediastina, causes the downward flow of blood to be temporarily arrested, and thus the veins are made prominent from their over-distention. Now, there are certain conditions of the internal organs of the thorax which tend to make such an impairment to the venous return of the blood through the superior vena cava permanent, among which may be mentioned extensive emphysema, lesions of the tricuspid valve of the heart, thoracic aneurism, tumors of the mediastina, cardiac dilatation or greatly enfeebled heart's action, extensive effusions into the pleural or pericardial sacs, collapse of the lung from the entrance of air into the pleural cavity, cancer of the œsophagus within the thorax, and many other causes which directly or indirectly would tend to impede the entrance of blood to the cavity of the thorax, or that of the right auricle.

The veins of the neck may exhibit, however, variations in the amount of blood which they contain, irrespective of disease; thus, in the acts of speaking, singing, or coughing, the superficial veins may swell enormously, from the prolonging of the expiratory effort (which arrests the venous return to the heart), and from the force which is employed by the muscular system to produce the effort.[1] There is more blood in the veins of the neck during the contraction of the heart than during its period of repose; more in the recumbent position than when we sit up; more when we are warm than when we are cold; and more during anger or excessive mental activity than when cold aud impassive.[2] If the veins

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[1] So apparent is this fact during the singing of high notes that the swelling of the veins in the neck can often be seen among professionals on the stage, even by the audience; and the extent of the venous engorgement may often be seen to vary with the pitch of the note. Probably the abdominal muscles tend to force the diaphragm upward and thus to crowd the blood in the superior vena cava to the upper part of the thorax.

[2] Sibson: Medical Anatomy. London, 1868.

be filled from any pressure due to disease, the affected side of the thorax may often correspond with the side of the neck upon which the veins are the more distended; while an equal distention of the veins during both inspiration and expiration is most commonly met with in those acute types of inflammation of the bronchial tubes, where the respirations are shallow, or in pulmonary congestion, pneumonia, emphysema, etc.

The *large veins* of the neck may be *seen to pulsate* synchronously with the systole of the heart, when the tricuspid valve allows the blood to regurgitate into the right auricle to so marked an extent as to cause the heart-impulse to travel as a wave along the column of blood in the superior vena cava, and thus to the veins of the neck. This symptom is, therefore, of the greatest value in deciding as to the condition of the right auriculo-ventricular opening and the valve which tends normally to occlude it; and, since this valve usually does not become insufficient without previous disease of the lungs or of the mitral valve, an important guide is thus afforded the diagnostician in locating the primary cause either in the lung or the left heart.

The veins of the neck are filled with blood from the venous sinuses of the brain and from the superficial and deep veins of the head and face; for this reason any obstruction to the free escape of blood from these latter veins, if long continued, produces a *cyanosed condition* of the face, and, often, *brain symptoms,* as the result of passive hyperæmia of that organ, or of carbonic acid poisoning. The face of the sufferer from emphysema manifests, in a most striking way, the cyanotic condition of the face;[1] and vertigo, specks before the vision, noises in the ears, and fulness in the head are liable to be produced by coughing or the slightest exercise in this class of patients, illustrating the effect of an increase of the hyperæmia of the brain.[2] The turgidity of the face, bleeding at the nose, vertigo, and possible convulsions of whooping-cough again illustrate the effect of the prolonged paroxysm of coughing upon the venous circulation of the head and brain; while the frequent attacks of fatal apoplexy, which are produced by fits of anger, exercise, or intense excitement, in those whose arteries have become weakened by atheromatous changes, may be due, in part, to the impeded return of venous blood to the thorax, thus creating an indirect increase of the pressure in the arteries.

The veins of the neck are a frequent source of embarrassment to the surgeon, since, in those diseases where respiration is greatly interfered with, the *veins swell enormously*, and often so cover the parts which the surgeon is endeavoring to reach, as to require some steps which shall obviate the difficulty. As a rule, simple compression over the vein, at that angle of the wound which lies nearest to the head, will cause it to collapse, but sometimes it becomes necessary to apply a ligature to it, and

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[1] See page 61 of this volume.

[2] Loomis: Diseases of the Respiratory Organs, Heart, and Kidney. New York, 1880.

subsequently to divide it. It should always be remembered that, in the region of the neck especially, there is great danger of the *entrance of air* into the severed vein, unless a double ligature be first applied, and the vein severed between the points ligated.

This distressing accident has always occurred, as far as my research has extended, in operations about the head, neck, or axilla.

Experiments on animals by Morgagni, Valsalva, Bichat, and Nysten, have shown death to arise in the dog from an injection of three cubic inches of air into the jugular vein, and in the horse from three ordinary human expirations.

Bichat, in his experiments, concluded that even *one bubble* might result in death; but his associate investigators—Bell, Magendie, Amussat, Cormack, Wattman, Nysten, and Erichsen—do not verify such a conclusion. Death seems to depend not only upon the amount of air introduced, but the rapidity of the injection seems also greatly to influence it.

In medicine, however, we have only to deal with the *spontaneous* admission of air into venous cavities, dependent upon a thoracic vacuum existing both within the pleuritic and pericardial sacs, and occurring during the act of inspiration. There has been much discussion, and many theories have been advanced as to the exact physiological condition produced by the entrance of air into veins, and the mechanism of its action as a cause of death.

Bell's theory argued that death was the direct result of *air upon the medulla oblongata.* Cormack ascribes death to *distention of the right heart* alone, without abnormal valvular or pulmonary conditions. Erichsen[1] denies both of these conclusions, and claims that death results from *obstruction in the pulmonary capillaries* from the frothy condition of the blood, which resists the vis-a-tergo of the heart. This theory has had great support; is based upon extensive experiments and pathological research; and, where small quantities of air enter veins, probably is correct.

Moore,[2] however, in his paper on this subject, advocates an explanation, in which the *valvular* element is brought out as the most important factor, and which certainly merits attention. He states his explanation briefly as follows: 1. Air, from its light density and compressibility, on entering the right ventricle, fails to close the *wet tricuspid valve* during the ventricular systole. 2. During the following diastole of the heart, the air enters, or, rather, floats, into the pulmonary artery. 3. During the second ventricular systole, the wet *pulmonary valves* also fail to close, and adhere to the sides of the vessel. 4. The succeeding diastole now draws blood into the ventricle from both the auricle and the lungs. 5. The cardiac systole returns the blood again to its original situation,

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[1] Science and Art of Surgery. Philadelphia, 1878.

[2] Holmes' Surgery. New York, 1870.

as both the tricuspid and pulmonary valves are open, and thus the circulation becomes arrested.

These two latter explanations probably cover the mechanism of death, the former being the most plausible when the amount of air in the heart cavities is small, the latter when a large quantity of air is suddenly introduced.

In 1818, Beauchesne reported the first case of this accident occurring during the removal of a tumor of the right shoulder, the internal jugular vein being wounded. The patient lived fifteen minutes.

Subsequently cases were reported by Dupuytren, Delpech, Castara, Roux, Ulrick, Mirault, Warren, Mott, Malgaigne, Bégin, Erichsen, Cooper, Clemot, and others. Some of those recovered; some met almost instant death; some died of pneumonia from bronchial irritation at a later date. In all of these cases, however, an abnormal condition of the opened vein existed, characterized by a failure to collapse, termed by the French "*canalisation.*"

This abnormal condition may be produced either *artificially* or by some *anatomical* changes. *Artificial canalization* may result from one of four conditions, viz., 1. Tension of the aponeuroses, holding the mouth of a vein open. 2. Veins opened by platysma contraction. 3. Traction on the pedicle of a tumor. 4. Vein, at an angle of the wound, opened by traction on the flaps. *The abnormal anatomical conditions* producing canalization are: 1. Indurated cellular investments about the vein. 2. Induration or inflammatory thickening of the venous coats.

Thus, in Beauchesne's case, traction existed; in Delpech's, hypertrophy of axillary vein; in Castara's, section occurred during traction; in Roux's, section occurred during traction; in Ulrick's, the vein was inclosed in a tumor; in Mirault's, the vein was inclosed in a tumor; in Warren's, tension from the position of the arm existed; in Mott's, the *facial vein* was made tense from the position of the head; in Malgaigne's, the vein was inclosed in the tumor; in Bégin's, the jugular vein was tense from traction.

When air is allowed to enter into the veins of a dog by section, there occurs: 1. A hissing noise, with gurgling at the mouth of the vein. 2. Struggles during the subsequent inspirations. 3. A churning noise at the apex of the heart during the ventricular systole, with a bubbling, thrilling, and rasping sensation on palpation. 4. The circulation becomes feeble, but the heart's action *remains forcible.* 5. The animal becomes unable to stand, rolls over, utters a few plaintive cries, is convulsed, extrudes its fæces and urine, and dies. In man, however, there are additional symptoms given us by the *expressions* of the patient; thus, the patient experiences a terrible constriction in the thorax immediately after the air enters; screams, moans, and subsequently whines as the symptoms increase. The pulse early becomes imperceptible; the heart's action labored; convulsions come on rapidly; and death usually occurs. Still, in Mirault's case, three or four hours elapsed before death; in Clemot's, several hours; in Beauchesne's, fifteen minutes; in Roux's and Malgaigne's, death from pneumonia ensued; while in Erichsen's and Cooper's cases, recovery took place.

As *prevention* of this accident is of vital importance, the following suggestions may be of value: 1. Always close the mouth of any *open* vessel *instantly*, both on the proximal and distal end, and compress every vein before cutting it. 2. Avoid raising *any tumor* or the *shoulder* in operations about the neck, head, or axilla, without protecting the large veins by pressure. 3. Compress between the wound and thorax, if a cause for fear exists, during alterations in the position of patient or tumor. 4. Bandage the chest and abdomen tightly to prevent *gasping respirations*, which tend greatly toward this accident.

As to the plan of *actual treatment*, after the accident has occurred, many suggestions have been offered, though their value will depend somewhat on the views held as to the mechanism of death. Thus, Moore advises a *supine* position, to allow the blood to fall to the *back* part of the heart, and thus raise the tricuspid valves. Others advise the head low and the feet high, to relieve the anæmia of the medulla. Mercier suggests *compression of the femorals*, axillaries, and abdominal aorta, for the same object; but this is objected to by others on account of the necessity of venous return, which is retarded by this method. Warren advises either *bleeding* from the temporal artery, *tracheotomy*, or *stimulants*, as the indications seem to demand, with galvanic shocks across the chest in case the heart's action seems to fail. Gerdy *compresses the chest*, hoping to expel or facilitate the passage of air through the lungs. In apparently fatal cases, Amussat and Blandin recommend *suction of air* from the heart, by means of a catheter passed into the open vein, or into the right jugular, if the former be impossible, with compression of the chest at the same time. Magendie and Roux advocate suction alone. Reid and Cormack suggest the *opening of the right jugular vein* to relieve the right auricle.

Many of these plans have to me serious objections. Compression of the chest, after the accident has occurred, seems useless, and increases the pulmonary obstruction. Bleeding from the temporal artery depletes the already empty arteries. Tracheotomy only relieves a secondary symptom (dyspnœa). Erichsen lays great stress on artificial inflation of the lungs to overcome the obstruction in the pulmonary capillaries, and suggests that mechanical respiration be kept up after this procedure, using at the same time ammonia to the nostrils.

Artificial respirations, with the *mouth* and *nostrils closed*, have been suggested as a remedial measure, the object being to expel air from the heart by the vein through which it entered. Finally, *injections of warm water* into the heart cavity, to render the valves movable, and subsequent artificial respiration to keep up the cardiac action, is resorted to and recommended by Moore as a remedy in the severe type of cases. His steps for this operation are as follows: 1. Raise the head during the injection, to allow the air to escape through the fluid. 2. Open some vein in the neck, and evacuate its blood, to further assist the escape of the air. 3. Avoid throwing in additional air with the syringe. 4. Inject with force enough to FILL, but not *distend* the heart cavities. 5. Inject two ounces at a time, with velocity enough to raise the wet valves which are adherent to the walls of the heart. 6. Stimulate the heart's action, during the operation, by galvanism and artificial respiration.

THE MUSCLES OF THE NECK AND THEIR FUNCTIONS.

When the *platysma muscle* is in action, it draws down the lower lip, and thus tends to widen and open the mouth. This action is a frequent cause of the expression of melancholy, as mentioned on page 36, but it may also be seen in those cases where the patient gasps for breath, owing to extreme difficulty in respiration, and is then a most formidable and dangerous symptom. It is by means of this muscle that the lateral wrinkles of the neck, which can occasionally be produced at will, are chiefly created.

In thin necks, a *delicate cord* may often be perceived which runs transversely across it, parallel with the clavicle but slightly above its upper border, and which may be seen to rise and fall with the movements of the chest during respiration. This is the posterior belly of the *omo-hyoid muscle,* which is attached to the cervical fascia, and by it to the apex of the lung. During inspiration, this muscle renders the cervical fascia tense, and thus tends to raise the apex of the lung, co-operating with the scaleni and sterno-mastoid muscles of that side of the neck to assist in the perfect performance of that act. If we trace the nervous supply to this muscle, we will find that it derives motor power from *three sources,* viz., the cervical plexus, the pneumogastric, and the hypoglossal; thus indicating that the muscle is destined to assist in three important functions.[1] By means of the filaments derived from the cervical plexus, it is capable of acting in the various movements of the neck, in perfect harmony with the other adjacent muscles; by means of the filaments from the pneumogastric, it is placed under the control of the nerve of respiration, and thus acts in harmony with the respiratory muscles, while the filaments from the hypoglossal nerve bring its action into perfect accord with the muscles of the tongue, most of which are chiefly attached to the hyoid bone.

The *scaleni muscles*, the *levator anguli scapulæ*, and the *omo-hyoid* are the chief muscles of the neck concerned in respiration;[2] hence to the physician and the physiologist they possess an importance which the muscles that simply control the movements of the head or neck do not

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[1] John Hilton, op. cit.

[2] Porter: Surg. Anat. of Larynx and Trachea. Burns: Anatomy of Neck and Head.

have. By the scaleni muscles the first and second ribs are made a point of resistance for those muscles which act upon the remaining ribs during inspiration; but to accomplish this effect the spinal column has to be also made a fixed point from which the scaleni muscles can act upon the two upper ribs. It can thus be perceived that the scaleni muscles can also be made to act from the ribs in case the spinal column is to be moved; and the neck can be deflected by them toward the side upon which the muscles in action are situated, if those of one side act alone, but, if those of both sides act simultaneously, the spine will be kept erect.

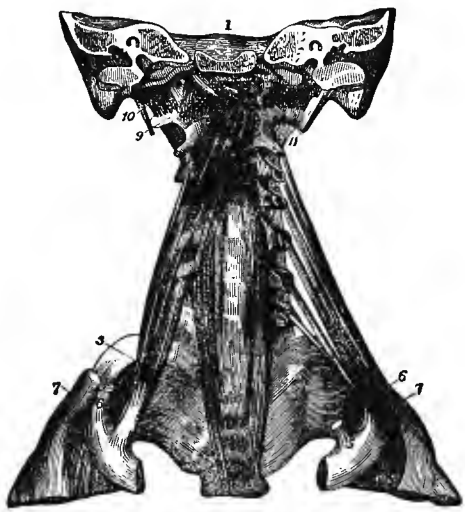

FIG. 106.—Prevertebral muscles; 1, basilar process of occipital bone; 2, anterior aspect of cervical vertebræ; 3, commencement of dorsal vertebræ; 4, longus colli muscle; 5, scalenus anticus muscle, arising from first rib; 6, scalenus medius muscle arising from the first rib; 7, scalenus posticus muscle arising from the second rib; 8, the rectus capitis anticus major muscle; 9, rectus capitis anticus minor muscle; 10, rectus capitis lateralis muscle; 11, styloid process of temporal bone.

The table of muscles acting upon the head (see page 30) may prove of assistance in explaining the mechanism of production of some of the distortions of the head and neck which are not infrequently met with.

The *muscles of the tongue, pharynx, soft palate,* and those of the *supra-hyoid region* are chiefly concerned in the act of deglutition. Perhaps no better way can, therefore, be devised to illustrate to the reader the various functions of these muscles, than by giving a hasty sketch of that act in its different stages, and the muscles which assist to produce it. I quote, therefore, from my late work upon the nervous system.

The Act of Deglutition and its Mechanism.

For convenience of description, it has been the custom of physiologists to divide the act of deglutition into three distinct periods. The first period comprising the passage of the bolus of food through the mouth, which is under the control of the voluntary muscles; the second, the passage of the bolus through the isthmus of the fauces and the pharynx; the third, the passage through the œsophagus to the cavity of the stomach.

In the *first period*, the food is first seized by the lips, then forced between the jaws by the tongue and the buccinator muscles; and by the teeth it is not only masticated, but is also mixed with the salivary secretion. When the food is ready to be swallowed, the mouth is first closed, as the act is performed with extreme difficulty when the mouth is open, since the tongue cannot properly act upon the bolus. The tongue now becomes widened, so as to offer a large surface to the bolus of food, and, with the bolus placed behind it, is pressed backward along the roof of the mouth. In case the food to be swallowed happens to be in a liquid form,

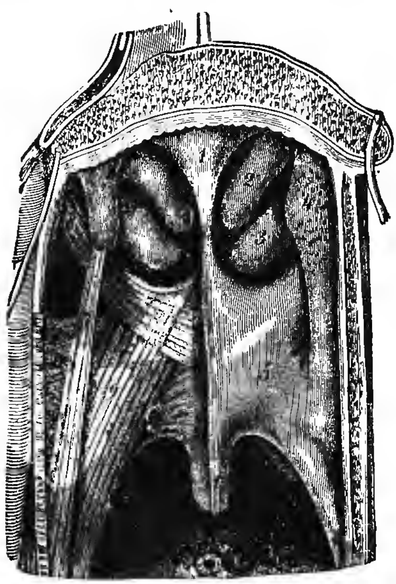

FIG. 107.—Anterior view of the naso-pharyngeal space; on one side the mucous membrane has been dissected away (after Luschka). 1, septum; 2, middle; 3, lower turbinated bone; 4, tuberosity of the pharyngeal orifice of the Eustachian tube; 5, soft palate; 6, uvula; 7, stylo-pharyngeus muscle; 8, levator-palati; 9, palato-pharyngeus muscle. (Ziemssen.)

the tongue is so curved that its edges curl upward, while its dorsum is depressed in the centre, thus forming a *longitudinal groove* along its entire length, and the soft palate is so closely applied to the base of the tongue as to admit of a sucking force.

The importance of the tongue during this period of the act of swallowing, cannot be overestimated. Animals, in which the tongue has been paralyzed by section of the nerves of that organ, exhibit the utmost distress in their efforts to bring the food to the back portion of the mouth, and are forced to so toss the head as to bring the force of gravity to their aid.[1] Drinking also becomes even more interfered with, and the tongue is no longer used to help in the act, but various devices are used to bring the fluid where the reflex act of the fauces will help to carry it to the stomach. If it were not for the fact that, after removal of the tongue for local disease, the stump was of sufficient length to be of great assistance

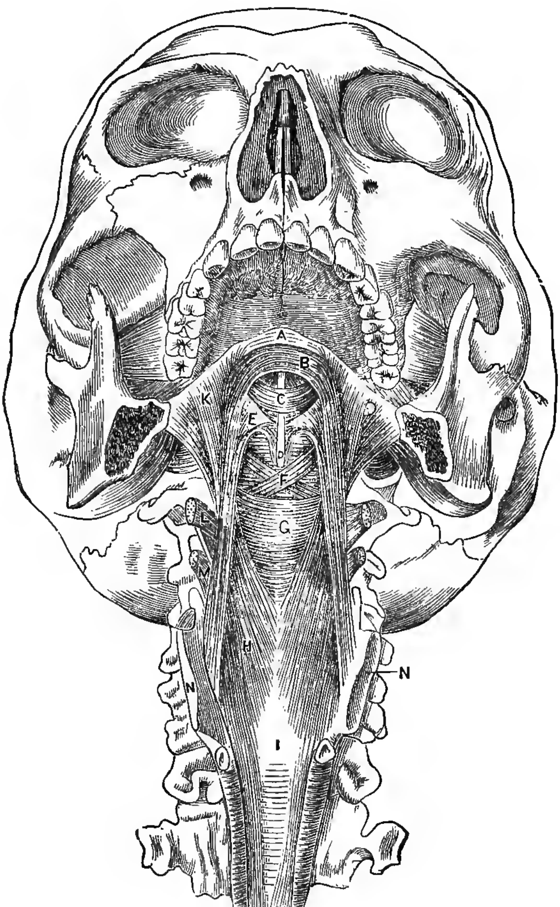

FIG. 108.—Anterior view of the muscles of the pharynx and palate after removal of the tongue, hyoid bone, and larynx as far as the posterior segment of the thyroid cartilage (Luschka); A, aponeurosis of the soft palate; B, thyroid portion of the palato-pharyngeus muscle; C, arch-like connection of the levator palati muscle; D, azygos uvula; F, G, bundle of constrictors in posterior wall of pharynx; H, pharyngeal portion, and K, palatine portion of palato-pharyngeus muscle; L, glosso-pharyngeus muscle; M, hyo-pharyngeus muscle; N, posterior segment of thyroid cartilage; 1, aponeurosis of the thyro-pharyngeo-palatine muscle; below which are the longitudinal fibres of the œsophagus springing from it. (Cohen.)

[1] We see this also marked, but to a less extent, in patients afflicted with glosso-labial paralysis.

in controlling the bolus of food, such an operation would be a questionable procedure.

In the *second period* of deglutition, the bolus of food, by being crowded against the soft palate, tends to raise it; and the levator palati muscle further assists in retaining the palate in this elevated position, while the superior constrictor muscle of the pharynx causes the posterior wall of the pharynx to bulge forward and thus to meet the uvula. The posterior nasal openings are thus mechanically closed to the entrance of the food into the chamber of the nose, preparatory to the series of reflex movements which are to ensue, for the purpose of forcing the bolus downward into the œsophagus and thence into the stomach.

The *larynx* is now *suddenly raised,* so as to bring the superior opening of that organ underneath the base of the tongue, which has been crowded backward during the first period, in order to force the bolus against the soft palate, and whose soft structure renders it admirably adapted to mould itself to the irregularities of outline of the laryngeal opening. By this position of the tongue, the epiglottis is also applied over this opening,[1] and the entrance of food into the larynx is furthermore protected against, by the approximation of the vocal cords by means of the adductor muscles of the larynx. The muscles which thus raise the larynx are the anterior belly of the digastric, the mylo-hyoid, the genio-hyoid, the stylo-glossus, and some of the fibres of the genio-glossus.

Simultaneously with the elevation of the larynx, the palato-pharyngei muscles contract and *raise the lower end of the pharynx,* thus shortening the length of that organ and tending to draw the pharynx over the bolus of food very much as a glove is drawn over the finger; while, at the same time, the curve of the posterior pillars of the pharynx is thus made straight, and, by the approximation of these muscles to the sides of the uvula, the opening of the pharynx into the nares is now completely occluded.

The constrictor muscles of the pharynx now come into play, contracting in succession from above downward; the posterior pillars of the fauces, by their approximation, prevent the bolus from again entering the mouth; and the bolus of food is thus forced to enter the œsophagus.

Now it is apparent that most of these movements are of a *reflex character* and are excited by the presence of the bolus of food, which passes out of voluntary control as soon as it passes the anterior pillar of the fauces, at which point the second period of deglutition may be said to commence. Every reflex act presupposes some sensory filaments to convey the impression to the brain, and certain motor filaments to transmit

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[1] It was formerly supposed that the epiglottis was the chief instrument in preventing the entrance of food into the larynx, but the large number of cases where the epiglottis has been removed and no difficulty in deglutition apparently produced have thrown much doubt as to its importance.

the impulses to the muscles destined to act upon the bolus; and it is now believed that the glosso-pharyngeal nerve possesses both of these sets of fibres, as well as those controlling the special sensation of taste. This nerve may then be considered as a nerve of taste, a nerve of motion to the pharyngeal muscles, and the true "*excitory nerve*" of the act of deglutition.

The importance of the *soft palate* in the act of deglutition is particularly shown during the swallowing of liquids, since it has to be closely applied to the base of the tongue in order to allow of a partial vacuum within the cavity of the mouth, and thus to draw the fluid along the furrow formed by the curving upward of the edges of the tongue. This fact is clinically shown by patients affected with paralysis of the velum, who experience great difficulty in swallowing liquids; since the fluid is liable to escape through the nose. A case is reported by Bérard of this character, where a young lady was obliged to free herself from all observation whenever she attempted to drink, as the escape by the nostril was so profuse as to occasion embarrassment.

The prevention of the entrance of food into the cavity of the larynx, as has been mentioned, is insured, (1) by the base of the tongue, (2) by the epiglottis, and (3) by the approximation of the vocal cords; but that such accidents do still happen from attempts at inspiration [1] during eating is attested to by the violent coughing excited, and by the instantaneous expulsion of the foreign substance, unless it should chance to become mechanically arrested in the larynx. Longet accounts for the symptoms excited by such an accident as the result of an exquisite sensibility possessed by the mucous lining of the upper part of the larynx. It is well attested that the danger of entrance of fluids into this organ is far greater than in the case of solids, and the act of gargling is especially liable to be followed by such an occurrence, since the larynx is much wider open than in the act of deglutition. In the administration of anæsthetics to patients who have eaten largely before the hour appointed for surgical relief, a great danger of the entrance of vomited matters into the cavity of the larynx is encountered, since the sensitiveness of the mucous lining is destroyed, and the expulsive efforts of Nature are often wanting.[2]

The *third period* of the act of deglutition is confined to the œsophagus, through which the bolus has to pass to reach the stomach. The downward movement of the bolus is assisted by alternate contraction of

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[1] As occurs during attacks of laughing, hiccough, etc., when food is present in the mouth, or during too hasty an effort to consume food.

[2] In cases where this accident occurs the tongue should be forcibly drawn out of the mouth, so as to pull up the epiglottis, and the foreign body extracted by the finger if possible, or, if not, the patient should be held by the feet, and thus by shaking the patient, gravity may help to dislodge it. I once saved the life of a patient by this means when all others had failed, and fatal asphyxia seemed imminent.

the longitudinal fibres of the tube, which shorten it and tend to draw its walls upward over the bolus, and contraction of the circular fibres, which constrict the tube and force the bolus downward. The fact that gravity has little, if anything, to do with this downward movement is proven by the fact that the position of the body does not seem to affect it, while acrobats are often known to perform the feat while standing upon the head or hands. The time consumed in the passage through the œsophagus was estimated by Magendie[1] as about two minutes in animals, but it is probably much shorter in man; although we are often conscious of a delayed termination of the act, and are forced to hasten it by the drinking of fluids, as most of us can attest. It is probable that this peristaltic action of the œsophagus, like that of the intestinal canal, is partly controlled by the nervous influence of the sympathetic system, although the pneumogastric nerves have also an extensive distribution to this organ.[2]

Deglutition is *essentially a reflex act*, save in its first period, when volition plays an important part. It cannot take place unless some stimulus is applied to the mucous lining of the fauces; and those apparently voluntary acts of deglutition, which are produced when no food is within the mouth, are undoubtedly due to the swallowing of saliva, or to irritation of the fauces by the base of the tongue itself. When we tickle the fauces, we can see all of the act of deglutition, confined to the second period, artificially produced, and this irritability of the fauces is so extreme in some persons as to render any attempt to examine the throat one of difficulty, and often a cause of reflex vomiting. So important is the education of the throat to enable the patient to tolerate the presence of instruments, that all surgical procedures upon the larynx, if performed from within the mouth, require often months of training to enable the patient to assist the operator in a step, whose execution may be a matter of a few seconds only. All forms of local applications are used to insure an anæsthetic condition of these parts, and the internal administration of medicinal agents is furthermore often required to render such procedures within the cavity of the larynx possible.

That the *centre* for the *reflex act of deglutition* is confined to the medulla oblongata is proven by experiment on animals whose brain has been entirely removed with the exception of the medulla, when irritation of the fauces will still continue to produce all the movements of the second stage of that act.

Clinical Points Pertaining to the Muscles of the Neck.

The separate muscles or groups of muscles may exhibit evidence of impairment in their motor power—paresis; or a total loss of motor power

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[1] Journal de Physiologie.

[2] Michael Foster regards this third act of deglutition as more closely dependent on the *central nervous system* than the movements of the intestinal tract, and attributes it to reflex action due to the bolus.

—paralysis. As examples of this fact, the two large superficial muscles of the neck, the sterno-mastoid and the trapezius, both of which are supplied from the same source—the spinal accessory nerve—may be affected with a loss of power either simultaneously or separately; and symptoms will thus be produced which are of so positive a character that the existing condition can easily be diagnosed by any one familiar with the action of the affected muscle.

If the *sterno-mastoid muscle* be affected upon one side only, the head will be held in an oblique position, with the face directed toward the affected side, on account of the action of the unopposed muscle.[1] The chin will be slightly elevated, and the head cannot be voluntarily turned toward the healthy side, although little force is required to place it in its proper attitude by the hand of the physician. Since other muscles assist in the rotation of the head, this unnatural position of the head is not carried to an extreme extent, being still opposed by the muscles which retain their normal power of movement. To make the diagnosis positive, place the hand underneath the chin of the patient, and instruct him to flex the head upon the chest while you resist his effort to do so, when the muscular belly of the healthy side will become prominent, and and that of the paralyzed side will not; thus affording the physician the best possible means of estimating, not only the existence of the condition, but also the extent of the paralysis. When unilateral paralysis of this muscle has remained for some time, the opposite muscle assumes a *state of contracture,* which causes the obliquity of the head to be more difficult to mechanically overcome. If the muscles of *both sides* are paralyzed, the head is no longer held in an oblique position, but is pointed straight forward; while rotation of the head, especially if the chin be simultaneously raised, is performed with some difficulty by means of other muscles. The same absence of the prominence of the muscles during attempts to flex the head under resistance will be present upon both sides instead of one only, as before mentioned; and a leanness of the neck may be apparent, if the muscles have progressed far toward the condition of atrophy, as the result of disuse or disease of the motor cells of the spinal cord.

If the *trapezius* be the seat of paresis or paralysis, the deformity will be chiefly confined to the scapular region. This bone appears to be drawn downward and forward from its normal position. Its inferior angle is tilted inward, and thus is in closer relation to the spines of the vertebral column than in health, while its upper portion is farther removed from the spine. The weight of the arm, assisted by the action of the rhom-

[1] While torticollis is most commonly due to contraction of the sterno-mastoid muscle, it may be produced also by disease of the cervical vertebræ, by the cicatrices following deep burns of the skin of the neck, by paralysis of the muscles (as in hemiplegia), by congenital malformation, by tumors of the neck, and by other causes.

boideus and levator anguli scapulæ muscles, tends to draw the acromion downward and forward, and, in consequence of this, the clavicle projects away from the anterior part of the chest; the supra-clavicular fossa appears deeper than normal; and the posterior angle of the scapula can be felt in the posterior portion of that space with an unusual degree of distinctness. Since this muscle is supplied from *more than one source*, the condition of paresis is more common than that of paralysis, and hence the position of the scapula may be modified to some extent by the nerves affected.

In this condition, voluntary elevation of the shoulder is limited; or, at least, is affected by other muscles than in the normal state. It is this fact that accounts for the enormous increase in the size of the omo-hyoid muscle, which sometimes becomes so enlarged as to resemble the anterior border of the trapezius muscle in the state of firm contraction. The relative actions of these two muscles afford us a clue to decide as to which of the two is the cause of the prominence, provided the history of such a case is unknown, since the omo-hyoid muscle tends to raise the superior and internal angle of the scapula, and thus tends also to *deepen the supra-clavicular fossa*, because it acts upon the clavicle, causing it to stand off from the wall of the thorax: while the trapezius muscle elevates chiefly the acromial end of the scapula, and thus tends to draw the whole bone toward the vertebral column, and to render the supra-clavicular fossa less deep, since the clavicle is approximated to the chest-wall.

The *elevation of the arm* above the horizontal line of the shoulder is chiefly effected by the movements of the scapula, in which the bone is caused to revolve, as it were, upon a pivot in the centre of its body, thus causing the inferior angle to recede from the vertebral column, while the upper and internal angle is brought more closely in relation with it. Now, to effect this movement, the trapezius muscle is the most important factor, since its fibres act upon the acromion process, which is, in this case, the end of a long arm of a lever; and, when this muscle is paralyzed, a most characteristic effect upon the elevation of the arm toward the head is presented from the absence of this powerful factor in the movement.

When *both of the trapezii muscles* are simultaneously paralyzed, these anomalies are present upon both sides of the body. Both shoulder blades having fallen outward and forward, the back has an appearance of being excessively rounded in a transverse direction, and the head is maintained in an erect position with more difficulty than in health, since it tends to sink upon the chest. When we consider that paralysis of the trapezii muscles may be associated with a lesion which impairs the free action of the *spinal-accessory nerve* of either side, we can better appreciate why, in such cases, the internal branch of that nerve may become affected and a *difficulty* produced in *swallowing* (due to paresis of the constrictor muscles of the pharynx); a *loss* of or *huskiness* of voice (due to laryngeal paralysis); and a peculiar *nasal tone* of the voice (due to the paresis of the velum palati) may also exist as a further evidence of the impairment of this important nerve.[1]

REGIONS OF SPECIAL INTEREST IN THE NECK.

In the *supra-clavicular region* of the neck, a wound may produce most serious consequences, and even prove immediately fatal, if the subclavian artery, which lies within this space, be opened, or the vein which accompanies it be punctured. The supra-scapular vessels and also the transverse cervical artery and vein, both of which cross the neck in this region, may be the source of most alarming hemorrhage, if wounded. This latter vessel is so situated that the fragments of a broken clavicle

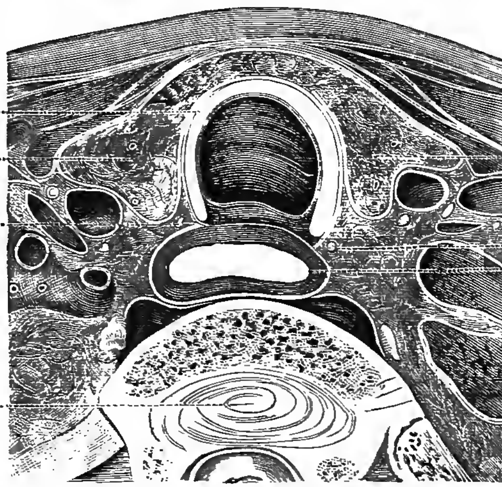

FIG. 109.—Transverse section through the neck at the lower surface of the first dorsal vertebra. (After Braune.)

may cause perforation of its coats, if driven backward with violence. I have seen paralysis of the upper extremity follow an injury to this region, from severing of the main cords of the *brachial plexus:* and even a slight injury sustained by these nerves may create neuralgic pains which are extremely severe and may be felt in the arm, forearm, or hand. It is possible for the brachial plexus to be injured even if the wound received be situated far back in the neck, at the posterior limit of this space, especially if the instrument be carried slightly forward. The *phrenic nerve,* which crosses the scalenus anticus muscle and thus lies between the subclavian artery and vein, may be severed, if the wound be carried inward near to the median line of the neck; in which case, a sudden difficulty in respiration will be the symptom that will indicate the character of the injury, as the diaphragm will no longer act upon that side.

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[1] For the full explanation of these symptoms, the reader is referred to the late work of the author: The Applied Anatomy of the Nervous System. New York, 1881.

In this region of the neck, the *apex of the lung* rises above the level of the first rib, especially at the end of a full inspiration; and, in case the shoulder happens to be depressed, it is quite possible for a pointed instrument to pierce the lung through the neck. I was once called to see a patient, who was suffering from a marked emphysema of the tissues of the neck, following a puncture of the supra-clavicular region, just above the clavicle, and, on questioning him, I ascertained that he was holding his breath after a full inspiration, at the time of the accident. While I have never met with a reported case of pneumo-thorax from such an accident, I can see no anatomical reason why the air from the apex of the lung cannot enter the pleural sac, and thus produce those alarming symptoms of dyspnœa and collapse which often follow such a perforation. Finally, it is possible for the axillary artery to be injured in this space, provided the instrument inflicting the wound pass slightly below the level of the depressed clavicle, and in the direction of the shoulder.

In phthisis, during the later stages, when cavities have formed and decomposing pus within the lung is creating the so called "hectic fever" by its absorption, the deep lymphatic ganglia of the supra-clavicular space are not infrequently found to be enlarged; this has been explained by Blandin[1] as the result of the communication of the lymphatic vessels of the lung with these ganglia. Should these ganglia ever be found to be the seat of suppurative inflammation, a practical point is afforded by the aponeurosis of this region; which indicates that early incision should be made, in order to prevent the accumulated pus from burrowing underneath the aponeurosis and thus entering the axilla.

The *nerves* from the *cervical plexus,* which ramify in the skin of this region, and descend from above in nearly a perpendicular direction, suggest a point in making incisions; since, if made in a perpendicular direction, less danger of dividing these sensory nerves exists, and thus an annoying pain, which is often referred to the region of the shoulder (because the supra-acromial nerve is derived from the same source), may be avoided. Blisters may be also applied, in this space, to affect the trunks of the brachial plexus, since it lies nearer the skin here than elsewhere.

It frequently becomes necessary to compress the *axillary artery* in this space, when wounds of a serious nature occur close to the shoulder-joint; this can be best performed by first depressing the clavicle and drawing the tip of the shoulder forward, when the finger can be crowded behind the clavicle, and the pulsations of the artery can be felt, it may be caught between the finger and the first rib, and thus held until surgical relief is procured. Another method much in use consists in wrapping a large key in a handkerchief, and using that as a wedge between the clavicle and the first rib, but it is greatly inferior to the fin-

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[1] Op. cit.

ger of a strong man, since the artery does not want to be pushed downward, but rather *backward* and *inward* against the unyielding surface of the rib itself. It once became my privilege to thus save the life of a patient, when the emergencies of the case rendered ligation of the bleeding vessel impossible, without additional assistance being procured. It may be well here to call the attention of the reader to the fact that, in the case of aneurism of the axillary artery, the clavicle is usually so raised as to render this means of compression difficult, and often impossible. When, in the experience of such men as Sir Astley Cooper, attempts to so control the artery have signally failed, it is well to be forewarned. One other important structure within this space deserves mention: I refer to the external jugular vein.[1] It is deeply situated at the inner border of the sterno-mastoid muscle, and hence may be here compressed against the first rib in case it chance to be wounded, or, when bleeding exists from some of its tributaries; but it is too deeply situated for superficial wounds to reach it.

In those rare cases, where the subclavian artery requires compression, a superficial incision through the skin and cervical fascia will often enable the finger to press the artery, either against the first rib, the middle scalenus muscle, or the transverse process of the seventh cervical vertebra; but, in some cases, the artery can be controlled without such an incision being made, the steps differing but little from those given to compress the axillary artery.

Certain *surgical guides* of value pertain to this region.[2] The posterior border of the sterno-mastoid muscle is a guide to the external jugular vein; and, by putting this muscle into action, that vein may be rendered prominent. It is well to remember also that the posterior border of the sterno-mastoid muscle corresponds to the outer border of the scalenus anticus muscle, which is the guide to the subclavian artery. The course of the external jugular vein corresponds to a line drawn from the angle of the jaw, where the vein commences, to the middle of the clavicle, where it terminates.

Sterno-Mastoid Region.

The *sterno-mastoid muscle*, which crosses the neck obliquely from the mastoid process above, to the sternum below, is the great surgical landmark of the neck. In its middle portion, the anterior border slightly overlaps the common carotid artery; while, at the root of the neck, the muscle divides into two fasciculi of insertion, which are called the sternal and clavicular. Between the sternal borders of the muscles of the two sides, close to the superior opening of the thorax, is seen a depression,

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[1] See fig. 64 of this volume.

[2] For the effects of paralysis of the trapezius muscle upon this region, the author would refer the reader to page 169.

called the "*fonticulus gutturis,*" which has a marked respiratory movement when the breathing is rendered difficult from any cause; but it may be absent in those young subjects whose necks are abundantly supplied with adipose tissue in this locality. Between the sternal and clavicular insertions of this muscle, another depression exists upon either side of the neck, which has even a greater importance than the one previously mentioned, since a puncture through this opening might result in death from injury done to the *common carotid artery,* if the instrument were directed slightly inward, or to the *internal jugular vein,* if directed slightly outward. In those cases where the two insertions of this muscle have to be divided, as occurs in attempts to ligate the first portion of the subclavian artery, and, as some authors have suggested, for the relief of deformities due to its abnormal contracture, the operator cannot be too strongly impressed with the *close proximity of large veins* to the under surface of this muscle, and the great caution which should always be used in passing a director underneath the muscle previous to dividing it.

It follows from these remarks that all wounds of the lower portion of the sterno-mastoid region must be extremely dangerous, since, if not very superficial, the *common carotid* and *subclavian arteries* may be involved; and the *internal jugular* and *subclavian veins,* as well as the *phrenic, pneumogastric,* and *sympathetic nerves,* are structures whose injury is followed by serious consequences. In the middle portion of the sterno-mastoid region, the *cervical plexus* of nerves may be involved, if the injury penetrate much deeper than through the skin; while, in the upper part of this region, the *occipital vessels* and the *vertebral artery* are extremely liable to be wounded.[1] The peculiar curve which is taken by the vertebral artery between the atlas and the axis, renders this vessel especially liable to be opened by a wound near the head, involving the posterior part of the neck, since it throws the artery out on a level with the tips of the transverse processes of these vertebræ.

The sterno-mastoid muscle may be pushed outward by enlarged ganglia, and by abscesses of the supra-sternal and supra-clavicular regions, which, by following the deep cervical fascia, often burrow underneath this muscle.

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[1] Foreign bodies in the pharynx occasionally demand a division of the structures of the neck, when they cannot be removed through the mouth, and are so imbedded in the walls of that organ as to expose the patient to a risk of perforation of some of the large blood-vessels of the neck, which lie in close relation to the lateral wall of the pharynx. They may also create abscess of the surrounding structures, even when the danger of directly wounding the neighboring vessels is improbable; and they may thus do damage to the important nerves of the neck, or, by creating a weakness of the walls of the blood-vessels, produce a fatal hemorrhage by their rupture.

Supra-Hyoid Region.

In the supra-hyoid region, the submaxillary gland may become the seat of disease, while, above the hyoid bone, the parotid gland may also attract the attention of the practitioner, since it may become affected with a degenerative process, and demand removal. The proximity of several superficial lymphatic glands in the region of the parotid may occasion a diseased condition of these superficial structures, to be mistaken for disease of the parotid gland itself—a point that should be well determined by a study of the anatomical relations of the parotid and a most thorough examination of the patient. It is a clinical fact that the salivary glands are less frequently affected with degenerative changes than any of the glandular structures of the body, and it is stated most positively by Velpeau that these changes are always secondary to the disease of neighboring lymphatic structures. It has never been my privilege to remove the parotid gland for disease, but it is stated by some of the leading authorities that the removal of a diseased parotid is much easier than in the healthy state, since the gland is not infrequently incapsulated, and, when not so, is so contracted and hardened as to greatly alter its normal relation to the surrounding parts, so that a part may be superficial which, in health, is deeply situated. The operation was first performed by Warren, of Boston, in 1798, and has been since performed by a few of the leading surgeons of Europe, and by Mott, McClellan, Horner, White, and some others of our own country.[1]

Anterior Cervical Region.

The *omo-hyoid muscles* of the two sides form the outer boundaries of a *broad triangular space,* which stretches across the front of the neck; whose base corresponds to the upper border of the two clavicles and the upper border of the sternum, and whose apex corresponds to the hyoid bone. In its central portion, which corresponds to the median line of the neck, lie the sterno-thyroid and sterno-hyoid muscles. This space is covered by a strong fascia, the deep fascia of the neck, which is firmly attached to its apex and base, and is rendered tense during the acts of speaking, coughing, singing, and other expulsive or violent muscular efforts. It is evidently intended as a *wall of support* to the deeper veins of the neck, when they are rendered turgid by any act which tends to impede the return of venous blood to the thorax.

In the *region* of the *hyoid bone,* which lies nearly on the same level as the lower jaw, when the head is carried at a right angle to the spinal column as it should be in health, a depression can be perceived above the prominence of the thyroid cartilage, the so-called "pomum Adami." This corresponds, anteriorly, to the attachment of the apex of the

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[1] Velpeau collected thirty-five cases, and H. H. Smith fifty-three cases of entire removal of this gland.

epiglottis to the thyroid cartilage, and to the thyro-hyoid ligament which joins the larynx to the hyoid bone; hence, as this is the most frequently selected place for cut-throat from the ignorance of anatomy by those of suicidal tendencies, the hyoid bone and the greater part of the epiglottis lie in the upper portion of the wound. The hyoid bone has been fractured by the strong grasp of the garroter.[1] Its cornua serve as a *guide* to the *lingual artery* of either side, where that artery lies within the lingual triangle, so that it is usually felt for, in operations to tie that artery in

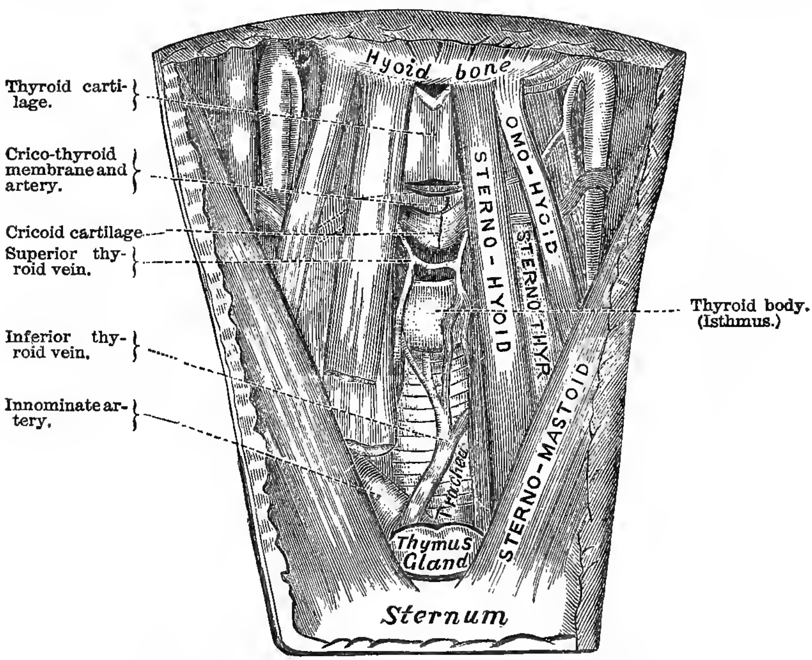

FIG. 110.—Surgical anatomy of the laryngo-tracheal region. (Gray.)

case of wounds of the mouth and the tongue, or in cut-throat, where it has been divided. This artery is occasionally tied for the relief of tumors of the tongue, or to control excessive hemorrhage from severe types of ulceration of that organ. The proximity of the hypoglossal nerve (to sever which would cause paralysis of the tongue upon that side), and the large veins which lie in close relation to the vessel, render the operation one of difficulty even to the cautious surgeon.

When we place the finger upon the side of the larynx, below the level of the prominence of the thyroid cartilage, the "pomum Adami," we can easily perceive the pulsations of the *common carotid artery*, since it does not bifurcate into the external and internal carotid arteries until it reaches the level of that prominence. We can thus understand how

[1] Holden: Human Osteology. London, 1878.

wounds of the superior carotid region are liable to involve the *common carotid* trunk or even the *external* or *internal carotids,* since they lie quite superficially at this point; and the *internal jugular* vein and the *pneumogastric nerve,* which are inclosed in the same sheath with the common carotid, may also be injured. It is not usually mentioned by authorities that effusions of blood or accumulations of pus may extend from this region of the neck into the mediastina of the thorax, by following the cellular layer which invests the large blood-vessels at the root of the neck, which is often extremely loose. It is possi-

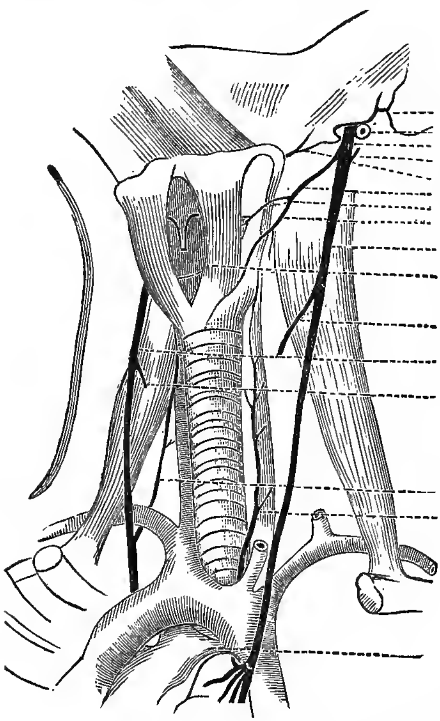

FIG. 111.—Laryngeal branches of the pneumogastric nerve in the newly-born child. (Henle.)

ble for enlarged glands of this region to press upon the sheath of the common carotid. Andral[1] reports a case where the pneumogastric nerve was so atrophied by pressure from a gland, that the patient died from dyspnœa which was gradually developed, and which, in the latter stages of the disease, was intense.

The *anterior region* of the neck presents, in the median line, the following parts from above downward: the hyoid bone, the depression beneath it, the thyroid cartilage of the larynx, the crico-thyroid depression, the cricoid cartilage of the larynx, the rings of the trachea, and

[1] As quoted by Blandin.

the thyroid gland. In the infant, the thymus gland rises into the lower portion of the neck, but, in the adult, it atrophies and almost entirely disappears, so that nothing can be seen of it above the upper border of the sternum. Most of the parts above mentioned can be seen or felt by a most superficial examination, and they all have some important surgical bearings which should not be unfamiliar even to the physician who might hesitate to employ them.

The hyoid bone has already been discussed in the first pages of this chapter. It should, however, be remembered that its greater cornu is the guide to the lingual artery, and that, as it affords attachment to the base of the tongue, it is an important agent in raising the larynx during the second stage of deglutition, and in protecting its superior opening, since the epiglottis is prevented from being displaced.

The thyroid cartilage of the larynx forms the protective investment of the cavity of that organ, and also acts as a firm point of attachment for the vocal cords and the muscles which tend to regulate their position and tension, during the acts of respiration, singing, and talking. In the male adult, the anterior and upper part of the thyroid cartilage increases in size, thus forming a prominence seen in most necks, called the "pomum Adami," while between it and the hyoid bone, a bursa is placed to facilitate the movement of the thyroid cartilage beneath the hyoid bone during the second stage of the act of deglutition.[1] If we examine the thyroid cartilage carefully with the finger, through the integument and muscles which cover it, we can usually map out the outline of its upper and lower borders and its superior and inferior cornua. The superior border is the guide to the point of *bifurcation* of the *common carotid artery* into the external and internal carotids, which lie upon the same level, while it also corresponds to the level of the third cervical vertebra. Upon the lateral aspect of this cartilage, the lateral lobes of the thyroid gland can be felt; and, since this gland rises and falls with each respiratory effort, it can be easily distinguished from any abnormal growth of that region of the neck. The thyroid cartilage is seldom, if ever, opened to relieve impeded respiration, since the attachments of the vocal cords and the apex of the epiglottis in the median line render such a step contra-indicated. On the upper and front part of the thyroid gland, near the upper border of the thyroid cartilage, can be felt the pulsations of the *superior thyroid* artery, which ramifies upon it. This pulsation is used as another surgical test to discriminate between the gland in case it be enlarged, and a tumor of new-formation.

In cases of inflammatory diseases of the interior of the larynx, pressure upon the thyroid cartilage will often give pain; hence it is the custom with some physicians to use this cartilage as a means of confirming or excluding the presence of such conditions within the laryngeal cavity.

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[1] For the details of the mechanism of this act, see page 163 of this volume.

The *cricoid cartilage* is a point of interest both to the surgeon and the physician, since its superficial situation renders it always capable of being felt by the finger, even in babies whose necks are usually short and often extremely fat. It is the great external landmark to the air-passages, and a guide also to the upper opening of the œsophagus, which is partially attached to it posteriorly. Since it lies on the level of the fifth cervical vertebra, it may be of use in determining the relative situation of other parts to the spine. Again, if a transverse line be drawn across the neck at the level of the cricoid cartilage, it will intersect the point at which the omo-hyoid muscle crosses the sheath of the common carotid artery, and, since the artery is usually ligated either just above or just below that muscle, this cartilage is a valuable surgical guide to the seat of election.

The *depression* between the thyroid and cricoid cartilages is easily felt through the tissues which cover it in front, but it does not extend far to either side of the median line, and cannot, therefore, be felt well at the side of the larynx. It is in this space, which in health is covered by the crico-thyroid membrane, that a tube is generally inserted,[1] in those cases where suffocation from any cause appears imminent. Since it lies below the level of the vocal cords, the objection urged against the opening of the thyroid cartilage does not hold good in this case, and the operation is to be preferred to that of tracheotomy, if it can be as easily performed. Unfortunately, however, the distance between the cricoid cartilage and the upper border of the sternum is greatly under-estimated by the majority of observers, since it is scarcely one and a half inches in an adult, when sitting with the head in an easy and normal posture. If the head be thrown well backward, the length of this interval may be increased to about two and one-quarter inches. Now, when suffocation becomes imminent, the trachea and the larynx move up and down with great rapidity during the struggle for breath; the veins of the thyroid body, which descend in front of the neck, are enormously swollen and bulge outward as if about to rupture; the head is usually flexed upon the chest, in order to afford all possible room for the parts; and thus the space between the larynx and the sternum is rendered extremely short, and when the head is raised to see the larynx, the dyspnœa is increased to a paroxysm. It can thus be understood how an opening between the cricoid and thyroid cartilages is not always practicable, and that tracheotomy is often the easiest means of affording relief.

The *trachea*, or the main air-tube, extends from the cricoid cartilage or the fifth cervical vertebra to its bifurcation into the right and left bronchus in the thorax, at a level of the third dorsal vertebra. It is able to bear external pressure without collapsing, by the cartilaginous rings

[1] The operation of "Laryngotomy," as distinguished from that called "Tracheotomy," where the rings of the trachea are divided to insert the tube.

which give it form; and these rings are often of importance as a means of locating the position and relations of certain portions of the tube. In the neck, not more than seven or eight of these rings are present, and none of them can be felt externally. This is accounted for by the fact that the trachea becomes more and more deeply situated as it passes downward, and because the isthmus of the thyroid gland covers the second, third, and fourth cartilages. Moreover, the thymus gland projects upward into the neck of children, and thus adds an additional source of difficulty in determining the situation of the rings by the sense of touch.

So rapidly does the trachea recede from the surface of the neck that, on a level with the upper border of the sternum, in an adult whose neck is short and fleshy, fully one inch and a half would intervene. I quote the following sentence from Holden, since it expresses the result of my own experience, and possibly that of many of my readers:

"In the dead subject, nothing is more easy than to open the trachea; in the living, no operation may be attended with greater difficulties."

In addition to the obstacles mentioned on the preceding page, the thymus gland may be present; there may be a middle thyroid artery to cause unexpected hemorrhage, and the left innominate vein may cross the trachea unusually high up in the neck. It is a rule, therefore, with all good surgeons to divide the trachea as high up as possible, even cutting through the cricoid cartilage in children, when found necessary. It is also very important that all incisions should be made in the middle line of the neck—"the line of safety."[1]

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[1] The operation of tracheotomy dates back to the early period of Antyllus—A. D. 340—who performed it several times. It is not alone used as a remedial measure for inflammatory affections, since foreign bodies may become lodged in the air-passages and require removal. It is usually preferred by surgeons to the operation of laryngotomy, since it presents fewer dangers and many additional points of advantage in its performance. To those not familiar with the points of the operation, it may be of advantage to state that the opening of the trachea is usually followed by a *paroxysm of coughing*, due to the entrance of cold air into the tube, during which little or nothing can be done; but, as it soon tends to pass off, when the first stimulus of the air ceases to be felt, the symptom is not so serious as is often supposed by spectators, who often imagine that the patient is in immediate danger of death. In spite of the ease with which the operation is performed upon the cadaver, I regard it as one that should not be attempted except by a practitioner possessing skill and some surgical experience. In some cases, I have seen the flow of blood excessive; and Desault was once compelled to abandon the operation from this cause alone, while Roux only saved a patient by applying his mouth to the opening of the trachea, and thus sucking the blood from the tube. Such cases should be remembered when we hear the operation spoken of as but on a par with venesection, in point of difficulty. As regards the indications for surgical interference in the air-passages, I believe that the presence of a foreign body in the trachea is always a justification for the step, although I am aware that such foreign bodies have been known to remain in the tube for years without destroying life; but I am still of the belief that the operation is worse

Posterior Cervical Region.

The *posterior region of the neck* is largely filled with muscles and strong elastic ligament—the ligamentum nuchæ. In the quadruped, this ligament is of enormous size, and acts as a powerful elastric spring to extend the head and neck after it has been flexed by muscles. The fact, which has been mentioned in connection with the description of the vertebral column, that the spinous processes of the middle cervical vertebræ are purposely *made short* to allow of the motion of the neck in a backward direction, explains why they are indistinctly felt through the muscles which cover them. It might be well to again call attention to the reason why dislocation is more common in the cervical vertebræ than in the dorsal and lumbar regions, and why it is possible to produce death by a pointed instrument, in this region of the spine, when such an accident is impossible in the dorsal vertebræ, but such points can be recalled by referring to that portion of this volume which treats of the spinal column.

Wounds of the region of the nucha are not dangerous as long as they are superficial, since only a slight hemorrhage may be produced which can, as a rule, be checked by compression or by a ligature; but, if deep, such wounds may be very serious and immediately fatal, since the instrument may penetrate the sub-occipital fossa, or between the atlas and the axis. The vertebræ are rarely broken in this region, since they are more thoroughly protected by muscles than in any other part of the spine, and

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than useless in membranous croup, unless the step be taken before the inflammatory process has extended beyond the limits of the larynx. In two hundred and forty-five cases where the operation was performed for the relief of this latter malady, one hundred and eighty-eight died, which is a mortality of about seventy-five per cent; while in twenty-nine cases of tracheotomy performed in the healthy tube for the extraction of foreign bodies, only one fatal case was reported (as collected by Henry H. Smith: Operative Surgery, Philadelphia, 1852). Such a remarkable difference in the percentage of mortality certainly seems to point to the presence of previous disease of the tube as modifying the results of the operation; and to sustain the objection which I raise against the unnecessary delay of the operation, when it seems indicated, as well as its uselessness after the exudation has extended down the tube.

I should advise the practitioner to be guided somewhat by the severity of the disease in deciding this momentous question; and, in case a hereditary tendency to croup existed in the family, especially if some of the family had previously died from such an attack, I should deem an early operation justifiable, as affording a better prospect of recovery than purely medical aid. I should regard the operation as unjustifiable, in any case, where the symptoms of asphyxia were alarming and the blood already so thoroughly impregnated with carbonic acid as to render the nerve-centres sluggish; since the patient would not probably react, and the fatal issue would rather be hastened by the shock and loss of blood.

Tracheotomy has been performed for œdema of the larynx, but it is not justified, in my opinion, until scarification has been thoroughly resorted to.

since the short spinous processes render them less liable to be affected by a blow which would tend to do them violence.

From a strictly medical point of view, this region has a particular interest, from the fact that it is the one most frequently selected by furuncles and anthrax. The intense pain which all forms of local swellings of this region are liable to produce, is explained by the close adhesions of the integument to the subjacent tissues. When it becomes necessary to apply counter-irritation to this region (since it is the one most used to affect the brain and the upper portion of the spinal cord for reasons mentioned in the first chapter of this volume), care must be taken not to wound the muscles or the nerves, as I have known tetanus and death to follow the simple application of a seton in the nape of the neck. The ramifications of the occipital artery, and, sometimes, of the transverse cervical artery, may be wounded in this region, but simple compression will usually arrest all danger of serious hemorrhage. Severe sub-occipital abscess may sometimes occur, which may denude the skull of its periosteum and thus lead to necrosis of the cranial bones. The constant tendency to movement of these parts is mentioned by Hilton [1] as the physiological explanation why such abscesses tend to remain chronic, and to discharge their products through long and tortuous sinuses; he therefore lays great stress upon the necessity of absolute rest, insured by adhesive straps applied to the shaved scalp in such a manner as keep the muscles in a state of enforced repose, while the apertures of the sinuses are left unobstructed. I should suggest, from my own experience, the introduction of drainage tubes to further insure the free escape of the secretions, since absolute rest to the parts is thus more completely insured.

POINTS IN THE DIAGNOSIS OF ABNORMAL SWELLINGS IN THE REGION OF THE NECK.

When any abnormal swelling of the neck is perceived, it becomes the duty of every physician to ascertain, by every known means which is at his command, the exact boundaries of the new-growth, and such other points pertaining to it as shall enable him to determine its character. Its general shape and position will often enable him, at once, to connect it with certain structures which have been discussed as entering into the construction of the neck; although its shape may still further assist him, in many cases, to determine its character. Thus, if it appear *nodular* and *irregular* in shape, it may be suspected that the glandular structures of the neck are involved; although this cannot be considered as essential to the development of such a growth, since effusions into surrounding parts may so alter the shape of the tumor as to mask its origin. *Smooth* and *globular* swellings, if markedly circumscribed, are usually of the encysted or fatty character. Changes in the color of the skin covering the

[1] Rest and Pain. N. Y., 1879.

growth may often be observed, such as a *diffused redness,* when suppuration is present and is approaching the surface; a *blueness* or a *prominence of the veins* of the surface, as exists often in malignant growths and in venous enlargements; and a tendency toward *ulceration,* as exists in malignant or syphilitic deposits. Again, the tumor may *pulsate,* if situated over an artery, or if aneurismal in character; when the pulsation should be carefully studied to ascertain if it is simply a rising and falling movement (as would be present if a tumor rested upon a vessel), or an *expansive pulsation,* indicating that the tumor received an impulse directly from the heart, which is transmitted in every direction (as in aneurism). Moreover, the pulsation may be made to cease, if a tumor simply rests upon a large blood-vessel, by displacing it from such association, which would be impossible if the artery were itself dilated.[1]

FIG. 112.—Fibro-cystic growth. (After Hamilton.)

Palpation of the growth may enable the physician to detect the presence or absence of *fluid,* since fluctuation can often be positively felt even when the tissues covering the tumor are of some thickness; while the *sensibility,* the *hardness* or *softness,* the *character of pulsation,* and the *extent* and *amount of its attachment* to surrounding tissues may be thus determined. A very hard tumor is often found to be associated with scirrhus, especially if the skin be puckered over it; and sometimes those albuminous deposits, which are also malignant in character, may be dense

[1] Should the reader seek further information as to the differential diagnosis of aneurismal sacs and the other forms of tumors of the various anatomical regions of the body, the author would respectfully refer them to his more exhaustive work on Surgical Diagnosis.

to the touch. Fatty tumors are of a peculiar doughy feel, and are movable and painless to the touch; they are also lobulated, as a rule, and are liable to become pedunculated, as the skin is stretched by their weight. Fibrous tumors are generally firm and resistant to the touch; are usually freely movable in the surrounding tissues; are painless, and grow slowly. Glandular tumors are very hard and elastic, unless undergoing suppuration; are extremely movable; are multiple, as a rule (lying in the course of the lymphatic chains which accompany the deep and superficial veins); and are often associated with a scrofulous or syphilitic history.

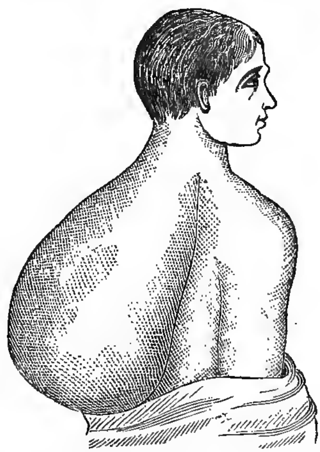

FIG. 113.—Fibro-cellular tumor of the neck and back.

Finally, the use of the hypodermic needle will often enable the physician to determine positively the character of the contents of any tumor which fluctuates, thus often deciding as to the best course to pursue in treating it.

DISTRIBUTION OF THE ARTERIES.

In connection with the vessels of the neck, which we have been discussing in reference to special regions, it may not be deemed a digression if I call attention to those points, so admirably taken by Hilton, as regards a definite plan of distribution of the branches of special arteries. In previous pages, we have, from time to time, spoken of practical points of interest pertaining to most of the prominent arteries of the head and neck, although no attempt has been made to systematically describe the arterial system of those regions; and it seems proper that so simple and admirable a statement as that of Hilton should not be omitted, if this work is to add to the general intelligence of the practitioner of medicine as to the anatomical construction of the head and trunk. I therefore quote from his book [1] the following general statements pertaining to the *subclavian artery:*

[1] Rest and Pain, 1879.

"I point out that the branches distributed from the subclavian artery, apart from its continuation to the upper extremity, are distributed for one simple purpose, viz., to supply all the parts concerned directly and indirectly in the *process of respiration;* that is the simple object of the distribution of the subclavian artery. Thus:

"The vertebral, besides supplying other parts, is distributed to that portion of the spinal marrow from which the phrenic, spinal accessory, and posterior thoracic—all important nerves of respiration—take origin.

"The internal mammary supplies the sternum, cartilages of the ribs, origin of the pectoralis major, phrenic nerve, diaphragm, and the upper half, or respiratory portion, of the abdominal muscles.

"The superior intercostal artery goes to the first and second ribs. Now, the first is the most important of all the other ribs in the respiratory function, as it forms the fixed point for the action of the intercostal muscles in elevating the chest.

"Of the branches of the thyroid axis, the inferior thyroid builds up the trachea, a tube essentially connected with respiration, and sends a branch upward (ascending cervical),[1] which accompanies and nourishes the phrenic nerve, and constitutes, in fact, an ascending comes nervi phrenici. The transverse cervical supplies the trapezius, and the posterior border of the scapula with the muscles attached to it, all of which may be considered accessory to respiration. The supra-scapular supplies the clavicle and scapula, both of which are rendered respiratory by the attachment they give to accessory respiratory muscles."

The same author again illustrates the distribution of the *internal maxillary artery* as one which is destined to show a presiding function over the *parts employed in mastication,* explaining, in a very ingenious way, the object of those branches which are apparently disconnected with the masticatory apparatus, as branches which are designed to complete the ossification of those bony parts to which the muscles of mastication are attached, and others as are designed to nourish the nerves which control their power of movement. Unfortunately, however, the entire arterial system cannot be thus clearly divided into groups, whose function is well defined, without including branches from different trunks; although even this point is used by the renowned author, above quoted, as a proof of some special *physiological action* of the part to which the distribution of the arterial, as well as the nerve trunks, can afford us a clue, if we study Nature in the proper spirit, believing that no structure is carelessly placed or constructed without a plan.

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[1] A branch of the *superior intercostal* artery, one of the points of collateral circulation after ligation of the common carotid artery or the subclavian artery in its first portion. See Darling and Ranney: Essentials of Anatomy. N. Y., 1880.

CHAPTER III.

THE BONES OF THE THORAX.

THE framework which contains the heart and lungs is formed by the dorsal vertebræ, behind; the twelve ribs upon either side, which form a portion of the posterior, the lateral, and a part of the anterior wall; and the sternum, in front. The dorsal vertebræ have been already considered in connection with the other parts of the vertebral column, and little of

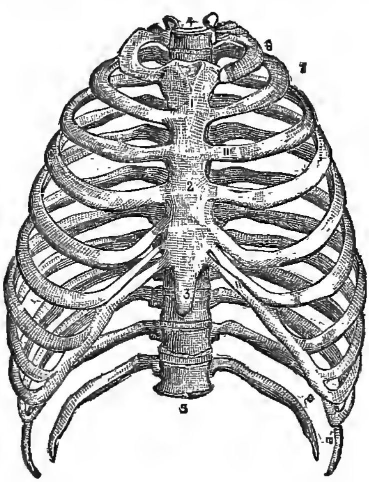

FIG. 114.

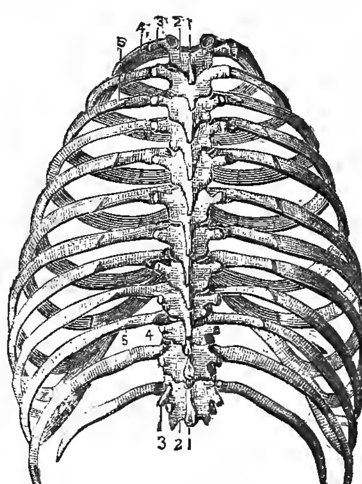

FIG. 115.

FIG. 114.—Front view of the bones of the chest; 1, the manubrium of the sternum; 2, body of the sternum; 3, ensiform cartilage; 4, first dorsal vertebra; 5, twelfth dorsal vertebra; 6 and 7 are opposite the first and second ribs on the left side; 9 and 10, false, or floating ribs, which have no cartilaginous connection with the sternum; 11, 11, are placed over two of the costal cartilages.

FIG. 115.—The bones of the thorax, seen from behind: 1,1, the spinous processes of the first and twelfth dorsal vertebræ; 2, 2, laminæ of the same vertebræ; 3, 3, transverse processes of the vertebræ; 4, 4, points where the first and tenth ribs articulate with corresponding transverse processes of vertebræ; 5, angle of the third rib.

practical interest remains to be added. The *backward curve* of the spine in this region serves to increase the antero-posterior diameter of the chest, and thus to afford more room for the lungs; while the *immobility* of this portion of the spine tends to prevent the possibility of compression of the organs of the chest or of the important structures contained in the mediastina. Its *ridigity* also is of special value in affording a fixed point of resistance for the muscles of respiration, and in completing the arch of the ribs with a key-stone, which should resist all tendency to displacement, in case of violence being received upon the anterior part of the chest. The bearing which the dorsal curve of the spine has upon the results of direct force when applied to the spine has been mentioned in previous pages, but it can well be again repeated, to call attention to the wise provision which Nature always takes to guard against injury to any organ contained within a bony cavity, by so arranging the parietes of that cavity as to present the most effectual and, at the same time, the simplest mechanical device, which shall combine strength, lightness, and perfect symmetry.

THE RIBS, if their cartilages be included, form a series of arches which extend from the dorsal vertebræ forward to the sternum; and, as they successively increase in length from above downward as far as the seventh rib, and then steadily decrease in their length, the shape of the chest is caused to *bulge in its middle part,* and to be constricted at its upper and lower openings. The upper aperture[1] is open and gives passage to blood-vessels, nerves, the trachea, the œsophagus, the thoracic duct, the apices of the lungs and three muscles; while the lower opening, which is open in the skeleton, is closed, in the recent subject, by a thin flat muscle, the diaphragm, which separates the thoracic and abdominal cavities, and which has openings for the passage of the œsophagus, the aorta, the vena cava ascendens, the thoracic duct, and the pneumogastric and splanchnic nerves.[2] This muscular partition is not flat but vaulted, with its convexity looking upward, so that the lungs extend farther down near the surface of the chest, than in its central portion. The ribs have the power of movement in an upward and downward direction; they can increase the *width* of the chest, since they turn outward as they are raised, and also its *depth,* since the sternum is raised with the ribs and is therefore thrown forward. The diaphragm, by its contraction, can also increase the *height* of the thoracic cavity, since it becomes more nearly a horizontal partition when contracted than when at rest.

The *first seven ribs* are called the "true ribs," since they are directly attached to the sternum by means of costal cartilages of their own; while the "false ribs,"[3] viz., the eighth, ninth, and tenth, are attached to the costal cartilage of the seventh; and the last two, or "floating ribs"[4] are

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[1] This opening usually measures about two inches from before backward, and three and a half inches in its transverse diameter. When it is remembered that some *forty different parts* of the human frame pass through this small opening, it will be apparent that the surgical conditions of the first rib, the first dorsal vertebra and the upper part of the sternum have more than a common importance.

[2] The parts enumerated cover only the more important structures which pass through the floor of the thorax. Some twenty-six different structures can be individually enumerated.

[3] Called "diaphragmatic ribs" by Sibson.

[4] A misnomer, since they are extremely movable only after death.

only tipped with cartilage and are not attached at their outer end. In rare instances, a thirteenth rib is present in man; thus resembling the construction of the chimpanzee, who has the thirteen upon each side, but the same number of vertebræ as man.

The *costal cartilages* are a direct continuation of the ribs between their anterior extremities and the sternum, and are a mechanical device on the part of Nature to render the arches of the ribs more elastic than they would be if composed entirely of bone: they thus permit of the movement of the ribs during respiration, while their inherent elasticity favors the return of the ribs after they have been raised during inspiration and they thus act as mechanical agents in expiration. In addition to this important function, these cartilages give to the chest-walls an ability to withstand violence when directly applied to it, far in excess of that which bone alone would possess, since they enable the ribs to yield to the blow: thus any force received upon the sternum is immediately distributed to *fourteen elastic arches* which extend backward to the vertebræ (the seven true ribs of each side, and their cartilages) and by this means its effects are greatly modified. Blows of the most severe character can thus be received by the chest with comparative impunity, especially during a *full inspiration,* since the muscles of the chest also tend to assist the bones to bear the shock; but when the lungs are emptied of air, as in expiration, the relaxation of these muscles renders the danger of direct violence greater than when the ribs are raised, because the arches are more *obliquely placed* in reference to the spinal column, and since they then possess no muscular support. Notwithstanding these wise provisions on the part of Nature, the sternum is occasionally broken by direct violence, as in that case reported by Dupuytren, where the life of a man, supposed to have been killed by a falling beam, was saved by the timely discovery and reduction of such a fracture.

The *vertebral extremity of each rib* is placed higher than the sternal end; since, if both ends had been placed upon the same level, the upward movement of the ribs during inspiration would have been rendered impossible. The head of the rib is the fulcrum upon which it moves, and, if its attachment to the spinal column be carefully examined, it will be perceived that it is articulated to and wedged between two vertebræ. This arrangement insures the rib against the possibility of dislocation from the spinal column, while, at the same time, the intervening disk of fibro-cartilage acts as a spring to break the force of any blow transmitted along the rib.

There are two important portions in each rib at its vertebral end, called "the tubercle" and "the angle;" the former of which articulates with the *transverse process* of the vertebra which supports the rib, and thus tends to make it still more securely fastened to the spinal column, while the latter indicates the point where the rib makes a sharp curve forward. The *angles of the ribs* are placed more and more distant from the tubercle, as we trace them from above downward; and this is found to be the strongest part of the bone, since it is forced to bear the greatest strain in case of violence, and because the angle demands an increase in the compact tissue. It is at the angle, or very close to it, that fractures of the ribs occur when due to violence received upon the anterior surface of the chest, as when the chest is compressed.

In this kind of fracture, viz., by indirect violence, the broken ends of ribs are *forced outward and away from the pleural covering* of the lung, so that complications of the pulmonary organs are infrequent; while, in those forms due to direct violence, as from a blow, the kick of some animal, etc., the ribs are usually *driven directly inward* at the seat of injury, or near it, and thus the pleura is extremely liable to be wounded or the lung-tissue may be involved. This fact explains why pleuritic effusion, pneumo-thorax, pulmonary hemorrhage, pneumonia, and emphysema may follow such an accident, and probably endanger the life of the patient.[1]

The ribs are the most *vascular bones* of the body; hence the rapidity of union in case of fracture, and probably also their great elasticity. The vessels of the bone are placed in a groove upon its lower border, and a practical point is thus suggested to the physician in performing the operation of *tapping the chest* for fluid, as the *upper border of the rib* should be taken as a guide in the introduction of the trocar, lest the vessels be wounded and blood escape into the pleural cavity. Another practical point suggested respecting this operation is the importance of *drawing up the skin* of the chest before introducing the trocar, since, when the instrument is withdrawn, the skin glides over the orifice of the puncture from its elasticity and from the force of gravity, and thus air is prevented from entering the pleural sac.

The *first rib*[2] is the strongest of all, since it is so situated as to be obliged to support the upper part of the sternum and the clavicles; and, as before mentioned, it forms a boundary of the *superior opening of the thorax*, and, therefore, bears relation to all of the structures which pass through it. When these structures have been enumerated, one can see at a glance that a fracture of this rib, which, fortunately is extremely rare on account of its great strength and situation, is a very grave accident from the nerves and vessels which lie in close relation to it; while the fact that it is the starting-point of motion of all the other ribs in the act of inspiration, and that this function is arrested by its fracture, gives the accident another and possibly as important an aspect. The structures which pass in more or less close relation to this rib are as follows: the

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[1] For the differential diagnosis of each of these affections from other surgical conditions having points of resemblance to them, the reader is referred to the Treatise on Surgical Diagnosis, written by the author. New York, 1880.

[2] The *tubercle* of this rib is used by surgeons as the *bony guide to the subclavian artery*, in operations for the ligation of that vessel.

large arteries of the neck (carotids and subclavians[1]), as well as the two internal mammary arteries, the two superior intercostals, and the arteria thyroidea ima; the large veins (jugulars, subclavians, innominata, and inferior thyroids); important nerves (pneumogastrics, phrenics, cardiacs, first intercostals, and sympathetic); and other important structures (the trachea, œsophagus, thymus gland in the child, the apices of the lungs and their investment of the pleura, and the thoracic duct).[2]

Between the ribs are spaces, called "intercostal," which, in the recent subject, are filled by the intercostal muscles. These muscles comprise an external and an internal set, which differ in their function, since their fibres are directed antagonistically so as to cross each other like a letter X in each intercostal space. The internal intercostal muscles tend to *depress the ribs* and thus to act as aids to expiration, while the external intercostal muscles help to *raise the ribs,* and are, therefore, classed as inspiratory muscles. The arrangement of the fibres of these muscles serves to render openings, due to separation of the fibres, impossible, and thus to prevent hernia of the pulmonary organs through the parietes of the chest. The same arrangement of fibres is still more beautifully shown in the abdominal muscles, which are even more liable to protrusions of viscera, as the bony support is absent; and which are, therefore, even more carefully protected by the fibres of the muscles. The intercostal spaces are widest at the anterior extremity of the ribs. where they become joined to the costal cartilages, and they are narrowest where they join the spinal column.

The STERNUM occupies the anterior part of the chest, and serves as a completing portion of the bony framework of the thorax. It is ossified, in contrast to the costal cartilages which lie adjoining it, in order to be better adapted to the protection of the important organs and blood-vessels which lie behind it, while, at the same time, it thus serves as a firm point of origin for some of the most important muscles of the trunk.[3]

If the bone be carefully examined, four faintly marked transverse lines can be seen, which are the traces of the original division of the bone into five pieces. The most prominent line of the four can often be felt through the skin, and is *used as a guide* to determine the exact situation of the second rib. The upper portion of the bone serves to afford artic-

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[1] Occasionally the innominate artery, upon the right side of the body.

[2] The abnormalities of the veins, and of the large arterial trunks given off from the aortic arch, render it impossible to positively state the exact relations of the first rib in any individual case; it should also be remembered that the ribs of the right and left side differ somewhat in their relations. Many unimportant structures which pass through the superior thoracic opening have been omitted, since no practical value is associated with some of them.

[3] Three pairs of the neck; four pairs of the abdominal wall; two internal muscles; and the pectoralis major of either side.

ulation for the clavicle, one of the most important joints of the body, while its lower end, the xyphoid cartilage, affords attachment to the muscles which form the anterior wall of the abdominal cavity. The articular surface upon which the inner end of the clavicle revolves, has, in the fresh state, a saddle-shaped appearance (concavo-convex), which gives to that bone a great latitude of motion with little danger of dislocation, so that, although the end of the clavicle is much larger than the surface upon which it moves, it is seldom displaced, even when subjected to a severe form of violence, but is very commonly broken.

The length[1] and shape of the sternum vary with different individu-

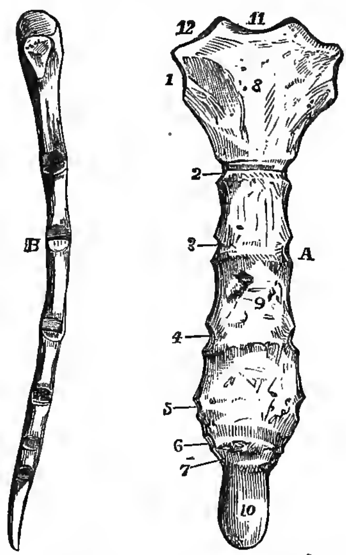

FIG. 116.—The sternum, or breast-bone: A, the bone as seen from the front; 1 to 7, point to where the costal, or rib cartilages, are attached; 8, manubrium; 9, body or gladiolus; 10, ensiform cartilage; 11, the notch seen between the ends of the collar-bones; 12, place where the right clavicle or collar-bone is attached; B, the right edge of the sternum.

als.[2] It may be bent backward in those persons who constantly bend the trunk, as shoemakers, and thus the heart may be pressed upon; while the xyphoid cartilage is often bent backward in workmen who hold tools against the pit of the stomach, such as carpenters, etc. The first and second portions of the sternum do not, as a rule, become joined; since a certain amount of motion, at that point, tends to assist the movements of respiration. It is the line of junction between these portions of the bone that has been mentioned above as a guide to the centre of the second rib.

The sternum may remain cleft at the time of birth, thus leaving the

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[1] The upper border of the sternum lies on a level with the *second* dorsal vertebra.

[2] It is shorter in the female than in the male.

thoracic organs almost naked; and it may also be fractured, either by direct violence or by muscular action. Chaussier reports two such cases, where this bone was fractured during parturition, by the patient resting upon the head and heels; and Faget and Gurlt each report a case produced by endeavors to lift weights with the teeth, when the body was bent backward. Billard was once obliged to perform gastrotomy, in order to raise a displaced fragment of the sternum, which was producing alarming symptoms from the pressure created.

The region over the sternum is a frequent seat of venereal tumors and ulceration, from its superficial and exposed situation; while caries is a frequent disease of this bone. So extensive may this carious process be that the entire bone has been removed by Boyer and Genouville, and even as far back as the time of Galen, large portions of it have been excised. In those cases where ligation of the arteria innominata is demanded, it may be necessary to trephine the sternum to reach the vessel; and Lænnec even proposed this step as preparatory to puncture of the pericardium, when greatly distended with fluid. The relation of the sternum to structures within the cavity of the thorax will be considered later on in this volume.

PRACTICAL POINTS OF INTEREST PERTAINING TO THE WALLS OF THE THORAX.

The thorax may be entirely absent at the time of birth, when imperfect development of the fœtus has existed, to which condition the term "anthoraco-cephalia"[1] is applied; but, when the upper half only is absent, the term "apectoro-cephalia" is used. The intercostal spaces may be rendered very *narrow* by lateral curvatures of the vertebral column, especially upon the side which corresponds to the deflection;[2] and the chest-wall may even be *indented* by the abnormal pressure so created upon one side, and caused to *bulge outward* upon the opposite side. In that disease of children called rickets, these lateral curvatures of the dorsal region of the spine are very common; and, as a clinical fact, the left side seems to be the most frequent seat of the curve. Indentation of the chest may not be due alone to spinal curvature, since localized injuries of a severe character may drive the chest-wall inward; while certain diseases of the lungs may create a retraction of the thorax by interfering with the *expansion* of that organ during the act of inspiration, thus causing the atmospheric pressure, which is constantly acting upon the outer wall of the chest, to become an agent in producing a permanent deformity. Thus, in old pleurisies, after the fluid has been absorbed, the bands of adhesion, formed in consequence of the inflammatory process, may tie down the lungs in some unnatural position, and in this way

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[1] A term used by Béclard.

[2] Blandin: Anat. Topog. Paris, 1832.

prevent its full expansion; again, in fibrous phthisis, the increase in the fibrous tissue of the lung may not only impair its expansibility, but even diminish its size by its steady contraction, thus causing an incomplete filling of the cavity of the chest; while cancer, atelectasis, and pulmonary gangrene, although infrequent as compared with those diseases previously mentioned, may sufficiently impair the expansion of the lung as to induce a thoracic deformity.

FIG. 117.—Mode of applying the chest-measurer. (After Sibson.)

Measurements of the *two lateral halves* of the chest will usually show a difference in the two sides, the right being from one-half to one and a half inches larger than the left. In the *female*, the upper ribs are more movable than in the male, thus accounting for the heaving of the chest seen in the woman, while the breathing of man is most prominently shown by abdominal movement (a point not without value in counting the respirations of a patient when covered with a sheet). This modification of movement in the female is to allow of pregnancy, without interference to breathing, which would certainly occur if the upper ribs were immovable. The sternum of the female chest is shorter than that of the male, so as to make more room in the abdominal cavity for the displaced organs during pregnancy. The upper opening of the thorax is also larger in the female than in the male.

As the chest-wall covers many important structures, in addition to the lungs and the propelling organ of the circulation, it is of great importance that the various guides to these parts be considered.

RULES FOR COUNTING THE RIBS DURING LIFE.

It is not difficult to count the ribs in those subjects who have little adipose tissue or restricted muscular development, but in fat people the difficulties become increased. It is by means of these bony arches, passing forward from the spinal column toward the sternum, that we are enabled to map out the position of the thoracic organs during life, and thus detect abnormalities which are often of great value in determining certain diseased conditions.

It has already been mentioned that the obliquity of the ribs caused some difficulty in determining the rib which corresponds to any given point on the surface of the chest, since the same rib is not on the same level in any two regions; hence, in the guides which will now be enumerated, only those are made prominent which are of daily use to the skilful diagnostician or the surgeon.

The *nipple* of the male, in a very large proportion of cases, corresponds to the interval between the fourth and fifth ribs, and lies about three-quarters of an inch external to their cartilages. The nipple does not correspond to the same point on the chest during inspiration as it does during expiration, since the ribs move underneath the skin of the mammary region; and the suggestion may, therefore, be given to take a record of the relative situation of this point at the *end of expiration*, when it may be found to lie as low as the fifth rib. In emphysema, the ribs may be so raised as to bring the sixth rib at this point; while, in phthisis, the ribs may be so far displaced downward as to bring the sixth rib four inches below the nipple, especially upon the affected side.[1]

The *guide* to the *second rib*, in front, has already been mentioned as the prominent ridge which crosses the sternum between its upper and middle portions (the manubrium and the gladiolus). The guide to the *fifth* rib most commonly used is the lower border of the pectoralis major muscle.

On raising the arm, the first serration of the serratus magnus muscle, which can be perceived below the axillary fold, serves as a *guide* to determine the position of the *sixth rib;* while the succeeding serrations correspond successively to the *seventh, eighth,* and *ninth ribs.*

The *scapula* covers the ribs, from the second to the seventh inclusive, upon the posterior surface of the thorax.

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[1] Sibson: Medical Anatomy. London, 1869.

When a tape is tied around the chest, on a *level with the nipple,* it will intersect the *sixth rib,* at a point midway between the sternum and the spinal column. As this is the point usually selected for aspiration of the chest for fluid in the pleural sac, it affords a very easy way of guiding the practitioner in introducing the trocar, remembering the importance of drawing up the skin so as to have a valvular opening after its withdrawal, in order to prevent the entrance of air into the pleural cavity.

The *eleventh* and *twelfth ribs* can be felt, even in corpulent subjects, by the finger, as two bony projections, outside of the erector spinæ muscle, which are directed downward and outward.

It is important to remember that the slope of the ribs causes the corresponding vertebra to lie on a higher plane than the rib, if any point be

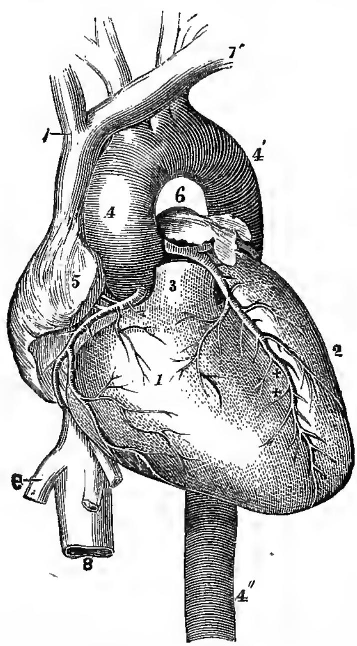

FIG. 118.—The heart and its vessels: 1, right ventricle; 2, left ventricle; 3, pulmonary artery; 4, ascending arch of aorta; 4′, descending arch of aorta; 5, right auricle; 6, left-auricle; 7, vena cava superior; 7′, left vena innominata; 8, vena cava inferior.

referred to its anterior extremity; the *end of the sternum,* therefore, corresponds to the level of the tenth dorsal vertebra, while the junction of the *third rib with the sternum* corresponds to the sixth dorsal vertebra.

EXTERNAL GUIDES TO THE THORACIC VISCERA AND THEIR DISEASES.

THE HEART. The outline of this important organ may be thus drawn upon the exterior of the chest: "1. Mark a point on a level with the third costal cartilage (upper border), one half inch to the right of the border of the sternum; and a second point on the same level, but one inch to the left of the sternal border. Connect these two points by a line, and you have the situation of that portion of the *base of the heart* where the pulmonary artery and the aorta escape, and where the superior vena cava enters the right auricle. 2. Mark a point two inches below the left nipple and one inch to the left of the border of the sternum; this represents the situation of the *apex* of the organ. The interval between the fifth and sixth ribs, in front, corresponds to about the same level. 3. Mark another point at the lowest part of the right edge of the sternum, before the xyphoid cartilage is formed, and connect it with the point representing the apex by a line slightly curved downward; this line will designate that part of the heart which rests upon the *central tendon of the dia-*

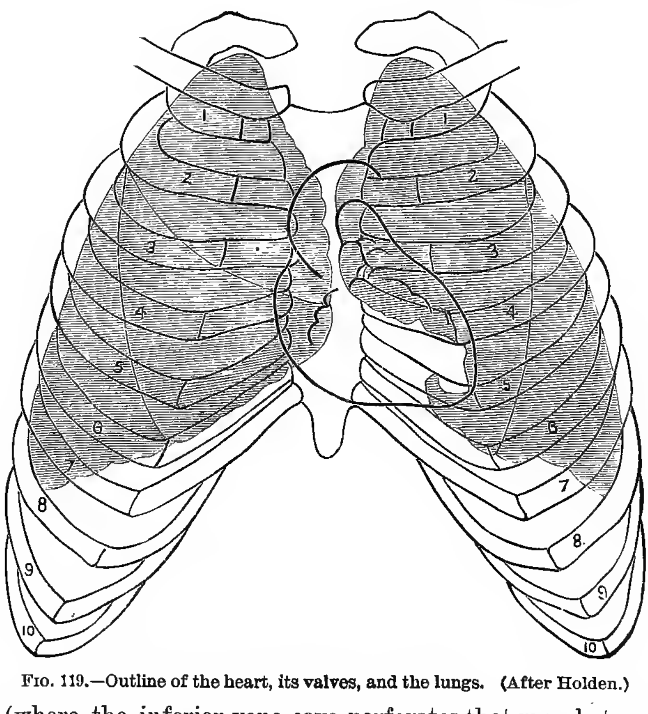

FIG. 119.—Outline of the heart, its valves, and the lungs. (After Holden.)

phragm (where the inferior vena cava perforates that muscle to enter the right auricle). 4. Now connect the right extremities of the lower and the upper lines previously drawn, by a line slightly curved with its convexity pointing toward the right, and you will have the outline of the *right auricle.* 5. To complete the outline of the heart you have now to draw a line curved toward the left side of the body, which shall pass close to the nipple but not embrace it, and which shall connect the left extremity of the superior line to the point representing the apex of the organ."[1]

[1] Holden: Surgical and Medical Landmarks. London, 1876.

By reference to figure 119 it will be seen that the surface of the heart is covered, in part, by lung tissue, on its anterior aspect; so that percussion over the precordial region of the chest yields two varieties of sound; the one called *deep cardiac dulness*, being present over the portion covered by lung tissue; the other called *superficial cardiac dulness*, being confined to the uncovered part. It will be also perceived that the right auricle of the heart, and a slight portion of the arch of the aorta, pass beyond the limit of the right border of the sternum, so that a pointed instrument, if passed close to that border through the *third* or *fourth* intercostal space, might wound the lung and auricle; if passed through the *second* intercostal space, the aorta could be punctured; while, if it entered the *first* intercostal space, the superior vena cava might be opened above its point of termination in the right auricle.

The *apex of the heart* is made to strike the chest-wall during each contraction of the ventricles, on account of the spiral direction of the muscular fibres, which form the walls of those cavities, and any deviation from the normal seat of the apex-beat may be of great value in determining either alterations in the size of the heart, or in the diagnosis of some obscure affection which mechanically tends to displace it. The normal seat of the *apex-beat* does not correspond with the seat of the apex in a state of rest, since the heart shortens during its systole; it should be found to exist, in health, at a point situated about *one inch below the left nipple and midway between the edge of the sternum and a line dropped from the nipple.*[1]

The conditions which tend to displace it may be thus enumerated, as such a table may help the practitioner to make a diagnosis when the symptoms render the existing condition obscure.

The heart-beat may be displaced *downward* by
- Hypertrophy of the left ventricle of the heart.
- Dilatation of the left ventricle of the heart.
- Emphysema of the lungs (especially of the left side).
- Mediastinal tumors.
- Aortic aneurism.
- Pleuritic effusion.

[1] Loomis: Physical Diagnosis. New York, 1878. Guttmann: Physical Diagnosis. New York, 1880.

The heart-beat may be displaced *upward* by

- Wasting of the pulmonary organs.
- Any form of abdominal tumor of the left side (if sufficiently large).
- Tympanites.
- Ascites.
- Cancer of stomach.
- Cancer of left lobe of the liver.

The heart-beat may be displaced to the *left* by

- Fluid in right pleural sac.
- Emphysema of right lung.
- Hypertrophy of left heart.[1]
- Pleuritic adhesions, drawing the heart out of place.

The heart-beat may be displaced to the *right* by

- Fluid in left pleural sac.
- Emphysema of lower lobe of left lung.
- Abdominal tumors (if large and confined to left side).
- Pleuritic adhesions.
- Hypertrophy of right ventricle.

In fat people, and in females possessing large breasts, it is often difficult to detect the exact situation of the apex-beat; and in cardiac dilatation the same difficulty is still more marked, as the heart-fibres are too weak to throw the apex with any force against the chest-wall. It is customary, therefore, to use both the eye and the sense of touch to determine the situation and the character of the apex-beat, the palm of the hand being applied to the chest, and the patient being requested to incline the trunk well forward, if the beat be indistinct, in order to throw the heart

[1] In hypertrophy of the heart, the apex-beat is displaced differently when the *left ventricle* is alone involved, from that form where the *right ventricle* has been increased in size as the primary result of obstruction to the pulmonary circulation; in the former, the apex-beat is carried *downward and to the left*, while in the latter, *downward and to the right*. (Sibson, Guttman.)

nearer to the surface of the chest by the aid of gravity. In the female, the breast has often to be raised in order to get the palm in sufficiently close proximity to the chest-wall as to distinctly feel the apex-beat; while the tips of two or more fingers are often employed in place of the palm, when any difficulty is present in definitely locating the point of the impulse. The eye is employed by the diagnostician in examining the heart, not only for the purpose of determining the point of the impulse, but also for the sake of ascertaining the *character of the beat* and the *extent of its diffusion*. Thus, in children with hypertrophy of the heart, the precordial region is perceived to bulge forward, probably from the too forcible impulse on the imperfectly ossified ribs, and the vibratory

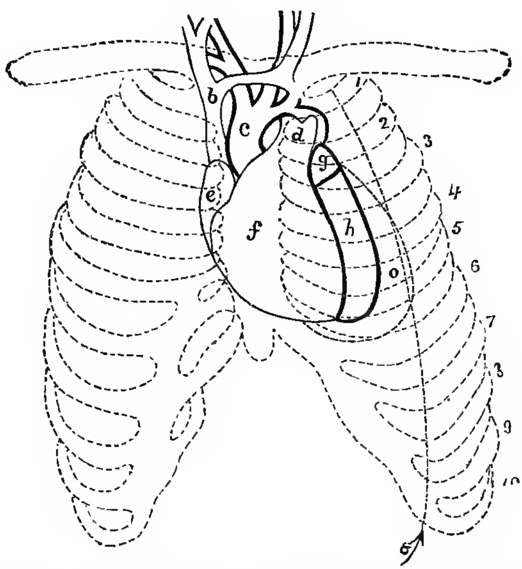

FIG. 120.—Hypertrophy of left ventricle. Heart in situ. *a*, the mammary line; *b*, vena cava superior; *c*, aorta; *d*, bulb of pulmonary artery; *e*, right auricle; *f*, right ventricle; *g*, left auricle; *h*, left ventricle (normal circumference); *o*, the hypertrophic ventricle. (After Rindfleisch.)

wave is transmitted over its whole surface; while, in the case of a dilated heart, a slight undulatory movement is all that sometimes can be perceived, and the heart-beat may be so feeble, in some cases, as to be incapable of being detected either by sight or touch.

The *valves of the heart* bear relations to the anterior wall of the thorax which should be at the perfect command of any one who hopes or aims to be skilful in diagnosis, since the direction of transmission of certain abnormal sounds, called "murmurs,"[1] which are indicative of some abnormality of the valve over which it is heard, is of great value in decid-

[1] For the area of diffusion of the various heart-murmurs, see subsequent pages.

ing as to their cause; and the situation of the point where the sound is most intense often enables the physician to tell which valve is affected, and thus to give an accurate prognosis. I am led, therefore, to make the anatomical guides to the normal situation of each of the four valves of the heart more prominent than if they were simply incorporated in the reading text, by placing them also in the form of a table, as follows:

AORTIC VALVE.—Behind the left edge of the sternum, at the third intercostal space.

PULMONARY VALVE.—Junction of the third rib and the left edge of the sternum (nearer the chest-wall than the aortic valve.)

TRICUSPID VALVE.—Behind the sternum, on a level with the fourth costal cartilage.

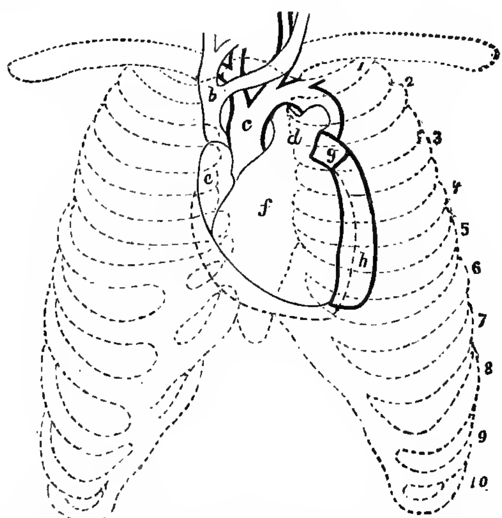

FIG. 121.—Hypertrophy of right ventricle. Heart in situ. Description as in the preceding figure. The contours of the hypertrophic right ventricle are indicated by dots. (After Rindfleisch.)

MITRAL VALVE.—One inch to the left of the sternum, on a level with the third intercostal space.

In a series of clinical lectures given by Dr. Latham,[1] the *following practical rule* was given and it has since been extensively quoted: "Make a circle of two inches in diameter round a point midway between the nipple and the end of the sternum. This circle will define, sufficiently for all practical purposes, that part of the heart which lies immediately behind the wall of the chest, and is not covered by lung or pleura." Now all of the valves of the heart lie outside of this area and are covered by a thin layer of lung-tissue; hence all heart-sounds are heard with far greater distinctness when the patient is instructed to stop breathing.

[1] As quoted by Holden: Landmarks, Medical and Surgical.

The *precordial region* of the chest is greatly altered in case of pericardial effusions, since the lower two-thirds of the sternum is rendered prominent, as well as the left costal cartilages from the second to the seventh, all of which are more widely separated than in health. The effects of abnormal conditions of the heart or its investing sac upon the walls of the thorax differ from those dependent upon pulmonary changes, in that the former tend to create a localized enlargement, confined to the precordial region, and in exact proportion to the extent of the pressure created upon the sternum and the ribs, while the latter tend to create modifications in the chest, which are analogous to those produced by either inspiration or expiration, and which are symmetrical if both sides be equally diseased, or confined to one side of the chest, if only one lung be impaired. The effect of pressure, due to alterations of

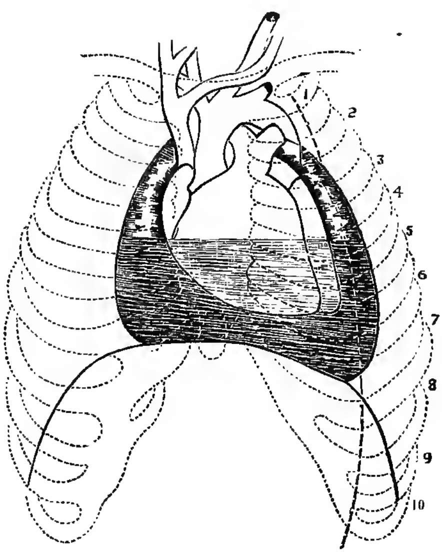

FIG. 122.—Diagram showing the pericardial sac partially filled with fluid, and plastic exudation upon the two surfaces of the pericardium above the level of the fluid. (After Loomis.)

the heart or pericardium, upon the anterior surface of the chest, is much *more marked in childhood* than when occurring during adult life, since the sternum then consists of three bones which are connected by cartilage, while the ribs themselves and their cartilages are also more yielding.

In *pericarditis* the fluid first finds its way backward, and, as long as it is insufficient to create any decided pressure upon the lung, tends to ascend in the pericardial sac; but as the effusion increases, the lungs gradually become crowded more and more to one side, so that the exposed pericardium, when fully distended, lies immediately behind the sternum and rises to the level of the second costal cartilage. When the formation of this fluid is rapid, the shape of this sack resembles a cone, with its apex pointing upward where it is attached to the walls of the aorta; but when the fluid forms slowly, the pericardium is distended in a lateral direction by the weight of the fluid, and the sac is thus widened to so great an extent as to often crowd the lungs so far backward as to render them completely hidden when the thorax is opened, while the left lung may be forced also to ascend, thus bringing its lower portion far higher than in health.[1]

When the *heart* itself *undergoes enlargement*, it does not tend, as a rule, to displace the lung to any marked extent, but rather to prolong itself downward and to the left side; hence the alteration in the position of the apex-beat,[2] and its value as a means of diagnosis (see page 197).

The *extent* and *force of the heart-impulse* is unquestionably modified greatly by the extent of the area uncovered by lung-tissue, since the impulse has a more direct effect upon the wall of the thorax when the lung-tissue between it and the surface of the chest is diminished. We may attribute the feeble impulse of the heart of those that are strong and robust rather to an ability to fully expand the lungs than to any inherent weakness of the heart itself, or the tissues external to the chest (although the latter may be one of the possible causes); while, in the feeble and emaciated, an abnormally forcible impulse may lead the physician to estimate the heart-power as fully up to the normal standard, when it is in reality extremely weak, and yields the strong impulse chiefly because the lungs have receded from between the heart and the chest, and the thin chest-wall more readily transmits the vibration.

A peculiar symptom is often afforded, in phthisis, by the shrinking of the lung from between the pulmonary artery and the chest-wall, in the form of a short, sharp, diastolic impulse, felt in the second intercostal space, and exactly synchronous with the second sound of the heart. The size of the area which is covered by the vibrations produced by the apex,

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[1] From *twelve to eighteen ounces* of fluid can be injected into the pericardial sac, in the state of health, and, hence, in *acute pericarditis*, the amount of fluid present cannot greatly exceed that amount. In a case of *chronic pericarditis*, however, *three pints* of fluid has been removed by Sibson. We can better understand, therefore, why the *gradual* accumulation of fluid will alter the shape of the pericardial sac more than a rapid development, since, not only is the quantity formed much greater, but the walls of the sac are exposed to a constant stretching process by the additional weight of the fluid.

[2] The position of the apex-beat of the heart upon the surface of the chest unquestionably differs when the right or left heart is alone involved, but the effect of hypertrophy of the *right ventricle* upon the position of the apex-beat seems to be a subject upon which authors disagree. Thus Sibson gives it as situated behind the xyphoid and lower part of the sternum; Guttmann, as carried to the right, often as far as the left edge of the sternum; Loomis, as carried *upward* and *to the left* (if total eccentric hypertrophy exists); while my own experience inclines me to believe a downward and inward displacement to be the most common indication of this condition.

if increased, does not necessarily indicate a hypertrophied condition of that organ, since the absence of lung-tissue may make a feeble heart yield an impulse widely diffused.[1] A point which will generally enable the physician to discriminate between the forcible impulse of a weak heart, which has become uncovered from shrinking of the lungs, and that of a hypertrophied heart, may be afforded by the statement that the former impulse is *never carried downward* below the normal situation of the impulse, but is rather raised, while the latter impulse is always found below the proper level.

THE LUNGS.—It must be remembered, in examining the position of organs in the cadaver, that the viscera do not occupy the same relative position to the walls of the thorax and abdomen as they do during

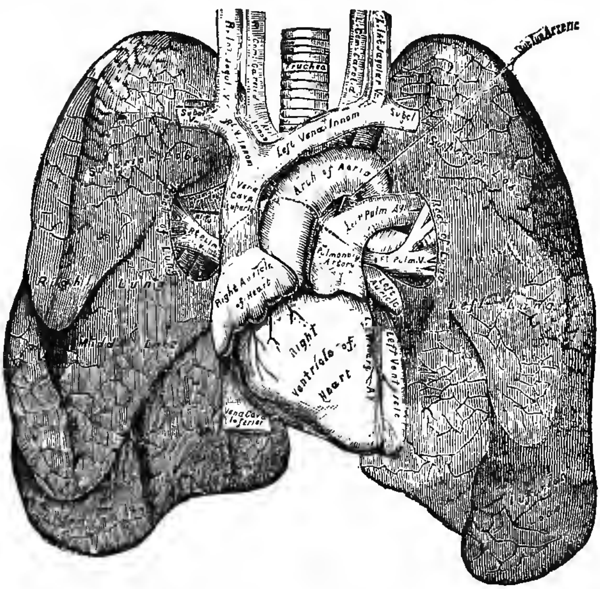

FIG. 123.—The lungs, and the middle mediastinum with its contained structures. (After Gray.)

life, since the *act of expiration* is usually the *last one of life*, and this last forcible expulsive act is in marked contrast to the tranquil expiration of the healthy subject.[1] As before stated, each act of inspiration produces changes in the contour of the chest; the clavicles and ribs are raised; the sternum is caused to project forward; the upper costal cartilages are caused to assume nearly a right angle with the sternum; the upper ribs are made to approach each other, while the lower ribs are more widely separated; the cartilages of the false ribs are spread outward so as to cause a widening of the abdominal space between them: the effect of all these phenomena being to widen, deepen, and raise the chest, to shorten

[1] Sibson, op. cit.

the neck, and to cause an apparent increase in the length of the abdomen. During the act of expiration, the position of all of the above-mentioned parts is exactly reversed; the ribs and sternum descend; the spaces between the upper ribs are widened, while they are diminished below; the costal cartilages of the false ribs are again approximated, and the abdominal space between them is narrower; the neck is lengthened; and the whole chest made narrow and flat; and the abdomen is apparently shortened.[1] It is, therefore, evident that during life the whole of the *internal organs are kept in a state of perpetual motion,* since, as the chest rises with the inspiratory act, the diaphragm goes downward, dragging with it the lungs and the heart, and pushing the abdominal organs from beneath it. If we examine the respiratory movements of an animal whose viscera have been exposed without destroying its normal functions, this movement seems much greater than it really is, since the ribs and organs move in *contrary directions,* and thus give a deceptive appreciation of the actual descent of the internal organs.

The *apex of each lung* rises into the neck for a distance of one and a half inches, and slightly higher in the female than in the male, on account of the increased size of the superior aperture of the thorax; hence, wounds of the neck are liable to be followed by the entrance of air into the surrounding tissues, when the seat of the injury is low down near the root of the neck, and especially if the person was inspiring when the injury occurred.

The *anterior border* of the lung of either side runs parallel with the other behind the sternum, from the level of the second costal cartilage to that of the fourth, but below that point the edges diverge; hence, the great blood-vessels of the thorax, as well as the aortic and the pulmonary valves of the heart, are covered with lung-tissue. The divergence of the anterior border of the lungs is due largely to the position of the heart, and the line of each of the two borders is therefore not symmetrical; that of the right side following the direction of the cartilage of the sixth rib,[2] while that of the left side crosses the heart below the cartilage of the fourth rib. On the sides of the chest, the lungs of either side can be found as low as the eighth rib; while behind, the posterior border of the base of each lung may usually be found to correspond to the tenth rib. It must be remembered, however, that these limits are increased downward about one and a half inches during a full inspiration.

The *shape of the thorax* may be often taken as a guide to the amount of lung-tissue and the general robustness of the individual; since the upper ribs are placed closely together in the strongest type of frame, and the lower ribs widely separated. During an attack of acute bronchi-

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[1] For these suggestions I am indebted to Sibson in his great work previously referred to.

[2] See Fig. 119 on page 196 of this volume.

tis, or in persons where emphysema has developed, the chest assumes the appearance of a deep inspiratory effort; the neck is short; the sternum and clavicles are higher than normal; the lower intercostal spaces are wider than the upper; the spaces between the cartilages of the false ribs are increased by the outward movement of the cartilages, and the abdomen is thus widened below the xyphoid appendix of the sternum; while the scapulæ may also be raised far above their proper level.

The typical chest of *phthisical disease*[1] resembles closely that condition described as seen after a forcible expiration, and it thus makes a marked contrast to the emphysematous chest, which, as before stated, is analogous to the condition of a full inspiratory effort. In this class of subjects, we find the upper portion of the chest flattened and narrowed,

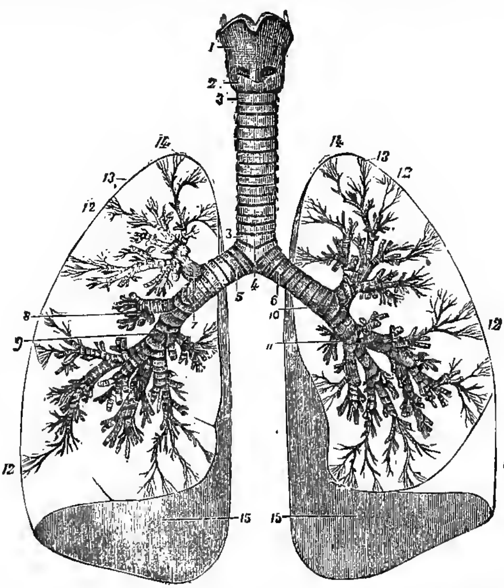

FIG. 124.—A diagram of the respiratory organs· 1, thyroid cartilage of the larynx; 2, cricoid cartilage of the same; 3, 3, trachea, bifurcating (at 4) into the right and left bronchi (5 and 6); 7 to 14, ramifications of the bronchi within the lungs; 15, the bases of the lungs, showing their concave form.

the neck long, the upper ribs widely separated, the lower ribs near together, and the abdominal space between the cartilages of the false ribs narrowed by their approximation. It is not uncommon to find these changes more marked upon the side most affected, since the lung is rendered inexpansible in proportion to the extent of the disease, and both lungs are not symmetrically impaired, as a rule.

[1] Life insurance examiners pay great attention to the configuration of the chest as a means of estimating the risk of insurance. While exceptions may exist to the rule, a flat, narrow chest, with limited expansion, is not indicative of long life.

When an extensive *pleuritic effusion* is developed [1] upon one side, the chest manifests its presence by a fulness and prominence of the affected side, which causes it to present a contrast to the side where the lung is performing its proper function; the ribs are separated by the pressure of the fluid within the pleural sac, and the intercostal muscles, which form a hollow between the ribs in health, are forced outward to the level of the ribs themselves, thus rendering their borders more difficult of detection. The respiratory movement of the chest is greatly diminished on the affected side, and may be entirely absent; while the opposite side, being compelled to perform excessive labor, frequently shows an exaggeration of the normal movement. If the absorption of the fluid is followed by adhesion of the pleural surfaces, thus binding the surface of the lung to the wall of the chest, and rendering its inflation difficult, the affected side may be made to resemble the expiratory type so well marked in

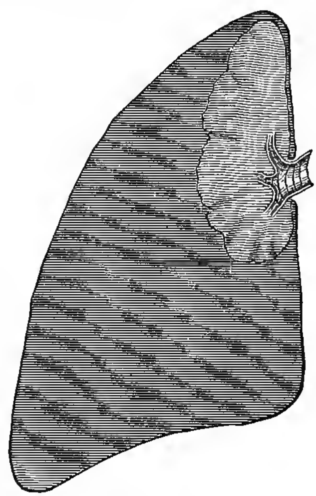

FIG. 125.—A diagram showing the pleural cavity completely filled with fluid, the lung being compressed. (After Loomis.)

phthisis, and the chest-wall may, in severe cases, be retracted so as to leave positive deformity.

The *normal outline of the lungs* upon the wall of the chest, as described in a previous page (see page 204) is not a constant one, but may be modified by disease of the lungs themselves; of the pleura; of the heart and its sac; of the large blood-vessels of the thorax, or even of the abdo-

[1] The physical signs usually given in text-books to determine *pleuritic effusion* from pneumonic consolidation of the lung, must not be considered as incapable of modification. I think, in at least *one-third* of all the cases which I examine, that *bronchial breathing* is heard below the upper border of the fluid (instead of the *absence of all respiratory sounds* as we are led by text-books to expect); and *voice sounds* are also often transmitted by the fluid. The rational symptoms are, therefore, of the greatest value in the diagnosis of pleurisy.

minal aorta, if near the diaphragm; of the bronchial glands; and of the abdominal organs.

Causes of Displacement of the Lungs in their Relations to the Walls of the Thorax.

In emphysema, since the lungs are abnormally expanded, the outline of the lungs is similar to that perceived during a full inspiration; hence the borders will be found to have been extended downward some one and a half inches below the normal limit of expiration, and the pressure created within the thorax crowds the lung-tissue between the chest-wall and the heart, thus forcing that organ out of its normal position in the chest in a downward direction. If only one side be affected to a marked degree, the heart may be displaced laterally and downward.

In all *wasting diseases,* and especially in phthisis, the lungs tend to diminish in size and to assume a *higher position* in the cavity of the thorax; hence the lower limit of the lung, as revealed by percussion, may be raised as high as the fifth intercostal rib in front, and the heart may be so uncovered, as a result of the shrinking of the lungs, as to present a marked increase in the area of superficial and deep cardiac dulness (see page 197). The *apex-beat of the heart may be also raised* to a slight extent, as the result of diminished pressure of the lung, and the elasticity of the arch of the aorta, which acts as a partial support for the heart.

In *pneumonic consolidation,* the lung-tissue becomes so much increased in weight that it tends to sink lower in the thorax than it would in health; while the opposite lung, being called upon to perform the labors of both, becomes excessively inflated during each inspiration, and, therefore, its lower border sinks proportionally in the chest. We can thus explain the clinical fact that, in pneumonia, the lower limits of pulmonary percussion are often carried below the normal line.

In *pleurisy,* the lung is caused to float upon the fluid in the pleural sac, and, as it increases, the lung becomes gradually compressed and solidified; hence the percussion note of lung-tissue is, at first, raised, but the character of the note is soon changed, since the air is expelled from the lung on account of the compression, and it therefore often becomes difficult to map out the line of the fluid and where the lung-tissue begins. Besides this direct cause of the displacement of the normal outline of the lung, the fluid can indirectly cause an alteration in the position of the opposite lung by creating a displacement of the heart (see page 198).

In *pericardial effusion,* the lung-tissue is forced away from the anterior surface of the pericardium when sufficient fluid has accumulated to create *lateral* pressure upon the lungs. Hypertrophy and dilatation of the heart cavities may also cause an alteration in the limits of pulmonary percussion, since a force is thus created which tends to displace the adjoining viscera.

All forms of *mediastinal tumors* (especially aneurism of the aortic arch) are frequently manifested by an early alteration in the relative position of the anterior borders of the lungs, behind the sternum. The lungs may, in severe cases, be entirely forced out from behind the sternum, and the bone itself become destroyed by the pressure upon it which eventually impairs its nutrition.

Finally, the outline of the lungs may be affected in their relation to the wall of the thorax by all those conditions of the abdomen which tend to *raise the diaphragm* beyond its proper limits. Among these conditions may be mentioned tympanites, ascites, large abdominal tumors which reach the diaphragm, extensive ovarian dropsy, cancer of the liver and of the stomach, and tumors of the diaphragm itself. In some exceptional cases of cancer, or of starvation, the abdominal organs waste so rapidly from defective nutrition as to produce a *perceptible falling of the diaphragm;* in these cases, the lungs would likewise tend to sink downward, and thus the limits of pulmonary percussion would be extended in the same direction.

CHAPTER IV.

THE CHEST AND ITS CONTAINED ORGANS.

THE TOPOGRAPHY OF THE WALLS OF THE THORAX, AND THE CONTENTS OF THE VARIOUS REGIONS OF THE CHEST.

THE parietes of the thorax have been more commonly subdivided by anatomists into the anterior or sternal region; the lateral, or costal region; and the posterior, or dorsal region. For the purposes of more accurately defining the situation of lesions of the thoracic viscera, it is the custom, however, with purely medical authors to subdivide the chest-wall still more extensively. Thus, the anterior of the chest is divided, by the bony outline of the sternum itself, into three portions, a central and two lateral portions; the former of which is again subdivided into the "supra-sternal," the "superior sternal," and the "inferior sternal" regions, while the lateral regions are each subdivided, from above downward, into the "supra-clavicular," the "clavicular," the "infra-clavicular," the mammary," and the "infra-mammary" regions.

The side of the chest is divided into the "axillary," and the "infra-axillary" spaces or regions; while the back of the chest is furthermore divided into a central space, called the "inter-scapular region," and a lateral region on each side, which is usually subdivided into three spaces, called the "supra-scapular," the "scapular," and the infra-scapular" regions.

Although it is not important or perhaps advantageous to the surgeon to thus subdivide the chest surface into so many different regions, since no object can be gained, except from a medical point of view, by so doing; still it is of *great value to the physician* (who aims to excel in the discrimination between diseases of the thoracic viscera and the stages of advancement which any of those diseases have reached), to have the contents and boundaries of these various regions of the chest most thoroughly at his command. It is as an aid to such a knowledge, that I append the boundaries of each, and the various parts which lie in relation to that portion of the internal surface which corresponds to each of the regions above named.

The SUPRA-STERNAL REGION has already been considered, to some extent, as one of the regions of the neck, rather than as belonging to the chest; but, since it contains some structures which are of special interest to the physician in connection with the diseases of the thorax, it is again repeated. It lies *above the sternum,* and is bounded by the anterior edge of the sterno-mastoid muscle of either side. It contains the trachea, the arteria innominata (on the right side and at its lower angle), and, occasionally, the arch of the aorta, when it rises unusually high.

The SUPERIOR STERNAL REGION lies over the sternum, *above the line of the lower border of the third rib.* It contains the anterior border of the lung of either side, which nearly meet above this level; also, the ascending and transverse portions of the aortic arch; the pulmonary artery, for its entire length; and the bifurcation of the trachea (situated on a level

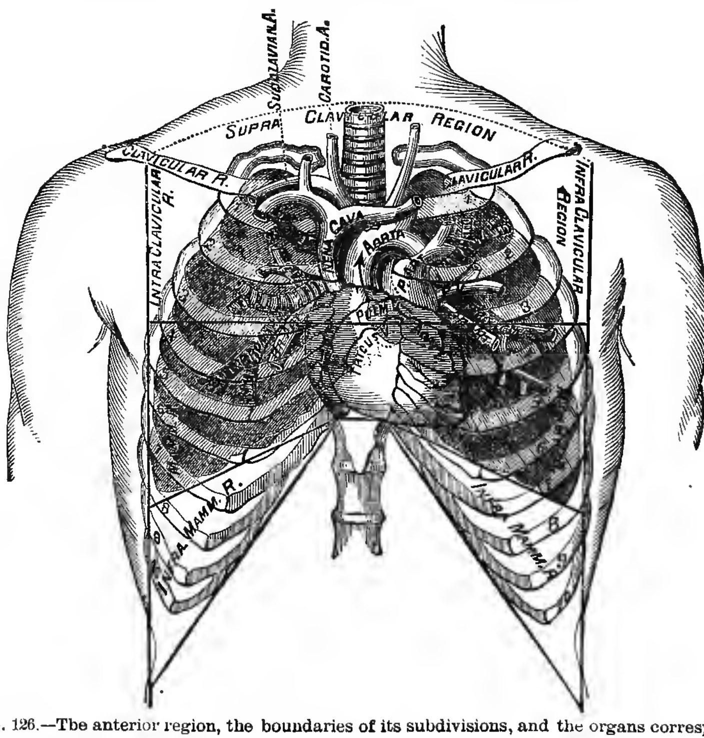

FIG. 126.—The anterior region, the boundaries of its subdivisions, and the organs corresponding to these subdivisions. (After Loomis.)

with the second rib in front, or third dorsal vertebra, behind). By reference to a cut on page 196, it will be seen that the aortic and pulmonary valves of the heart are in close proximity to the borders of this region.

The INFERIOR STERNAL REGION corresponds to that portion of the sternum which lies *below the third rib.* Upon the right side only, does the anterior border of the lung extend throughout the entire length of this space (see cut on page 196), since the left lung is deflected over the heart. The greater part of the right ventricle of the heart, a smaller part of the left ventricle, and a part of the auricles, lie behind this portion of the sternum; while the tricuspid and mitral valves of the heart are situated within this region (see page 200). The attachment of the central tendon of the diaphragm to the pericardium, a part of the left lobe of the liver, and a part of the stomach are also contained in this space.

In connection with the regions pertaining to the sternum, it will not be inappropriate to consider that space between the reflections of the pleuræ of the right and left lung, called the "*anterior mediastinum.*" This space is not directed parallel with the median line of the sternum, but rather slants obliquely toward the left side, on account of the heart. It is, therefore, important to remember that the pleura of the right lung projects beyond the middle line of the sternum, in the region of the third or fourth rib, and might thus be wounded by puncture, apparently out of the line of the lung.

The SUPRA-CLAVICULAR REGION is a triangular space which has already been considered at some length in connection with the neck (see page 170), but it may again be recalled as it bears relations to the thoracic viscera. It is a triangle, whose base corresponds to the clavicle, its upper border to a line drawn from the outer third of that bone to the upper part of the trachea, and its inner border to a perpendicular line drawn through the sterno-clavicular joint. It contains the apex of the lung, upon either side; also, the subclavian and the carotid arteries;[1] and the subclavian, external jugular, transverse cervical, suprascapular, and internal jugular veins.[1]

The CLAVICULAR REGION lies behind the inner three-fifths of the bone. It is in close relation to the subclavian artery and vein; to the arteria innominata on the right side near to its inner extremity; to the carotid and subclavian arteries on the left side, at its inner extremity;[2] and to lung-tissue on both sides for nearly its whole length.

The INFRA-CLAVICULAR REGION is bounded by the lower edge of the clavicle, above; the third rib, below; the edge of the sternum, internally; and by a line drawn perpendicularly from the point of junction of the outer and middle thirds of the clavicle, externally. The contents of this space differ on the two sides of the chest. On the right side, the superior lobe of the lung, the right bronchus (on a level with the second rib), the superior vena cava and a small portion of the aortic arch (lying close to the border of the sternum) are found. A pin introduced at the junction of the upper border of the third costal cartilage and the sternum, on the right side, would pierce the arch of the aorta; while one, introduced

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[1] Whether the carotid artery or the jugular vein which accompanies it can be included in this space depends on the limit placed as the internal boundary of the space.

[2] Since they arise from the arch of the aorta, upon the left side of the body; and from the innominate artery upon the right side.

at the edge of the sternum and through the second intercostal space of the same side would wound the superior vena cava, after first perforating the lung, before that vein entered the pericardium.[1] On the left side,

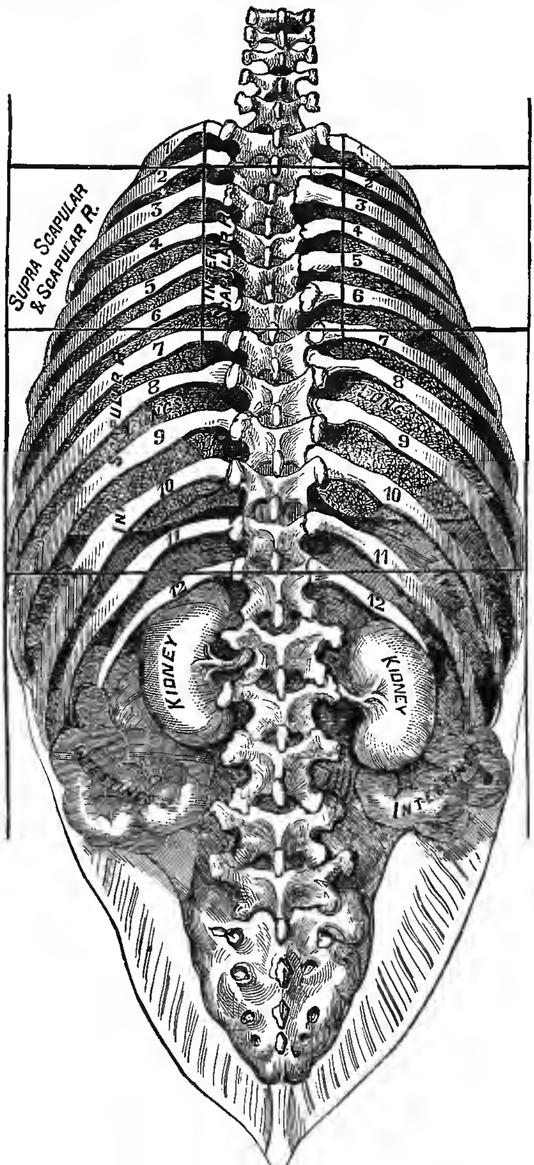

FIG. 127.—The posterior region, the boundaries of its subdivisions, and the organs corresponding to these subdivisions. (After Sibson.)

[1] See plate on page 196.

the superior lobe of the left lung, the left bronchus, and the pulmonary artery are to be found in this space. The two large vessels (the aorta and pulmonary artery) are each to be found behind the *second costo-sternal articulation,* on the right and left side of the sternum, respectively.

The MAMMARY REGION is bounded by the *third rib* above; by the lower edge of the *sixth rib* below; by the edge of the sternum internally; and by a continuation of the line marking the external border of the infraclavicular region on the outer side. On the right side of the body, this space contains the attachment of the right side of the diaphragm as high as the seventh rib; the liver and diaphragm as high as the fourth interspace; a small part of the right auricle, close to the sternum, on a level with the fourth and fifth ribs, and the edge of the lung of that side which extends downward behind the sternum to the sixth rib, when it is reflected in a direction nearly parallel to the inferior border of this region. On the left side of the body, this space covers lung-tissue only as far down as the lower border of the fourth rib, since the heart causes the lung to leave the sternum at the fourth costo-sternal articulation; the exposed portion of the heart is contained in this region, and a small portion of the apex of the right ventricle.

The SUPRA-SCAPULAR REGION corresponds to the supra-spinous fossa of the scapula, and covers lung-tissue. It begins at the level of the second rib and extends downward as far as the limits of the spine of the scapula. It covers lung-substance on each side of the body.

The SCAPULAR REGION extends from the spine of the scapula to the lower angle of that bone. It therefore corresponds to the infra-spinous fossa. It covers lung-tissue throughout its entire extent. Its lower border corresponds to the *level of the seventh rib.*

The INFRA-SCAPULAR REGION extends from the line connecting the inferior angle of the scapula and the seventh dorsal spine to the level of the twelfth rib below. It is bounded internally by the spinous processes of the vertebræ; and, externally, by the line dropped perpendicularly from the angle of the scapula. This space is occupied by lung-tissue as far down as the level of the eleventh rib; but, below that point, the liver substance approaches the surface, on the right side, while, on the left side, the intestine fills the inner part of this space, and the spleen the outer part. The thoracic aorta lies to the left of the spinal column; and a small portion of the kidney can be found, on each side, close to the spinal column—but slightly more upon the left than on the right side.

The INTER-SCAPULAR REGION comprises that space between the inner border of the scapula and the spinous processes of the vertebræ, upon each side of the body. It, therefore, extends from the *second* to the *sixth dorsal spines.* It contains, if both sides be considered as forming only one space, the trachea, the main bronchi, the bronchial glands, lung-tissue, the œsophagus, the descending portion of the arch of the aorta, a part of the thoracic aorta, and the other structures which are contained in the posterior mediastinum.

The AXILLARY REGION extends from the external border of the mammary region, in front, to the external border of the scapular region, behind. It includes the axillary space which lies above the line, and those portions of the chest which lie both in front of, and behind it. It corresponds to the upper lobes of the lung of the corresponding side; and the main bronchus of each lung can be found deeply seated in this space.

The INFRA-AXILLARY REGION is limited, in front, by the infra-mammary region; above, by the axillary region; and, behind, by the infra-scapular region. It is limited, below, by the edges of the false ribs.

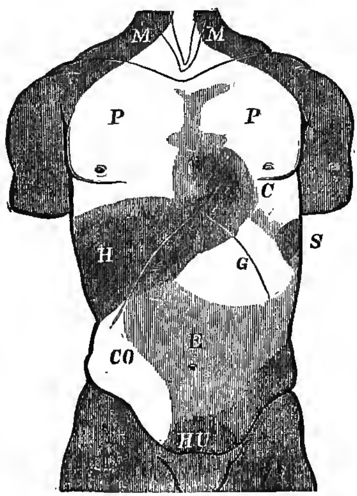

FIG. 128.

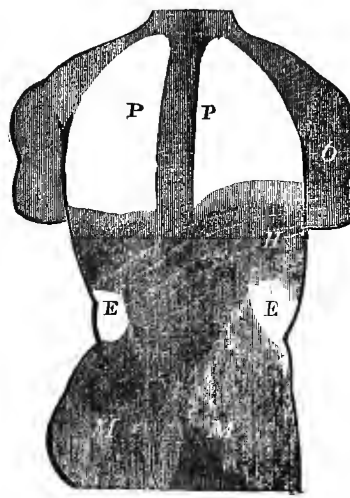

FIG. 129.

FIG. 128, Anterior, and FIG. 129, Posterior view of the normal limits and intensity of dulness on percussion; P, pulmonal sound; C, cardiac sound; H, hepatic sound; S, splenic sound; G, gastric sound (here the stomach is moderately distended with air); E, enteric sound. In the anterior view the intestines are tolerably free from air, except CO, colic sound, from distended colon. The descending colon and rectum are filled, and sound dull. HU, humoral sound, over a distended bladder; M, muscular, and O, osteal sounds. (After Piorry.)

This region contains, on both sides of the body, the sloping edge of the lung, which is lowest in the posterior region of the chest. On the right side, the liver helps to fill up this region; while, on the left side, the stomach and spleen are present.

SURGICAL POINTS OF INTEREST PERTAINING TO THE THORAX.

Fractures of the ribs may be the result of direct or indirect violence applied to the chest. The situation of the fracture is greatly modified by the type of injury which produces it, as has already been discussed somewhat at length on page 189 of this volume; and the danger of serious complications, from injury done to the thoracic viscera by the fractured ribs is much greater when that injury is due to direct violence than when produced from simple compression of the chest. Almost all forms of *direct violence* tend to drive the chest-wall inward at the point where the blow is received; and thus the pleura, the lung, the diaphragm, or the heart and pericardium may be injured by the fragments, if not by the blow itself. Such an accident may, therefore, become the cause of death, since hemorrhage, pleurisy, pneumonia, emphysema, pericarditis, myocarditis, aneurism, or peritonitis may be developed; and the respiration may, in rare cases, be greatly interfered with if the diaphragm be badly torn. It is infrequent to find these complications present, in fracture of the ribs from *indirect violence*, since, as before stated, the fragments are usually directed outward, and thus away from, rather than toward, the organs of the chest. During the contraction of the abdominal muscles, in the forcible expulsive efforts of parturition, the ribs have been known to be fractured; while I have seen the same accident occur in exercising upon the parallel bars of a gymnasium.

Any of the ribs may be broken, but the first and second are so thoroughly protected by the bones of the shoulder and the muscles of the chest that they are seldom fractured; but, if so, a most serious accident exists. Why this region should have any special dangers can be more easily understood by referring to page 189. The lower ribs are also comparatively exempt from fracture, since their mobility renders them capable of withstanding a much greater shock than the middle ribs which are firmly attached to the sternum in front, and to the vertebral column behind. Age seems to have a marked influence upon the liability of fracture of the ribs from any form of indirect violence, since the elasticity of the bones has become impaired. One practical point in the relief of fractures of the ribs is suggested by the physiological action of these bones during the acts of inspiration and expiration; since the constant movements of the chest interfere, not only with the union of the fragments, but also greatly increase the pain, which is experienced by sufferers from this accident. As soon as the patient has been seen and the existence of a fracture positively diagnosed, by an abnormality or irregularity of the rib, the presence of crepitus, and abnormal mobility of the fragments, the chest should be firmly compressed by strips of adhesive plaster, applied after a full *expiratory effort;* thus the broken ribs are held immovable during the process of repair, and the pain, experienced previous to the application of these strips, is greatly diminished. I am inclined to favor the application of these adhesive strips to the entire circumference of the chest at the seat of fracture, rather than an attempt to leave the uninjured side free to expand with inspiration, since I find, in most cases, that the latter is impracticable. The plaster used should be free from substances which will create an irritation of the skin and should be spread on twilled muslin or canton flannel, rather than on ordinary muslin, to render it incapable of stretching.

The ribs have *occasionally to be resected* for extensive caries or necrosis of these bones, and for tumors developed in connection with the ribs. The old opinion, that such a step was demanded to relieve the pleura from a source of irritation, has been somewhat modified of late, since the danger of pleuritic inflammation is rather increased by such surgical interference than avoided. Fortunately, the occurrence of extensive disease of the ribs is not so common as to bring this question prominently before the mind of the surgeon. Cloquet and Bérard, as well as Velpeau, report marvellous cases where the ribs have been excised so as to expose the pulsations of the heart (and one, where the whole fist could be inserted into the opening through the thoracic wall) without causing death to the patient; but the danger of compression of the lung by the air introduced into the pleural cavity is not to be considered as but one of the most extreme significance, as regards the life of the patient.

The *evacuation of fluid* from the cavity of the chest—the operation of "paracentesis thoracis"—is among the most ancient of all surgical procedures; being referred to as far back as the time of Hippocrates. It is so commonly performed, at the present time, by those who do not claim distinction for surgical skill, that it can hardly be classed as more than one of the common methods of relief, in those cases where pus or fluid has accumulated in the cavity of the pleura. I have also seen it performed for the evacuation of a large abscess of the lung itself, with good results. It is indicated in all cases where the compression of the lung by fluid in the pleura has progressed to such an extent as to interfere with the subsequent absorption, after the inflammatory process has subsided; and also, in all cases, where the danger of perforation of the walls of the thorax seems imminent, by collections of pus either within the pleural sac or external to it. The aspirator has afforded the practitioner a means of emptying such cavities with little, if any, danger of the entrance of air; and the step has, therefore, lost the chief element of danger which formerly deterred surgeons from frequently employing this method of relief. The space between the fourth and fifth, or the fifth and sixth ribs,[1] is usually selected for puncture, and the needle should be introduced close to the *upper border of the rib*, in order to avoid the intercostal vessels, and also in the central line of the axillary space, for the same reason. It is my custom to puncture one rib higher upon the right side than upon the left, as the liver is liable to be wounded if the

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[1] Verdue, Desault, and Boyer recommended the *lower portion* of the chest for tapping; while Lænnec advised the puncture to be made at the central portion of the chest, so as to assist drainage, while the patient was lying down. The valvular flap and incomplete evacuation now renders the question of future drainage of no importance.

puncture be made too low down upon that side; although, in case no adhesions exist, that organ is probably displaced downward by the fluid, if it be large in quantity. I prefer to have the patient in a sitting posture, as the weight of the column of fluid, above the seat of puncture, assists in its escape; and, as the lung tends to expand from above downward, as the fluid is withdrawn, that organ is therefore less liable to be injured by the needle. In case of tapping the chest for fluid in the pleura, it is my rule to be governed by the sensations of the patient, as to the amount which shall be withdrawn at any one time; always withdrawing the needle as soon as the patient ceases to experience relief, or begins to feel unpleasant effects from the decrease of pressure upon the lung. A *valvular opening* should always be insured by drawing the skin of the chest upward before the needle is introduced, since it tends to return to its normal position as soon as the needle is withdrawn, and thus covers the opening. In this way, the possibility of the entrance of air into the chest is greatly diminished.

The operation of *tapping the pericardial sac*, for fluid within its cavity, has not, as yet, seemed to meet with the approval of surgeons, although some forcible arguments can be urged in its favor. The constant movement of the heart within the sac, and the liability to puncture or laceration of that organ by the needle, seems to render the operation one of far greater danger than that upon the pleura.

The *deformities of the thorax* which are met with as a result of rachitic affections of the spinal column, and from the effect of atmospheric pressure upon the chest-wall, when the expansion of the lung does not keep pace with the rapidity of absorption of fluid within the pleural sac, have already been mentioned in the previous pages of this chapter (see page 192).

The lower costal cartilages are sometimes caused to glide over each other, thus constituting a trivial kind of dislocation. The direction of the upper ribs, where one of the surfaces looks upward, renders a wound made by a pointed instrument more liable to enter the chest if it come from above downward; while, from an opposite arrangement, the lower ribs are most likely to be perforated by pointed instruments held in a horizontal direction.

In *wounds of the chest* by pointed instruments, it should always be remembered that the *seat of the puncture* modifies the danger, in case the instrument enters the chest; and a reference to the contents of the different topographical regions (see cuts on pages 210 and 212) will enable the reader to ascertain the various structures which are liable to be involved in any of the different parts of the thorax. A peculiarity in the course of the *intercostal arteries* affords a point of some practical interest. These vessels are protected by a groove in the lower border of each rib, for the middle portion of their course only, since they are uncovered by bone both in the posterior and anterior portions of the chest; hence they are seldom wounded in the axillary region, but they may be in the parts anterior or posterior to it. The *internal mammary artery*[1] may also be wounded, if an instrument pierce the chest-wall in the vicinity of the sternum, while the heart cavities, the pulmonary artery, the aorta, and the superior vena cava may also be opened.

The dangers of wounding either the lung or the pleura have already been mentioned in previous pages. If the *pleura* only be wounded, an inflammation of that membrane may be excited; or, if the opening allow of the entrance of air into the cavity of that sac, the lung may be immediately collapsed, and the most alarming dyspnœa, and even symptoms of shock of a dangerous character, may be excited from so suddenly depriving the patient of the use of one lung. If the *lung* be wounded, a rapid pneumonia may develop, or hemorrhage may occur from the injury done to the vessels of that organ, which will probably escape from the mouth, although it may enter the pleura. Emphysema of the connective tissue between the lobules of the lung may occur, if sufficient air escape through the wound in the lung; or a similar condition of the pleural cavity may result, as before described, if the air be allowed to freely communicate with it by means of the lung. It might be possible for abscess of the lung to follow such an accident, if the damage inflicted injured the tissues to such an extent as to induce suppuration. Should the instrument penetrate the middle mediastinum, the phrenic nerve might be severed, and thus extreme dyspnœa might be created, irrespective of the pulmonary lesion; but the nerve is placed too deeply to be so wounded without the lung itself was pierced.

Wounds of the *region of the sternum* are of a most serious character, as can be seen when the important functions of the parts which are contained within it are considered. This region is so filled with vascular organs that the penetration of a sharp instrument may produce death from puncture of the pericardium, the right cavities of the heart, and the pulmonary artery; while, if it go still more deeply, the left cavities of the heart and even the arch of the aorta may be opened. The mediastinum lies behind the sternum, except upon the left side and in the dependent portion of the chest, where it is in relation with the ribs for a short distance; it could, therefore, be penetrated at this point by a sharp instrument without the sternum being pierced, but not elsewhere.

The relation of the *internal mammary artery* to the under surface of the sternum, especially that of the left side, renders the sternal region a source of hemorrhage, in those cases where the wound has been too superficial to affect the other sources of hemorrhage which have been already mentioned above. It was this danger that chiefly influenced Senac in

[1] This artery is most apt to be wounded in its upper portion, on account of the width of the upper intercostal spaces, the size of the vessel, and the fact that it is removed by about two lines from the edge of the sternum.

giving his rule as to the seat of election for puncture of the pericardium (third intercostal space, two inches from the middle line of the sternum), since he preferred to wound the pleura rather than run the danger of hemorrhage from the internal mammary artery (as would probably occur if Lænnec's[1] method were followed).

Abscesses not infrequently form in the mediastina and are thus properly mentioned in connection with this region. They may be of local origin, or the result of burrowing of pus from the region of the neck; since the deep cervical fascia may prevent the pointing of such accumulations at the seat of their formation, and the fluid be forced to find some other means of outlet. I recall a case where pus had thus escaped into the cavity of the thorax and pointed at the xyphoid cartilage of the sternum. The most common cause of such accumulations of pus within the cavity of the mediastina is disease of the dorsal vertebræ. Carious degeneration of these bones may give rise to very large collections of pus which are particularly prone to infiltrate the loose connective tissue which invests the aorta, and thus to travel downward, in the posterior portion of the chest; while, in occasional instances, the pus may escape from the cavity of the thorax by means of the aortic opening of the diaphragm, into the cavity of the abdomen.

It is not infrequently observed, when any cause of sympathetic irritation is present, affecting the *bronchial* or *œsophageal glands,* that so great an amount of tumefaction is created in them as to possibly produce dysphagia from pressure upon the œsophagus, or dyspnœa from pressure upon the trachea or the main bronchi, or possibly the phrenic nerve; and, in case they proceed to suppuration, they may evacuate their contents into the œsophagus, the right or left bronchus, the pleural sac of either side, or even into the pericardium.

The effects of *aneurismal tumors* of the aortic arch or the descending portion of that vessel will be considered in some detail in later pages of this work treating of the viscera of the thorax, but it may be here suggested to the mind of the reader that such tumors are liable to produce a local deformity of any of the regions of the chest, and especially of the sternal region, by absorption of the bones as the direct result of long-continued pressure.

In the region of the sternum, some *curious deformities* are occasionally observed at the date of birth. It has been found to be congenitally cleft or absent in its middle portions, thus leaving the pulmonary organs and the pericardium almost naked. The xyphoid cartilage may be cleft, or bifurcated, as an evidence of imperfect or arrested development. As

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[1] The suggestion made by Lænnec, in case of fluid in the pericardium requiring evacuation by surgical means, was to trephine over the lower portion of the sternum and tap the sac where it could be felt to fluctuate, and as low down as possible.

before mentioned, certain occupations may produce acquired types of deformity; thus, in shoemakers, the xyphoid cartilage may be so depressed as to impinge upon the heart from the constant attitude assumed in that occupation, while, in carpenters, the same effect is perhaps more frequently noticed, from the habit of using tools which are pressed upon this region in order to brace them firmly against the materials upon which they are employed. Severe blows upon this portion of the bone may result in a depressed fracture, as in Billard's case, where gastrotomy was required to replace it.

It is a well recognized fact that this region is a common seat of venereal growths and ulceration, probably on account of its superficial situa-

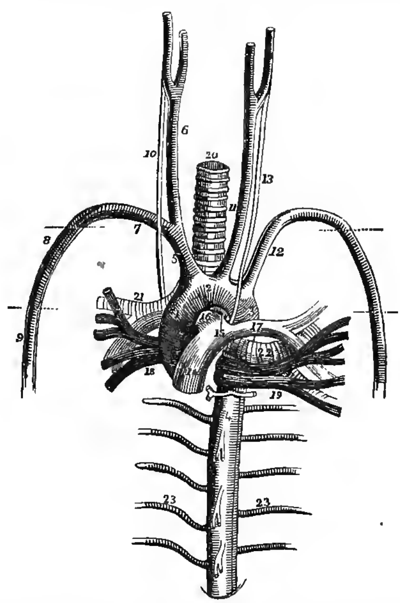

FIG. 130.—A diagram of the important structures within the thorax and neck. (After Wilson.) 1, 2, 3, arch of aorta; 4, thoracic aorta; 5, arteria innominata; 6, common carotid artery; 7, subclavian artery; 8, axillary artery; 9, brachial artery; 10, right pneumogastric nerve; 11, left carotid artery; 12, left subclavian artery; 13, left pneumogastric nerve; 14, 15, 16, 17, pulmonary artery; 18, right pulmonary veins; 19, left pulmonary veins; 20, trachea; 21, 22, right and left bronchus; 23, intercostal arteries.

tion; and caries and necrosis is, occasionally, so extensively developed in the sternum as to require removal either of portions of the bone or the bone itself, as is reported by Galen, Genouville, and Boyer. This bone sometimes requires trephining, when the innominate artery is to be reached; and it has been suggested by Lænnec as a step to be performed previous to puncture of the pericardial sac.[1]

[1] Senac's rule for puncturing the pericardium is to introduce the trocar in the *third intercostal space*, at a distance of two inches from the middle line of sternum.

Behind the upper portion of the sternum, there is little or no space left for the presence of lung-tissue, since the trachea and the large blood-vessels are in close relation to it. Just below its upper margin, the left innominate vein crosses the sternum to join that of the right side and thus form the superior vena cava. The large branches which arise from the arch of the aorta lie immediately behind this large vein; while deeper still, the trachea may be found, dividing into the right and left bronchus at a point corresponding to the junction of the first and second bones of the sternum, or on a level with the third dorsal vertebra. Behind all of these, lies the œsophagus. The arch of the aorta seldom reaches the upper border of the sternum, but may be found, as a rule, to extend to within one inch of that point; so that the aorta usually lies upon the trachea just above its point of bifurcation. If we draw a line upon the sternum, from the middle of the junction of the manubrium with the gladiolus to the right sterno-clavicular joint, it will indicate the *course* and *extent* of the *arteria innominata.*

The *mammary region* is a frequent seat of surgical affections. Abscesses often develop in this gland, during lactation, in consequence of some obstruction in the lacteal ducts. Benign tumors are also common in this region; and the seat of election manifested by scirrhus is proverbially the breast of the female. This fact seems to indicate that the constant irritation of the nipple during nursing, and the prominence of the breasts which exposes them to a greater liability to external forms of injury, are factors which tend to account, in some degree at least, for this affection.

The *costal region* of the chest has already been somewhat exhaustively considered, when the dangers of fracture of the ribs were discussed, and the surgical treatment of fluid within the pleural and pericardial sacs, by aspiration.[1] There is, however, another point of interest suggested by the distribution of the nerves and blood-vessels to this region that will tend to explain the efficacy of certain well-recognized methods of treatment. It is customary to apply both *wet* and *dry cups* over the surface of the chest, as well as blisters of large size, when we wish to make any decided impression upon the pleura. Such remedial measures are employed for the relief of the pain of pleurisy, as well as for neuralgic attacks affecting the intercostal nerves; and they are also frequently advised as a means of assisting in the absorption of inflammatory effusion, within the cavity of the pleura. Now, if they are to be attended with any benefit, such measures must be based upon some anatomical explanation; and we find a simultaneous distribution of both vessels and nerves from common trunks to the skin and the pleura of the corresponding side, as our justification for such a plan of treatment. I am frank to state that I have never yet been able to see how the *lungs* can be markedly relieved

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[1] See p. 216 for the steps of this operation and its indications.

by the local abstraction of blood from the surface of the chest, since the bronchial vessels are only for the purpose of *nutrition* of those organs and carry but a small proportion of the actual blood contained, and hence abstraction of blood from the chest must first affect the amount of blood in the aorta itself, before it can affect the bronchial vessels, which are themselves but minor factors in the general pulmonary circulation. I do not believe that the intercostal vessels nourish the lung substance, although they do the pleura; and to affect the amount of blood in the lung itself, general depletion would be of as much, if not of more avail than any attempt to reach the lung through the blood-vessels of the thorax. If we accept the results of those experiments of Cammann, who proved that the *pulmonary* and *bronchial vessels* of the lung *do not communicate* (by injecting into the bronchial and the pulmonary arteries two fluids which would generate a gas when they came in contact with each other, and thus create an inflation of the lung), we are still more fortified in the position which we have taken, as to the absurdity of attempting to reach the pulmonary circulation by any type of local depletion.

The explanation of the arrest of pain by local abstraction of blood is supposed to rest in the relief of the pressure, upon the nerve trunks or filaments, created by the over-distended vessels; while its effect upon the absorption of inflammatory effusions within the pleural sac is based upon a similar relief to the over-distended blood-vessels, which ramify upon the surface of that membrane, and which are unable to absorb rapidly on account of the sluggishness of their current. I am inclined to think, however, that a moderate withdrawal of the fluid by the aspirator, thus relieving the excessive distention of the sac, hastens the process of absorption after an attack of sub-acute pleurisy, more than blood-letting, dry cups, or blisters to the chest.[1]

In the *region of the back*, the walls of the thorax may present the condition of *spina bifida*. This is characterized by the appearance of a fluctuant tumor, of varying size, dependent upon an arrest of development of the spinous processes of the dorsal vertebræ and a protrusion of the membranes of the spinal cord through the opening so produced; thus forming a tumor which fluctuates, since it usually contains the cerebro-spinal fluid. The size of this tumor depends upon the extent of the abnormal opening, and the amount of protrusion of the membranes. The shape of the tumor is usually oblong, with its long axis parallel with the axis of the vertebral column, on account of the shape of the opening through which the membranes escape. The contents of these tumors explain the fact that pressure upon them may cause the fluid to again return to the spinal canal, or possibly to enter the ventricles of the brain[2] in excess, and so create brain symptoms.

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[1] For the details of this operation see p. 216.

[2] The functions of this fluid are to equalize the pressure within the brain,

Curvatures of the dorsal region of the spine may follow the condition of rickets, when the lateral curve normal to this region[1] may be increased to such an extent as to constitute a deformity; or, in cases less frequently met with, the posterior curve of the spine may be increased. In tabes dorsalis, however, which acts upon the bodies of the vertebræ, consisting of a tuberculous change in the bones, the flexion most often seen in the dorsal region consists of a curve from behind forward.

When a person falls forcibly upon the back, the projection of the ribs beyond the spinous processes of the dorsal vertebræ affords a partial protection to this portion of the spine, although the dorsal vertebræ are more liable to be struck in such an accident than the cervical or lumbar, on account of the curve of that region, which rather favors than avoids violence. Nature has, however, compensated for this risk by so interlocking the processes as to render the movement of this region a limited one, and external violence is therefore capable of doing less damage here than it would elsewhere. A practical point is afforded (in those cases where suppuration and deep abscess follow a blow received on the spine) by the *vertebral aponeurosis,* which tends to prevent the pus from pointing, and favors its infiltration into adjoining parts; such abscesses should, therefore, be incised early.

Wounds of this region cannot cause a dangerous hemorrhage, provided the designated region be confined to the spinal column proper, since it is almost impossible for a pointed instrument to penetrate into the spinal canal, and the muscular structures are not supplied with vessels of large calibre. The absence of large arterial trunks from the exposed surfaces of the body is one of those wise provisions on the part of Nature, by which she guards the important parts of the frame from those injuries which we are constantly liable to receive from without.

The *diaphragmatic region* of the thorax may be lacerated during any form of violent exertion, especially in those cases where the patient has fallen from a great height and has made extra exertions to save himself. Such lacerations are usually met with upon the left side, since the liver tends to support the right side of the diaphragm, while the left side is comparatively unsupported.

The diaphragm may be wounded through the costal, lumbar, costo-iliac, or dorsal regions. The convexity of the muscle brings its central

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when the *amount of blood* in that organ *suffers variation,* as in the respiratory act. It also protects certain parts of the brain from injury (see page 148).

[1] For details of this lateral curvature, which is normal to the majority of adults, see page 140.

The *guides to the thoracic viscera,* which are afforded by the spines of the dorsal vertebræ, are of great importance to the diagnostician; they may be found mentioned in connection with the description of the bones of the vertebral column (page 142) and also in the enumeration of the contents of the special topographical regions of the chest (page 141).

portion far above its seat of attachment to the margins of the chest and the dorsal vertebræ, while its position is never constant, since it moves up and down with respiration. In those cases where *abscess of the liver* is aspirated, the diaphragm is usually pierced by the needle before it enters the liver substance; and the obscure sense of fluctuation, by which the knowledge of the existence of deep abscess of this organ is gained, is best perceived by crowding the *tips* of two or three fingers into the space between the seventh and eighth ribs and giving an impulse to the left lobe underneath the xyphoid appendix of the sternum, thus using the muscular tissue of the diaphragm as a part of the conducting medium. Blows received below the margin of the ribs, if acting obliquely from below upward, may cause an injury to the diaphragm.

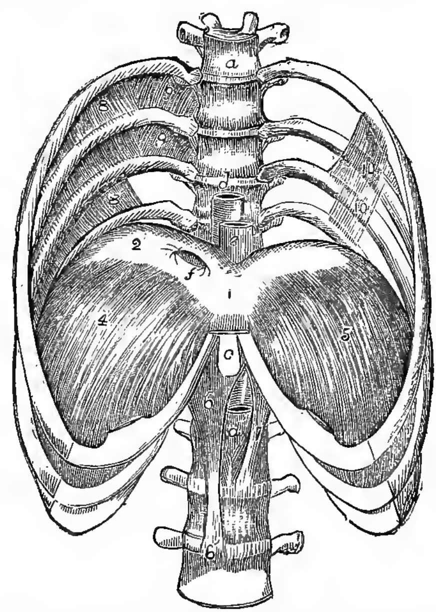

FIG. 131.—Lower part of the chest, showing the diaphragm: *a*, sixth dorsal vertebra; *c*, ensiform cartilage of the breast-bone; *d*, the aorta, cut across, lying in front of the spinal column; *d'*, the aorta appearing below the arch formed by the pillars of the diaphragm; *e*, œsophagus (cut across) descending through the tendon in the centre of the diaphragm; *f*, opening for the passage of the inferior vena cava; 1, central tendon of the diaphragm; 4, 5, right and left muscular portions of the diaphragm; 6, 7, the pillars of the muscle arising behind from the lumbar vertebræ; 8, 8, 10, 10, internal intercostal muscles; 9, 9, external intercostal muscles.

The condition of pregnancy, or the presence of any form of abdominal tumor, if very large, may tend to displace the diaphragm upward, even above the limits of a full expiratory effort; hence a practical point in tapping the chest, when such a complication exists, viz., to select a higher point for perforation than in the normal subject.

Numerous cases are on record where the omentum, and even the intestine, has been forced through the some of the openings of this mus cle; a severe type of *hernial protrusion* may thus exist, without its presence being suspected, unless the aids of auscultation and percussion be brought to bear upon the case.[1]

The diaphragm is an important muscle from a physiological standpoint, since not only is inspiration largely controlled by its contraction, but a *suction action* upon the blood in the inferior vena cava is thus produced,[2] which greatly assists in causing the return of the venous blood from the lower extremities and the abdominal viscera to the right auricle of the heart. In addition to these functions which are being constantly employed, and which are necessary to the life of the individual, the diaphragm is an important factor in the acts of hiccough, laughter, yawning, sobbing, and sneezing.

That portion of the muscle which invests the œsophagus, just before it enters the cavity of the stomach, is also endowed with a sphincter-like action upon that tube, and the regurgitation of food from the cavity of the stomach is thus prevented during each inspiratory act, when the abdominal organs are crowded downward, and pressure is thus exerted upon the stomach which lies in close relation to that muscle.

The contraction of the diaphragm[3] is supposed by Blandin to predispose toward the development of hernia of the floating viscera through that muscle, since it is brought in closer relation to them than when relaxed; this statement may hold good as regards those openings which are situated in the *tendinous portion* of the muscle, but I question if the effect of muscular contraction does not act as a barrier to such protrusions through the muscular openings, as they must of necessity be diminished in size. It is possible for the diaphragm itself to become protruded through the infra-sternal space, if it is itself affected with local growths.

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[1] For the symptoms which indicate such a hernial protrusion through the diaphragm, and the means of discrimination between it and tumors situated low down in the mediastina of the chest, the author would respectfully refer the reader to his work on Surgical Diagnosis, where the points are given in the form of tables of differential contrast.

[2] The pericardial sac is attached, above, to the walls of the large blood-vessels escaping from the heart, and, below, to the diaphragm; hence each inspiratory act tends to elongate this sac, and thus to assist the expansion of the heart cavities which, in turn, suck blood from the ascending vena cava, rather than from the descending vena cava, where gravity assists in emptying it.

[3] The compression exerted by the contraction of the diaphragm upon the liver, and possibly also upon the upper viscera of the abdomen, unquestionably tends to empty the blood-vessels of those organs; and it is claimed by Sibson that this is one of the forces which assist in forcing the blood into the inferior vena cava, and thus in propelling the current of blood in that vessel toward the right auricle of the heart. This effect, is, however, of less importance than it would be if these large veins were supplied with valves to prevent regurgitation; and the *suction force* of respiration must, therefore, be considered as paramount.

When the diaphragm is the seat of inflammation,[1] a *pain* is often felt in the *region of the neck* and the *top of the shoulder ;* and the same phenomena may be observed when the visceral layer of the pleura is involved. This can be explained as a transmission of sensation through the phrenic nerve to its points of origin (the third, fourth, and fifth cervical nerves), and a reflex irritation of the descending filaments of the cervical plexus, which afford sensation to the integument of the region of the shoulder and clavicle. A point of diagnostic value in inflammation of the diaphragm is afforded in a difficulty of respiration; while the so-called "sardonic laugh" is mentioned by some authors as diagnostic of this special type of disease.

The *base of the chest* is the spot usually selected for the application of *leeches* or *blisters* in case of inflammation of the diaphragm, since the vessels and nerves which supply the lower intercostal spaces are distributed, in part, to the diaphragm itself. It should be remembered, however, that this rule does not apply to similar conditions of the liver, since the venous blood, which is sent to that organ by the portal system, comes nearest to the surface of the body in the region of the anus; while its arterial supply is derived from the abdominal aorta, and empties into the portal vessels.

The relative position of the diaphragm to the walls of the thorax is so inconstant[2] that it may be well to here recall some scattered points which are of too practical a character to be forgotten. It has been already stated in connection with the variations perceived in the situation of the apex beat of the heart, as well as in other places of the preceding portion of this volume, that the *diaphragm could be displaced* both upward and downward;[3] that, exclusive of its modified form during inspiration and expiration, the muscle is the passive subject of certain diseased conditions which tend to affect its relative position to the adjoining parts; and, finally, that these variations have a practical bearing upon the prognosis of penetrating wounds of the chest, as well as to the operation of paracentesis thoracis. Since emphysema is usually a bilateral disease, the diaphragm is crowded downward upon both sides when that affection is markedly developed; and thus the position of the abdominal viscera, as

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[1] As may occur from an extension of a pleurisy, pneumonia, pericarditis, hepatitis, or disease of the chest-wall, or mediastina.

[2] Birds, lizards, and snakes breathe by the movement of the ribs alone, the diaphragm being either absent or subsidiary.—Sibson: Medical Anatomy.

The "false ribs" are sometimes called the "diaphragmatic ribs," since they afford attachment for that muscle. Sibson considers the term "false ribs" as a misnomer, since they affect respiration to the same extent as the true or sternal ribs.

[3] On page 197 a table is given to show the causes of a displaced apex-beat of the heart. This same table will also assist the reader to properly understand the causes of displacement of the diaphragm.

well as that of the heart, is materially altered. Collections of fluid within the pleural sacs may also displace the diaphragm downward, and, with it, the adjoining viscera of the affected side. I have seen the liver almost entirely displaced from its relations to the chest-wall, lying free within the cavity of the abdomen, from a very extensive effusion of the right side of the pleura. The diaphragm may also be raised by any tumor of the abdominal viscera if sufficiently large to effect it; and one side may be more displaced than the other if the pressure be confined to one-half of the muscle. Thus an abscess, or any form of tumor of the liver will cause an encroachment upon the right side of the chest more than upon the left, and the heart may be crowded to the left side rather than upward; while tumors of the cardiac end of the stomach, the spleen, the left kidney or ovary, and other forms of abdominal tumors, may produce a diminution of the left side of the thorax, while the right side may be normal.

THE THORAX CONSIDERED AS A WHOLE.

It has been shown in previous pages that the walls of the thorax are purposely made flexible and capable of movement, in order to allow of respiration; that the capabilities of movement of the different parts are somewhat modified in the sexes; that the cavity of the thorax can be shortened and lengthened, both by the movements of the ribs and that of the diaphragm; that the thoracic organs move downward while the ribs ascend, and upward when they descend; that the neck is encroached upon by the inspiratory movements of the thorax; that the intercostal spaces are differently affected by the movements of inspiration and expiration, in different parts of the thorax; that certain diseased conditions of the thoracic viscera have a marked effect upon these points previously mentioned; that the chest-wall affords the physician a means of mapping out the relations of the viscera to each other in health, and often furnishes pathognomonic evidences of diseased conditions of viscera; and, finally, that many surgical guides are afforded by the bones and soft tissues of the thorax, which are capable of various applications in medicine as well as in operative procedures.

The *cervical* and *dorsal vertebræ form curves* which are relatively increased during inspiration, and thus the length of each of these two segments of the spinal column is shortened.

The five upper ribs *act exclusively upon the upper lobe* of the lungs and have no bearing upon the lower lobe or the diaphragm; while the sixth, seventh, and eighth ribs act in common and *co-operate with the diaphragm* in affecting the lower lobe of the lung. The steady increase of the length of the ribs from the first to the eighth tends to explain why the lower part of the sternum is pushed farther forward during inspiration than the upper part of the bone, as well as why the dorsal curve of the vertebral column is increased. The fourth, fifth, and sixth ribs have a curve whose convexity looks downward; the seventh rib is straight; and the eighth and ninth ribs have a curve whose convexity looks upward.[1]

The *epigastric space*, contained between the seventh and eighth costal cartilages, is widened in inspiration, and narrowed during expiration; and these cartilages and their articulation to the lower end of the sternum have been compared to the limbs of a pair of compasses which expand and converge with the respiratory act.

In the majority of males, the *thoracic expansion* during tranquil inspiration is about one-twentieth of an inch, and the *abdominal expansion* about one-third of an inch; while in the female, the thoracic expansion is increased over the previous measurement, and the abdominal expansion is decreased. Up to the age of fourteen, the two movements are alike in the two sexes. The abdominal expansion during inspiration is produced by the descent of the diaphragm.

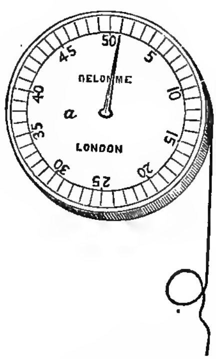

Fig. 132.

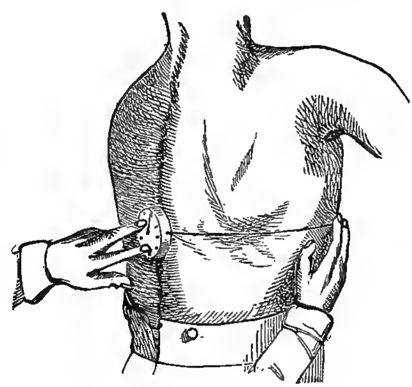

Fig. 133.

Fig. 132.—The stethometer of Dr. Quain—half the real size. (After Quain.)
Fig. 133.—Mode of applying the instrument when the string is used. (After Quain.)

It is customary with specialists, in the diagnosis of lung affections, to estimate by actual measurement the amount of expansion upon each side of the chest during tranquil breathing and forced inspiration, and to judge by the comparison of the measurements of the respective sides how great an impairment of inflative power either lung manifests. This same conclusion can be roughly drawn by instructing the patient to stand erect with the arms hanging loosely at the sides of the chest, and with the back toward you. If you now watch the *movements of the scapulæ*, during a full inspiratory effort, and again during tranquil breathing, you will perceive that these bones move outward from the spinal column, just in proportion to the amount of expansion of the chest upon that side; since the serratus magnus muscle is attached to the ribs anteriorly, and posteriorly to the posterior border of the scapula, and acts (since no resistance is afforded by the movable scapula), as a band over the expanding

[1] This is admirably depicted in the plates of Sibson's great work.

chest, which moves the scapula in the exact proportion to the increased circumferential measurement of that side.

When pus is formed within the chest, the wall of the diaphragm is crowded downward toward the cavity of the abdomen, and the space between the upper surface of that muscle and the inner surface of the ribs is very much enlarged. The lung may form adhesions in this abnormal position and then, if the patient recovers from the pus formation, the costal region is liable to become retracted.

It is asserted by Valentine that, *when blood accumulates* within the cavity of the chest, after it descends to the most dependent part of the thoracic cavity, it is liable to pass into the cellular tissue and thus create an ecchymosis in the loins. Should this accumulation of blood occur within the cavity of either pleura, such an infiltration could not occur without it first passed through that membrane; hence such an ecchymosis, as mentioned above, is not a constant symptom of thoracic hemorrhage.

In *auscultation of the chest,* it should be remembered that the upper part is much thicker, posteriorly, than the lower portions on account of the scapulæ, which render it difficult to perceive sounds created in that region

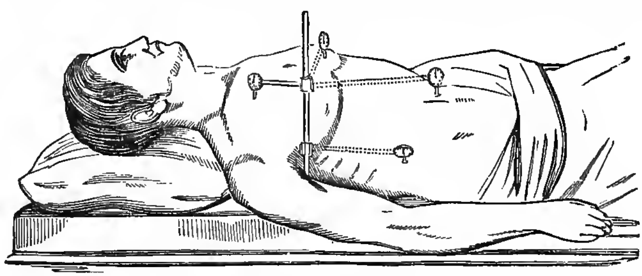

FIG. 134.—Mode of application of the chest-measurer, attached to brass rods. bent at right angles, when the patient is in the horizontal posture. (After Sibson.)

with the same distinctness as in other parts; while, in the lower portion of the chest, especially in the sternal region, the presence of the stomach and liver are liable to so alter the percussion note as to create marked variations, especially if the former organ be filled with solid food, or distended with gas. Percussion is used in the latter locality to determine the condition of the subjacent abdominal organs rather than to detect pulmonary disease. If the condition of the lung in its lower part be a matter to be decided, the *side of the chest* is the proper point for exploration, since the walls of the thorax are thin, and since the lung comes into close contact with it especially during a full inspiration. In the sternal region we are enabled oftentimes to determine by percussion and auscultation the condition of the contents of the organs contained within the mediastina.

The *relation of the spleen* to the lateral wall of the chest, upon the left side of the body, should not be forgotten in percussing the chest, low down in the infra-axillary space of that side. This organ, in a state of health, *cannot be felt below the free border of the ribs.* It extends from the upper border of the ninth to the lower border of the eleventh rib, and its presence is only to be detected by percussion over the *side of the chest,* since it is imperceptible in the anterior or posterior portions of the thorax, unless enlarged by disease. The remarkable prevalence of *malarial affections* of late, in all of which the spleen is usually very much increased in size, renders the size of this organ far in excess of its proper limits in the majority of cases examined in many regions of our country.

When we run, we inhale sixteen times as much air in a given period of time as during tranquil respiration. A deep breath is always drawn *before every form of expulsive effort;* we therefore see it precede an attempt to sneeze, cough, laugh, or cry violently; before the act of vomiting, since the diaphragm then acts as a fixed wall for the abdominal muscles to crowd the stomach against; before the expulsion of fæces, or urine, if any obstacle to its free escape exists; and, finally, before each labor pain.

The descent of the diaphragm "acts as a piston," since its effect is to lengthen the lungs and the pericardial sac, both of which rest upon it as the floor of the chest. This muscle may be regarded as consisting of *three distinct portions,* each of which has a different function and different anatomical relations, and which can be employed either in combination or separately, if emergencies arise to demand it.[1] The right portion lowers the liver and lengthens the right lung; the left portion acts upon the lung of that side and tends also to depress the stomach, the spleen, and the left kidney; while the central portion draws the pericardial sac downward and depresses the left lobe of the liver, the stomach, the pancreas, and the intestine. The right and left portions do not have the the same inclination within the thorax, because the pericardial sac and the heart tend to displace the lung of that side; and the same difference in the inclination of the two sides is stated by Sibson to exist during the contracted state of that muscle.

During the *inspiratory effort,* the larynx, trachea, and main bronchi are drawn downward, on account of the descent of the diaphragm; and the same effect is produced upon the pulmonary vessels and the aortic arch, on account of the displacement of the pericardium and the traction so exerted upon the large blood-vessels. Note, therefore, that the respiratory play of the contents of the thorax is not alone confined to the lungs and pericardium, since all the more important parts of both the respiratory and circulatory apparatus are likewise affected.

When any *marked difficulty to the entrance of air* to the lungs exists, as in laryngeal obstruction, pressure upon the trachea or bronchi, etc., the lower part of the chest will be observed to sink inward, rather than

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[1] Sibson, op. cit.

to rise as it does in health, and the abdomen will proportionally protrude, since the diaphragm puts on an extra effort to create suction. In *emphysema*, the sternum is caused to project forward, and the dorsal curve of the spine is markedly increased, thus giving the chest a peculiar "barrel shape"; moreover, the expansive motion of the chest is lost (since the lung fails to collapse during expiration), and the whole chest rises and falls like a solid structure. The organs of the abdomen are displaced downward, and the heart is pushed out of place, as evidenced by an abnormality of the apex-beat. The description given by Sibson of the appearance of a chest, in which one of the lungs is so impaired as to be rendered useless, is so complete that I quote it entire.

"When *one lung* is crippled, as from constricting adhesions, the opposite lung being developed, the contracted side presents the type of expiration, the expanded side that of inspiration. On the affected side, the shoulder slopes; the shoulder-blade drops close to the spine. The ribs are hollow and diverge below the clavicle, and crowd together and lengthen at the side, so as to cover the stomach or liver which encroaches on the lung. The seventh cartilage comes close to the linea alba. The nipple in relation to the ribs is high. The lung shrinks so as to uncover and draw toward it the heart, which beats more to the left or right side, accordingly as the left or right lung is affected. The diaphragm is high. Percussion is dull, respiration bronchial, vocal vibration feeble. The heart-sounds are loud and diffused; the respiratory movements are restrained. On the developed side, the shoulder is high; the scapula is raised away from the spine. The spine is curved toward this side. The ribs converge and are full below the clavicle; diverge, rise, and shorten at the side, so as to uncover the liver or stomach, which is encroached upon by the lung. The seventh costal cartilage diverges from the linea alba. The nipple in relation to the ribs is low. The lung expands so as to cover and displace the heart. The diaphragm is low. Percussion is resonant, respiration exaggerated, vocal vibration strong. The heart-sounds are feeble or inaudible, the respiratory movements are increased."

Many points of value in the auscultation of the heart are afforded by the chest. I have already pointed out the situation of the different valves, in the state of health; and a hasty description of the area of diffusion of the various heart-murmurs will not be out of place in the general résumé of the chest-wall.

MITRAL OBSTRUCTIVE MURMUR.—This sound is heard with the most distinctness over a limited area confined to the *region of the apex* of the heart, as can be determined by the apex-beat upon the surface of the chest. It is not usually diffused. It is never heard on the dorsal surface of the chest.

MITRAL REGURGITANT MURMUR.—This sound is heard with the greatest intensity at the *apex of the heart*. It is diffused to the *left* of the apex-beat, and is heard with almost the same intensity *between the* *fifth and eighth dorsal vertebræ behind,* as it is in front. The diffusion over the cardiac area of the chest is limited, as a rule, to a circle of about two inches in diameter, whose centre corresponds to the heart-impulse upon the wall of the chest.

AORTIC OBSTUCTIVE MURMUR.—This sound, like the regurgitant murmur heard at this valve, is widely diffused, both *along the carotid arteries,* and also *down the sternum* as far as the xyphoid cartilage. The point where the sound is most intense is usually at the base of the heart over the seat of the valve (see page 200), but it may often be heard with equal intensity at other points.

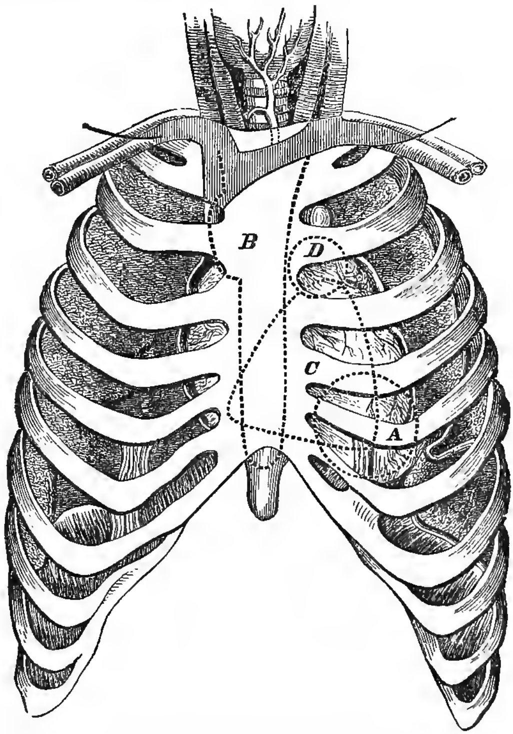

FIG. 135.—Diagram showing the areas of cardiac murmurs. These several areas correspond to the different spaces marked by the dotted lines, and a capital letter designates each area. A, the area of mitral murmurs; B, of aortic; C, of tricuspid; and D, of pulmonic. (After Gairdner.)

AORTIC REGURGITANT MURMUR.—Like the preceding sound, this murmur has a wide area of diffusion. It extends *into the carotid arteries* and *down the sternum.* Both of the aortic murmurs are the most widely diffused of all the cardiac sounds, and they may be heard at great distances from the heart, occasionally at the lower angle of the scapula. The aortic murmurs are to be distinguished by their relation to the sounds of the heart, and by their diffusion into the blood-vessels of the neck, rather than by any positiveness of area.

PULMONIC MURMURS.[1]—The obstructive and regurgitant murmurs of this valve are much less frequent than those of the left heart. They are heard with the greatest intensity over the *seat of the valve,* but the point may be situated an inch lower down. They are inaudible at the apex, and along the sternum. They are *never heard in the neck,* nor along the course of the large blood-vessels. On account of the superficial situation of the valve, these murmurs are usually louder than those produced at the aortic orifice.

TRICUSPID MURMURS.—The area of these murmurs corresponds to that portion of the heart which is *uncovered by lung-tissue* (see page 197). They are rarely audible above the third rib, and are usually loud, on account of the superficial situation of the valve. They are heard with the greatest intensity at or near the *xyphoid cartilage* of the sternum. They are infrequent, except as a secondary result of hypertrophy or dilatation of the right ventricle. The regurgitant murmur is the one which usually exists. *Jugular pulsation* is one of the strongest diagnostic symptoms of the existence of this latter condition of the tricuspid valve.

THE NERVES OF THE THORACIC WALLS.

Some admirable suggestions are made by Hilton,[2] as to the distribution of the nerves to the walls of the thorax, which will not only assist to explain some of the peculiar forms of pain felt within the chest, but also certain practical points as to their significance and methods of relief. I quote from him the following sentences:

"We observe that the same intercostal nerves which supply the intercostal muscles moving the ribs, supply also the serous membranes lining the thoracic parietes, and the skin over those different but physiologically associated structures, in order to produce harmonious and concerted action during the varied states of respiration. Here, then, we have the pleura representing the synovial membrane of a joint, the intercostal muscles representing the muscular apparatus connected with and moving a joint, the cutaneous branches of the nerves spread over the intercostal muscles, assimilating in their arrangement to the cutaneous branches which supply the skin over the insertions of the muscles moving the joint.

"But this physiological anatomy, without some application to practice, would, perhaps, be scarcely worth dwelling upon.

"Pleurisy of the pleura costalis, at the upper part of the chest, is often accompanied by *pain* and *tenderness of the skin,* not only over the seat of the pleurisy, but also in the axilla, and over the front of the

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[1] A slight regurgitation of blood at the pulmonary orifice is considered as the normal condition by some authorities.

[2] Op. cit.

shoulder, resulting from the course and the peripheral distribution of the intercostal nerves.

"It will be recollected that some filaments of the intercostal nerves pass through the walls of the chest to the skin covering it, and that some cross the axilla, and are then distributed to the skin of the front of the shoulder and the inner side of the upper arm; hence the pain and tenderness in these parts resulting from pleurisy.

"It may be noticed that persistent pain on the surface of the upper and posterior part of the chest and upon the anterior part of the sternum is not infrequently associated with disease of the heart and large blood-vessels. Indeed, I think I might generalize on this part of my subject, and make an artificial division of the back into three compartments. First, *high up between the shoulders,* where permanent pains—pains of nervous continuity—as a rule, coexist with disease of the heart, aneurism

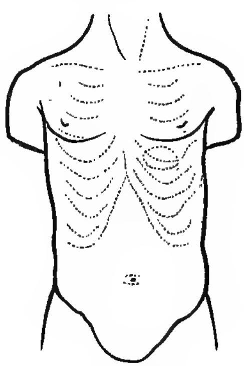

FIG. 136.

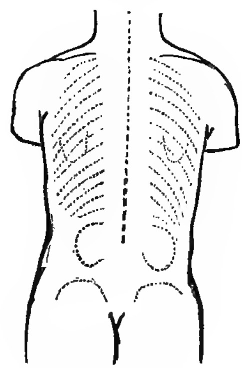

FIG. 137.

FIGS. 136 AND 137.—Anterior and posterior outlines of the trunk, for marking more readily the results of percussion and auscultation. (After Bennett.)

of the aorta, disease at the bifurcation of the trachea and bronchi, diseased glands, or stricture of the œsophagus within the posterior mediastinum; second, *between the middle and lower part of the scapulæ, and a little lower down,* where the existence of like pains are most frequently associated with disease of the abdominal digestive viscera, and, I think, with the transverse colon, through the medium of the great splanchnic and intercostal nerves; third, *the surface in the lumbar region,* where the pains are more distinctly associated with local disease in the loins, such as disease of the ascending or descending colon, the kidneys, lumbar lymphatic glands, spermatic nerves, and testicles.

"Patients suffering from cancer of the breasts often complain of pain in the back, between the shoulders, or on the side of the chest, and sometimes down the inner side of the arm, and across the axilla. In such cases, we not infrequently find cancer tubercles under the pleura costalis, or cancerous glands in the axilla, or in the posterior mediastinum. Such remote sympathetic pains occurring a long way from the real disturbing cause are explained by the course of the intercostal nerves.

"I would venture, hypothetically, to apply the following explanation to the painful effects resulting from the local application of cold air upon the peripheral branches of the intercostal nerves. I believe that the local influence of cold air may be sufficient to explain the occurrence of stitch, or that cramp in the muscles of the chest which prevents a full inspiration, by inducing tonic or spasmodic contraction of the intercostal muscles which are supplied by the same nerves (the intercostals) which supply the skin upon which the cold is applied. This explanation will hardly be deemed untenable, when I remind you that if a patient faints, we, anxious to excite respiration as quickly as possible, throw cold water over the face, or denude the chest, and flip its surface with a wet towel, and throw cold water abruptly upon the walls of the chest. And we do it for what purpose? It cannot be for the direct application of cold to the muscles themselves. It must be for the purpose of exciting the muscular apparatus which moves the walls of the chest, through the medium of the local application of cold to the cutaneous nerves.

"May not the irritation of an inflamed pleura bring on a congested condition of the muscles between the ribs, and thus engender the limited breathing and the painful cramps and stitches from which such patients suffer, in addition to that which results directly from any local inflammation of the pleura, and which induces pleuritic patients to limit their respiration as far as possible to the action of the diaphragm? This spasmodic contraction of the intercostal muscles, induced by the inflammatory condition of the pleura, is precisely analogous to what we see in joint disease. When the synovial membrane is inflamed, the joint is always fixed and rigid and difficult to move. If the pleura be inflamed, we ought not to be surprised if we find its muscular apparatus in a like condition, excited to powerful contraction and a spasmodic condition from the association between the synovial membrane and the muscles."

All physicians must have observed, in cases of pleurisy, that if the patients be asked to take a full breath, to raise the ribs and expand the lungs, they cannot do so without suffering pain; this is surely very suggestive of the importance of rest, and points to the value of strapping the chest in cases of acute or chronic pleurisy, with or without fractures of ribs; for it not only keeps the ribs quiet, but prevents any friction of the pulmonary pleura upon the inflamed pleura costalis.

These observations, of course, suggest another practical lesson—never to allow a patient suffering from pleurisy or pneumonia to talk or answer questions except by monosyllables, so as to avoid a full inspiration. Let the patient write all of his or her wishes upon a slate.

Many practical points pertaining to the nerves will be given in subquent pages, which treat of the effects of paralysis of the individual muscles which act upon the bones of the thorax.

THE MUSCLES OF THE THORAX.

The bones which compose the thorax are supplied with muscles which serve as a means of producing the various movements of the thorax in respiration, and also in so adapting the relative position of that part of the body to the other parts as to meet all the requirements of Nature. Furthermore, some of these muscles—chiefly the intercostals—serve to

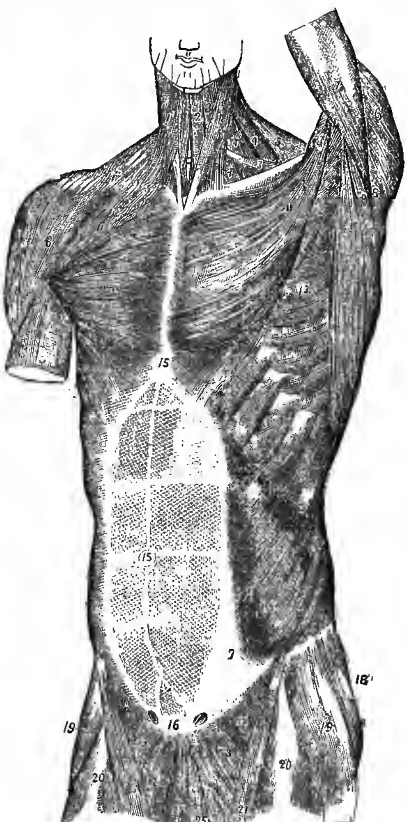

FIG. 138.—Muscles of the neck, chest, and abdomen. 1, 1, on the right side—the number rests over the platysma myoid muscle, on the left over the sterno-mastoid; 2, sterno-hyoid; 3, 3, upper and lower bellies of the omo-hyoid; 4, levator anguli scapulæ; 5, front border of the trapezius; 6, deltoid; 7, upper part of the triceps; 8, 9, the teres muscles; 10, latissimus dorsi; 11, pectoralis major; 12, part of the pectoralis minor; 13, serratus magnus muscle; 14, external oblique muscle of the abdomen; 15, 15, the upper part is placed over the xyphoid cartilage at the end of the breast-bone, the lower one at the navel; 16, on the symphysis pubis, is placed between the outer opening of the inguinal canals; 17, the tendinous aponeurosis of the external oblique muscle; 18, part of the gluteus medius; 19, tensor vaginæ femoris (which renders tense the tendinous envelope which ensheathes the muscles of the thigh and renders them compact when in action); 20, rectus femoris; 21, sartorius; 22, part of the iliacus and psoas muscles; 23 to 25, muscles which aid in drawing the thigh inward and forward.

fill up the spaces between the ribs themselves, and thus are a protective measure against hernial protrusions of the thoracic viscera, as well as mechanical aids to movement. The direction of the fibres of these latter muscles seem to confirm this fact, since they are so arranged that the fibres of the external set shall cross those of the internal set at nearly a right angle, thus rendering a separation of these fibres, of sufficient size to allow of visceral protrusion, next to impossible.

The muscles which are chiefly concerned in respiration are not all those of the thorax, since some of the neck and some of the abdomen may become most important factors in that process. It would certainly be a great omission, if the muscles of respiration were not enumerated in this work, in which so much has already been said of the inspiratory and expiratory efforts and their results upon the bones of the thorax and the viscera; and they are of interest to the physician, not only from the important aid which they furnish in performing many other acts besides those of breathing, but also because the paralytic state of certain individual muscles is often a most direct guide to the physician in determining the *seat of the lesion* which is the cause of the paralysis.

The muscles of inspiration are thus admirably classified in the work of a prominent author:[1]

MUSCLES OF ORDINARY INSPIRATION.	Diaphragm. Scalenus anticus. Scalenus medius. Scalenus posticus. External intercostals. Sternal portion of the internal intercostals. Twelve levatores costarum.
ORDINARY AUXILIARY MUSCLES.	Serratus posticus superior. Sterno-mastoideus.
EXTRAORDINARY AUXILIARY MUSCLES.	Levator anguli scapulæ. Trapezius (its superior portion). Pectoralis minor. Pectoralis major (its inferior portion). Serratus magnus.

The action of the *diaphragm*, as an inspiratory muscle, has been already considered at some length; while the effects of the scaleni muscles[2] upon the first and second ribs have been touched upon in previous pages. It may be well, however, to again state that, by the scaleni, the sternum is raised and the two upper ribs are made an immovable point from which the muscles can act upon the other ribs.

[1] A Text-book of Human Physiology, Austin Flint, Jr. New York, 1879.

[2] See p. 162 of this volume.

As regards the *intercostal muscles,* there seems to have been a greater difference of opinion between authors of note as to their action than in regard to any other muscles of the human body. The decision of Beau and Maissiat was based on extensive experimental research, and has been confirmed by Onimus and Sibson, viz., that the external intercostals raise the ribs and are therefore inspiratory muscles; while the internal intercostals, for the greater part, depress them and are expiratory muscles. I know

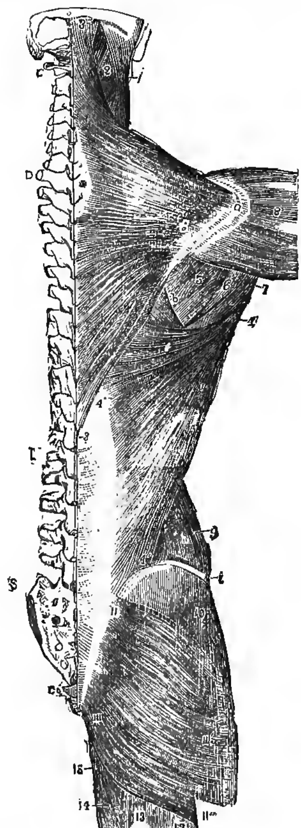

FIG. 139.—The outer layer of muscles of the back, shoulder, and hip. C, transverse process of the atlas; D, first dorsal vertebra; L, first lumbar vertebra; S, sacrum; Co, coccyx; *a*, acromion; *b*, base of scapula; *i*, crest of ilium; 1, upper part of sterno-mastoid muscle; 2, muscle which raises the scapula; 3, 3, upper and lower ends of trapezius muscle; *, half of the oval tendon belonging to the base of the trapezius muscle; 4, 4, latissimus dorsi muscle; 6, infraspinatus muscle; 6, teres minor muscle; 7, teres major muscle; 8, middle or acromial part of the deltoid muscle; 9, hind part of the external oblique muscle of the abdomen; 10, gluteus medius muscle; 11, 11", gluteus maximus muscle; 12, biceps muscle; 13, semitendinosus muscle; 14, adductor magnus muscle; 15, gracilis muscle.

of no better rule to govern the question of the action of any muscle in dispute than the following: "*Every muscle tends to bring the points of its origin and insertion more closely together, and acts upon that point* *which offers the least resistance to its action."* Now, in the case of the intercostals, the ribs must be brought more closely together by each set, since the muscles are placed between the ribs, and the only point to decide is, which point—the vertebral or the sternal extremity of the rib—affords the greatest resistance to the action of the two sets.

The action of the *twelve levatores costarum* cannot possibly be mistaken, since they act from the transverse processes of the twelve dorsal vertebræ upon the upper borders of the ribs, and thus must tend to raise them.

The *auxiliary muscles of inspiration* are capable of acting upon the ribs, when *some other part of the body is made a fixed point*, or, if the vertebræ be the fixed point, they are capable of acting either upon the head or upper extremity, depending of course upon their insertion. These muscles are brought into action in respiration, only when the movements of that act are exaggerated, as after exercise, and they cease to act when tranquillity has been restored. In those cases, however, where any obstruction to the free entrance of air to the lung is interposed from any cause, *all the muscles* which can in any way affect the expansion of the chest are called into action—the principal ones of this class being put down in the table as the "extraordinary" muscles of inspiration. Most of these muscles can be brought into play and made to act upon the chest by a simple act of volition; but, as they are chiefly inserted into the scapula, the arms must be made a fixed point in order to enable them to affect the ribs. This tends to explain the position which is assumed in all suffocative diseases, such as asthma, capillary bronchitis, laryngeal obstruction, etc.; where the anxious countenance, the position of the head (which is thrown forcibly backward), and the firm grasp of the hand upon some immovable object, with the arm extended, so as to made the shoulder-blades immovable, all bespeak pulmonary distress.[1]

The *movement of the scapula* upon the chest during the inspiratory act has already been explained as the effect of the serratus muscle upon the scapula, which, although in the relaxed state, still causes the shoulder-blade to move on account of the increased circumference of the chest; but, in very labored respiration, this outward movement observed in passive respiration becomes changed in character. The scapulæ are then seen to be raised, on account of the force exerted by the upper fibres of the trapezius and the levator anguli scapulæ muscles, although the pectoralis minor also assists in this movement by drawing the coracoid process forward, and the lower fibres of the pectoralis major as well, by acting upon the arm. The *serratus magnus* muscle becomes a most powerful agent in expanding the chest, provided that the shoulder-blades are made immovable by some position of the arm, forearm, and hand, which shall afford it a fixed point from which to act upon the ribs.

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[1] For all the facial evidences of dyspnœa, see p. 62.

We have not considered the *muscles which control the movements of the nostril* as those of inspiration, although they properly belong to that group, since they are unimportant in man; but, in the horse, and other animals where the nose and mouth do not communicate, and where all the respired air must, of necessity, pass through the nostril, paralysis of the facial nerve, which supplies these muscles with the power of movement, causes death from suffocation.

It will be seen, on looking at the preceding table of the muscles of inspiration, that five of them are properly muscles of the neck, rather than those of the thorax; while, by referring to the table of the expiratory muscles, it will also be perceived that all of the auxiliary muscles are those of the abdomen. I have thought it best, in spite of the apparent lack of system in the construction of this portion of the work, to discuss these muscles to some extent in this chapter upon the thorax, since it is impossible to give the reader a clear conception of the respiratory acts (whose effects we have discussed before the acts themselves), without encroaching to some extent upon adjoining regions.

Expiration may be considered as dependent upon one of three causes, as follows:

1. The influence of the elasticity of the lung-tissue.
2. The elasticity of the thoracic walls, and especially of the costal cartilages.
3. Muscular action, so directed as to diminish the transverse and antero-posterior diameters of the chest, by depressing the ribs and the sternum, and the vertical diameter of that cavity, by crowding up the abdominal viscera beneath the diaphragm.

It might be also possible to consider the *law of gravity* as one of the forces of expiration in the reclining posture; since it would then assist the abdominal organs to return to the position which they occupied before the diaphragm contracted. The elasticity of the ribs and the effect of the costal cartilages upon expiration have already been considered, and it now remains to enumerate those muscles which are properly considered as effecting the expulsion of air from the lungs after a full breath has been taken.

If we follow the author[1] from whose work the previous table was quoted, the expiratory muscles are as follows:

MUSCLES OF TRANQUIL OR ORDINARY EXPIRATION.	Osseous portion of internal intercostal muscles. Infracostal muscles. Triangularis sterni.

[1] Austin Flint, Jr., op. cit. The table is somewhat modified.

AUXILIARY MUSCLES OF EXPIRATION.
- Serratus posticus inferior.
- Obliquus abdominis externus.
- Obliquus abdominis internus.
- Transversalis abdominis.
- Sacro-lumbalis.
- Quadratus lumborum.

The *internal intercostal muscles* thus appear for the second time, and now as expiratory muscles, while, before, they were enumerated as inspiratory muscles. This apparent inconsistency is due to the fact that the portion of each muscle, which is situated between the bony ribs, acts from the point of greatest resistance—the vertebral extremity; while the sternal portion of each muscle acts from the point of greatest resistance to its fibres—the sternum itself—and thus tends to assist the inspiratory muscles. This statement is fortunately not one of theory only, since the observations of Sibson have confirmed it upon the human subject, when he found that the osseous fibres are elongated when the chest is distended, and shortened when it is collapsed; furthermore, the experiments of numerous physiologists upon the respiratory act in living animals, whose details are too long for repetition, also confirm it.

The *triangularis sterni muscle* tends to draw the second, third, fourth, and fifth ribs, to which its fibres are attached, toward the ensiform cartilage, the point of greatest resistance, and thus acts as an agent in diminishing the capacity of the chest. There has never been any doubt among physiologists as to the action of this muscle.

The *infracostal muscles* connect the ribs of the lower portion of the chest, at the posterior part of the thorax. They act from below, since the last ribs are made rigid by the muscles of the back during life, although they are extremely movable after death—hence the term "floating ribs" is a misnomer.

Before passing to the consideration of some of the clinical points suggested by the muscles of the thoracic walls, let us consider the other actions which the muscles already mentioned assist in, and such other points as are of general interest to the practitioner.

The arm, having been raised from the side of the chest, is returned to its former position by the combined action of the *pectoralis major*, the *teres major*, and the *latissimus dorsi*. The former muscle, if acting singly, tends also to draw the arm across the chest—a position of great advantage in auscultating the regions on the posterior aspect of the thorax. Beneath it lie the thoracic branches of the axillary artery, while its lower border marks the floor of the axillary space.

The *pectoralis minor muscle* depresses the point of the shoulder, since it draws upon the coracoid process of the scapula, while it also assists in bringing the scapula inward to the chest-wall.

The *subclavius muscle* also assists in depressing the shoulder, but it does so through the medium of the clavicle. In all positions of the upper extremity, where the shoulder is rendered immovable, it and the two preceding muscles are enabled to change the direction of their action, and thus to affect the size of the thorax.

The *serratus magnus muscle*, as before mentioned, acts as an inspiratory muscle when the shoulder is rendered immovable; it can, however, through its lower fibres, so act upon the lower angle of the shoulder-blade as to assist the trapezius in supporting weights upon the shoulder, provided the thorax is kept inflated by being simultaneously raised and made immovable.

The *levator anguli scapulæ muscle* tends to raise the scapula, after it has been depressed by the lower fibres of the trapezius muscle, and it thus assists inspiration; it may also act upon the cervical portion of the spine and assist in flexing the neck toward the same side as the muscle.

The *serrati muscles* act upon the ribs since the vertebræ act as the fixed point from which the force is exerted. The serratus posticus superior raises the ribs, and thus becomes an aid in inspiration; while the inferior muscle tends to depress the ribs, and thus becomes an expiratory muscle.

The *rhomboidei muscles*, when acting together upon the shoulder-blade, tend to draw the bone toward the spinal column—a movement seen when a person endeavors to overcome a tendency to "round shoulders."

The actions of the *trapezius muscle* are numerous. It may act upon the head or the scapula. Thus the head may be drawn to one side, if one muscle acts, or directly backward, if both muscles act from the scapula and the dorsal vertebræ; it may help to raise the shoulder when the head is fixed and its upper fibres only act, as in inspiration and the act of supporting weights upon that part, or, finally, it may produce a partial rotation of the shoulder-blade, as in the act of raising the arm above the head.

The *latissimus dorsi muscle* acts upon the arm, tending to draw it backward and inward; if the arm be fixed, it assists inspiration by raising the ribs, and it may be of use in movements of the entire trunk, as in the act of dragging the body, in the efforts to climb or to walk on crutches.

Clinical Points pertaining to the Muscles of the Thorax.

Many of the muscles, whose actions we have been considering, may present clinical features as the result of paralysis, either of a type where several participate in a general hemiplegic condition, or where the loss of power is confined to some individual muscle or set of muscles. Nearly all of the muscles of the thorax may be independently and separately paralyzed, and, in many instances, great care in the examination of the patient is demanded to fully ascertain in what particular muscle the function is abolished. The investigations of Duchenne have afforded us the means of making a diagnosis of these affections which are markedly in advance of previous knowledge in this direction.

The *pectoral muscles* may be independently paralyzed when the anterior thoracic nerves[1] are affected. These nerves are rarely alone involved, and this type of paralysis is therefore usually an accompaniment of paralysis of some other muscles. It may occur from some form of

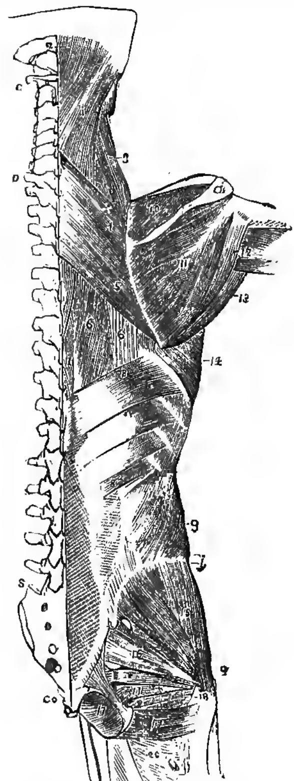

FIG. 140.—The muscles of the back, after the removal of the trapezius, latissimus dorsi, deltoid, gluteus maximus, and external oblique muscles. The muscles are: 1, splenius capitis; 3, levator anguli scapulæ; 4 and 5, the rhomboid major and minor muscles—these move the shoulder-blade and help to fix it when the arm is being used; 6, part of the erector spinæ muscle; 8, 8, the lower serrated muscle, the action of which is to pull the ribs downward; 9, the internal oblique muscle of the abdomen; 10, supraspinatus muscle; 11, infraspinatus muscle (partly seen in the foregoing); the white space between is the spine of the shoulder-blade, terminating in the acromion (*a*); 12, 13, teres minor and major muscles; 14, serratus magnus; 15, gluteus medius muscle; 16 to 19, muscles which are inserted into the great trochanter of the femur; 20, part of the adductor magnus muscle.

traumatism which has caused an impairment of the brachial plexus either entire or in part; in connection with an attack of hemiplegia; and in progressive muscular atrophy due to some lesion of the spinal cord.

[1] Branches of the *inner* and *outer cords* of the brachial plexus, given off in the axillary space.

Paralysis of these muscles is recognized at once by the impairment or total loss of power in adducting the arm, and by an inability of the patient to grasp the opposite shoulder with the hand of the paralyzed side, or to offer any resistance to passive abduction of the arm. The subclavicular fossa may be markedly deepened, if atrophy of the paralyzed muscles has taken place, and the ribs and intercostal spaces will be easily mapped out in this region. The anterior wall of the axilla may be so atrophied as to present simply a fold of loose integument, through which the subjacent parts can be felt.

When the *rhomboidei* and the *levator anguli scapulæ muscles* are paralyzed,[1] little alteration in the position of the shoulder-blade from that of its fellow can be detected. It is often difficult, therefore, for one unaccustomed to the detection of local forms of paralysis to recognize this condition. The chief diagnostic symptom, by which this condition can be determined, is an inability to produce the forced elevation of the shoulder of the affected side—the position assumed in supporting weights upon that part. When the trapezius muscle is simultaneously affected and has undergone atrophy, the shoulder-blade cannot then be drawn toward the vertebral column.

The *latissimus dorsi muscle*, which is supplied by the subscapular nerve,[2] is independently paralyzed only in cases of extreme rarity. It does occur, however, in connection with progressive muscular atrophy, as a subordinate symptom, much more commonly than as a special type of disease. In either case, little or no deformity is observed as the result of a loss of power in this muscle, provided the arm hangs loosely at the side of the chest; it is only when the arm has been raised that the power of bringing it forcibly downward, or of firmly adducting the arm, when hanging at the side, indicates a local affection of that muscle. A marked difficulty is also experienced in placing the hand upon the buttock, and the shoulder cannot be drawn as forcibly downward as in health; the contrast between the muscles of the two sides will often be of advantage to the physician, if the paralysis be unilateral.

The *serratus magnus muscle* is more often affected with isolated paralysis than perhaps any muscle of the thorax. This muscle is, and always has been, one of the greatest interest to the physiologist, since it is a most important factor in many complex movements; and a most extensive literature exists as regards its nerve-supply, its action, and its points of clinical interest. Berger, Weisner, Duchenne, and others have left little to add as regards the anatomy of this muscle or the diseases which impair its usefulness.

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[1] Supplied by nerves given off by the *brachial plexus*, above the line of the clavicle.

[2] A branch of the *posterior cord* of the brachial plexus, given off in the axillary space.

This muscle is supplied with motor power by the *long* or *posterior thoracic nerve*,[1] whose superficial situation renders it particularly liable to be involved in many forms of injury, while the extreme length of its course necessarily subjects it to further dangers, since it passes through the surgical region of the axilla as well as the neck. These two facts possibly explain the greater relative frequency of paralysis of this muscle as an independent disease over the others which have previously been discussed. Thus, direct injury is often the cause of this affection, as from carrying heavy weights upon the shoulder, contusions, blows, or severe concussion of the shoulder, bullet-wounds, stab-wounds of the neck, etc. Cases have been reported where this muscle has been paralyzed from over-exertion of the muscles of the shoulder and neck, as in mowing, puddling, shoe-making, rope-making, etc., and these instances may tend to explain why this disease is more frequent in men than women, and why the right side is more commonly affected than the left. In addition to these causes, this form of local paralysis has been known to follow exposure to draughts of cold air, sleeping on the damp ground, and as a sequel to typhoid fever. This muscle is not affected, as a rule, in those forms of general paralysis dependent upon the spinal or cerebral lesions, and, if it is so affected, it forms but a minor symptom in comparison with the others present. It may accompany progressive muscular atrophy of the muscles of the back and shoulder-blade.

When this disease is developing, severe neuralgic pains are often experienced in the regions supplied by the supra-clavicular nerve (a branch of the cervical plexus). A difficulty is soon noticed by the patient in performing certain movements, which induces him to seek medical advice. Now, if these movements are studied from an anatomical stand-point, it will be seen that the normal action of this muscle is confined chiefly to the movements of the scapula and the elevation of the arm above the line of the shoulder; and it is in the position and capabilities of movement of the shoulder-blade that we must expect to find evidences of this type of paralysis. We find the scapula somewhat raised and approximated to the spinal column when the arm hangs at the side; its inferior angle is carried inward, thus indicating a partial rotation of that bone; and the shoulder-blade seems to stand off from the chest-wall, especially at its inferior angle, giving the bone an undue prominence in this locality.[2] When movement of the arm is attempted, the effect of the paralysis becomes much more marked, since the patient finds himself *unable to raise the arm above the level of the shoulder*, since the rotation of the inferior angle

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[1] Arising by two heads, derived from the fifth and sixth cervical nerves.

[2] This is due to the antagonism of the *rhomboid* muscle, the *trapezius*, and *levator anguli scapulæ*, which are no longer counteracted by the serratus magnus. If these muscles are also affected, either by paralysis or atrophy, this deformity becomes much less marked.

of the scapula and the elevation of the bone which are necessary to that movement cannot be performed.

If the *arm be raised* to the level of the shoulder (a movement produced by the deltoid muscle alone), the inner border of the scapula, instead of being removed farther away from the spinal column, is approximated toward it; and, if the serrati muscles be both paralyzed, the shoulder-blades will thus be caused to almost touch each other. When we place the arm in this raised position, and carry it forward, the shoulder-blade becomes so separated from the wall of the chest that the hand may often be laid in the fossa which intervenes between it and the bone; this affords a very marked contrast to the position of the scapula of the healthy side, which is closely applied to the chest when the arm is so placed. Should both sides be simultaneously paralyzed, this same position of the arms produces a hollow between the scapulæ, in which the rhomboid muscles of either side distinctly project as muscular cords.

There are other symptoms of this affection, which are strongly diagnostic, although the previous points render an error in diagnosis improbable: among these may be mentioned an inability to cross the arm in front of the chest; impairment of the power of resistance to forcible retraction of the shoulder; and a difficulty in delivering a forward blow with the affected arm. As has been mentioned in previous pages, the serratus muscle only affects inspiration when the scapula is made a fixed point by means of the upper extremity; it can be, therefore, understood that no effects upon ordinary respiration are noticed in this type of paralysis.

The *dorsal muscles* are sometimes affected with paralysis, either of a partial or complete character; and thus the movement, the power of fixation, and the ability to maintain an upright position of that portion of the spine may be affected. In youth, various degrees of weakness of the dorsal muscles are observed which are confined to the distinct regions of the spine or which may be distributed to its entire length, and these may be either unilateral or bilateral. It is thus that *spinal curvatures* are sometimes produced; and the exciting cause may be traced to some injury, rheumatic affection, or some form of local inflammatory disease. There are various degrees of these paretic conditions, leading to manifold varieties in the amount and extent of the ensuing deformity, and in the ability of the patient to rectify the deformity by a voluntary effort. The condition where the spinal curve is increased in a backward direction (paralytic kyphosis) is usually most marked in the dorsal region, and presents a most diagnostic deformity; while, if the muscles be paralyzed on one side only, all grades of lateral curvature (paralytic scoliosis) are liable to be developed.

In some cases of the paretic condition, the dorsal muscles of the neck are simultaneously affected with those of the dorsal or lumbar regions. If such a condition be present, the head can no longer be carried erect and tends to sink forward, as soon as fatigue of the muscles takes place; the patient can still raise it by a peculiar swinging motion, and may then be able to retain it, by using the muscles of the anterior region, in a position where the head is inclined backward and the chin elevated. This latter position and the means by which the head is brought to assume the attitude are both highly diagnostic.

CLINICAL POINTS AFFORDED BY THE DORSAL NERVES.

The nerves which arise from the dorsal region of the spinal cord may afford the physician essential aid in diagnosis.

While it will not be possible to give all the information upon so important a subject in a small volume like the present one, the following points taken from the author's more extensive treatise[1] on that special department of anatomy may prove of value as a general résumé of the symptoms afforded by the nerves of this region.

"The distribution of the dorsal nerves to the *costal layer of the pleura* is a fact of great physiological interest. Hilton draws an analogy between the pleura and a synovial membrane of a joint; and the intercostal muscles are also compared by him to those moving a joint. Thus this author adduces further proof of his general law of nerve-distribution, since the skin of the chest, the intercostal muscles, and the pleura are supplied from the same source. In pursuing this same line of reasoning (and the analogy is not a strained one from a physiological stand-point), the abdominal muscles might also be included among the list of muscles which move the ribs; and the nerve-supply to them also would thereby be explained by this same axiom, viz., that the nerves which supply a joint supply the muscles which move it and the skin over the insertions to those muscles.

"It should be recollected that some of the filaments derived from the upper intercostal nerves *cross the axillary space* and supply the integument of the arm. The 'nerve of Wrisberg' is perhaps the most important of these branches. It may thus be understood why the pain of pleuritic inflammation may be carried to and felt in the region of the axilla and inner arm, and why distinct points of tenderness to pressure may sometimes be detected in these regions when the disease is confined to the trunk.

"From the suggestions thrown out as to the physiological importance of nerve distribution, and from the fact that the pleura is supplied from the same nerve sources as the respiratory muscles and the integument of the chest, abdomen, and inner arm, some important clinical lessons may be drawn. Patients, suffering from pleurisy, suffer a pain in the costal muscles which compels restricted movement of the ribs, and which limits the respiratory function largely to the diaphragm. Now,

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[1] The Applied Anatomy of the Nervous System. N. Y., 1881.

these painful cramps and stitches are independent of the pain arising alone from the inflamed pleural surface, and the diminution of the respiratory movement is due to a partially contractured state of the muscles of the chest, as is demonstrated by the fact that patients cannot draw a long breath if asked to do so. Hence, we may reasonably conclude that Nature has so distributed the nerves to the pleura as to enable that serous membrane to control the muscles which create movement of the adjacent costal surfaces, and thus to insure its quietude during the stages of inflammation or of repair. It is wisely suggested by Hilton, in this connection, that we learn a lesson in the treatment of such cases from Nature herself, viz., 'never to allow a patient, suffering from pleurisy or pneumonia, to talk except in monosyllables, so as to avoid a full inspiration.'

"The diagnostic value of pain is well exemplified in the region of the thorax. Persistent pains *high up between the shoulders* are strongly indicative of diseases of the heart, aneurism of the arch of the aorta, stricture of the œsophagus, and anything which would tend to create pressure within the posterior mediastinum.[1] If we meet with persistent pain in the space *lying between the middle of the scapula and the lumbar region of the spine,* we may have good ground to suspect the existence of some disease of the abdominal digestive viscera, the pain being carried to the surface probably by means of the splanchnic nerves.[2] It is not uncommon for disease confined to the transverse colon to manifest itself in the form of persistent pain in the lower intercostal region.

"The frequent occurrence of cancer in the mammary region renders its detection one of importance in its early stages, while, in the later stages, the pleura and the glands of the axilla and mediastina may be secondarily affected with cancer tubercles. Now, in these conditions, the presence of pain in the back, between the shoulders, in the side of the chest, or down the inner side of the arm, may possibly afford invaluable aid in diagnosis.

"The distribution of the *sixth* and *seventh intercostal nerves* to the skin over the *pit of the stomach* may be a useful fact to remember in making a diagnosis of the cause of pain in that region, since, by tracing the course of these two nerves from before backward, and observing the healthy or unhealthy condition of the structures near to which the nerves would pass—as the pleura, ribs, œsophagus, aorta, etc.—we may at last reach the spine as the seat of the disease which is producing pain in a region far remote from the cause to which it is really due. It is by no

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[1] John Hilton, op. cit.

[2] The great splanchnic nerve is connected above with the fourth, fifth, and sixth dorsal nerves, and below with the solar plexus and thence with the stomach, duodenum, liver, pancreas, and intestines. It seems probable, therefore, that the pain experienced in the region of the scapula, by patients afflicted with disease of the digestive organs, is referable in some way to the greater splanchnic nerve.

means uncommon for spinal affections of the mid-dorsal region to manifest themselves by a pain which is distressing, and referred to the pit of the stomach; and such an origin is rendered still more probable if present on both sides of the median line, since symmetrical pains are especially characteristic of central origin. Should such a pain exist, and a marked relief ensue when the patient is in a recumbent posture, the probability of spinal origin is still more distinctly suggested.

"It has been stated that pains which are confined to one side of the body are usually indicative of an exciting cause which is confined to the same side, rather than of diseased conditions of the central nerve ganglia. It is therefore customary, with those most familiar with the steps necessary to reach a scientific diagnosis, to search for some cause upon the same side of the body, in case a pain exists which is not symmetrically developed upon both sides. I have known the diagnosis of aneurism within the thorax to be discovered by a pain, which was one-sided, and which was the only symptom which the patient was conscious of, where the existence of the tumor would probably have gone on undetected but for this valuable guide. A constant pain in the back is one of the most positive signs of aneurism of the cœliac axis, and I question if the diagnosis of aneurism of the aorta in any part of its course should ever be made unless this symptom can be detected.

"Pain in the region of the *pectoral muscle* may indicate some cause referred either to the *third* or *fourth cervical* or the *first dorsal nerves;* hence we must look in two different localities for the exciting lesion. The distribution of the cervical nerves to the fascia covering the anterior portion of the chest is not sufficiently well recognized by the profession at large, and doubtless many cases have been a source of anxiety to the physician which could have been easily explained, had this point been impressed upon them.

"The distribution of the *lower intercostal nerves* to the integument covering the upper part of the *muscles of the abdomen* may be useful in diagnosis, since pain in this region of the abdomen may be created by pressure of fluid in the pleural cavities, and by other lesions situated above the line of the diaphragm. Is it not probable, therefore, that many cases of this character have misled the medical attendant who has referred the symptom of abdominal pain to organs within the cavity of the abdomen when the exciting cause was to be sought for within the chest or in the course of the lower intercostal nerves? Certainly, successful treatment depends upon accuracy in diagnosis; and the application of the laws of nerve distribution to fine discriminations in the appreciation of symptoms is a guide whose value and utility is not generally known.

"When we have our attention called by a patient to a pain, no matter where its situation may chance to be, we are positive that it can be traced to the nerves supplying the part. Here, then, we have a direct guide to follow which will usually lead us, if we are anatomists, to the source of the pain. As an example of this, and they are too numerous to mention in detail, there is one symptom in spinal disease which stands out prominently, and I might say solicits our proper appreciation of it, and that is a fixed and local pain upon the surface of the body, with or without exacerbations, and often without any local increase of temperature at the seat of the disease. I feel quite certain that through the medium of this one symptom alone, if properly employed, morbid conditions of the spine may be often diagnosed long before any palpable deformity exists, and a cure often effected by simple rest.

"It is in connection with the nerves of the dorsal region that pain is a more valuable guide than in almost any other portion of the body. The subjacent viscera, occupying the thoracic and abdominal cavities, are constantly manifesting diseased conditions by pain of a superficial character, through the intimate communications which exist between the splanchnic and dorsal nerves, at spots often far removed from the exciting cause. It is natural that the medical attendant, unless his attention has been directed to this fact, will attribute the pain to some fanciful cause in the locality of that pain, or to some general diagnosis of neuralgia, malaria, etc., when an anatomical knowledge might direct him aright both in diagnosis and treatment. We know that liver disease may be occasionally manifested by a pain in the region of the right shoulder, that gastric and intestinal disorders frequently produce a constant pain in the back between the scapulæ, and that tumors of the viscera may produce like results by pressure upon the splanchnic nerves or the solar plexus of which they form a part. Without such a knowledge and its satisfactory explanation, would we be apt to refer such pain to causes so remote? Would we look for causes of abdominal pain in the region of the thorax, without the knowledge that the lower intercostal nerves supplied the abdominal muscles? The lessons taught by anatomy are of a most practical character, and worthy of the study even of those old in the practice of physic. If a patient complains of pain on the surface of the body, it must be expressed by the nerve which resides there; there is no other structure that can express it, and somewhere in its course of distribution, between its peripheral filaments and its central point of origin from the encephalon or the spinal cord, the precise cause of this pain expressed upon the surface must be situated.

Intercostal Neuralgia.—"Those forms of neuralgia which have their seat in the nerves which arise from the dorsal region of the spinal cord are grouped under the term 'dorso-intercostal' neuralgia. The exact seat of the pain varies not only with the special nerve affected, but also with the branch of the nerve which seems to manifest the most irritation. Thus, if the upper two nerves are involved, the pain may extend to the arm as well as the trunk; if the posterior branches of the dorsal nerves be alone involved, the pain will be perceived in the back and loins; and, finally, if the anterior branches be alone the seat of pain, it will be conned to the intercostal spaces and the anterior region of the chest. It is rare to find the anterior and posterior branches of any dorsal nerve simultaneously affected with neuralgia. The anterior branches are usually the ones which suffer, and the pain assumes a type which is properly called 'intercostal.'

"Intercostal neuralgia is more common in women than in men, and chiefly affects weak, hysterical, and anæmic subjects. It appears often in those who are convalescing from some severe type of disease. The causes to which this form of neuralgia can be traced include exposure to cold or dampness, anatomical changes in the nerves themselves, diseases of some of the adjoining organs (especially in connection with phthisis), embarrassment to the venous return of the affected region, dilatation of the venous plexuses of the interior of the vertebral canal, aortic aneurisms (which lead to absorption of the vertebræ or ribs), all possible diseases of the vertebræ themselves and also of the ribs, diseases of the spinal cord, and malarial affections.

"This form of neuralgia is most common upon the left side, and Henle has attributed this clinical fact to the arrangement of the intercostal veins of the left side which relatively tends to impede the return of blood upon the left in contrast to the right side. From the extensive list of causes which have been given—and many of the subdivisions of each have been omitted—it can be readily understood that, to make an accurate diagnosis as to the etiology of intercostal neuralgia, is never possible without a most thorough physical examination of the subjacent organs, the bones of the thorax, and the conditions of the soft tissues.

"The symptoms of this disease are generally confined to the anterior and lateral walls of the trunk, more rarely to the back and the loins. The area of the pain indicates the nerves affected, which is often a point of great value in searching for the cause. While the pain is of a burning, dull, and persistent character for the greater part, yet it is characterized by paroxysms of tearing and lancinating pains which follow the course of the nerves affected with a remarkable precision. The violence of these paroxysms may be very great, so as to cause syncope. All respiratory motions, such as sneezing, coughing, blowing the nose, etc., increase the pain, and the skin is sensitive to the slightest pressure; even the weight of the bedclothes distressing the patient, although firm pressure may sometimes afford relief. While the paroxysm is active, the patients sit with the body inclined toward the affected side, and their faces indicate the most extreme anxiety. They neither dare to speak loudly nor to take a deep inspiration, on account of the pain induced by such efforts.

"In intercostal neuralgia, as in most other forms, there are certain points which are particularly sensitive to pressure, and are of great aid in confirming the diagnosis. These points comprise, first, one near to the vertebral column (*vertebral point*), where the nerve emerges from the inter-vertebral foramen; secondly, one at about the middle of the entire course of the nerve, corresponding to a line dropped from the centre of the axillary space (*lateral point*), where the lateral branch emerges beneath the integument; and, thirdly, one in front, near to the sternal border (*anterior* or *sternal point*), where the anterior perforating branch emerges beneath the skin.

"For some unknown reason, the intercostal nerves, when inflamed, are particularly liable to be associated with the appearance of that form of skin disease called 'herpes zoster.' This may or may not be accompanied by neuralgic symptoms, but is a valuable sign of a neuritis of the nerve supplying the region affected.

"The diagnosis of intercostal neuralgia can often be made only with extreme difficulty. That rheumatic affection of the muscles of the chest, commonly called 'pleurodynia,' is often confounded with it, and the diagnosis is to be made chiefly by the presence of the localized points of tenderness mentioned, and the rapid disappearance of all symptoms in the course of a few days, which is seldom observed in true intercostal neuralgia. Pleurisy is to be differentiated by its physical symptoms from this disease; and angina pectoris is to be told by the phenomena presented by the heart and pulse, as well as by the sense of impending death, threatened suffocation, intense anxiety, and the fact that the pain frequently shoots down the left arm.

"*Neuralgia of the Mammary Gland* (*Mastodynia*).—The skin over the mammary gland is supplied by the anterior and lateral branches of the second, third, fourth, fifth, and sixth intercostal nerves, and by some filaments derived from the supra-clavicular nerves, while the glandular structure itself is supplied by the lateral perforating branches of the fourth, fifth, and sixth intercostal nerves. This region is especially liable to an extreme form of neuralgia, first described by Sir Astley Cooper under the name of 'irritable breast.' So intense is the pain in some cases of this affection that it is compared to the sensation of cutting, tearing, or stabbing the part with a knife. It is usually paroxysmal in character, and generally of short duration, although such attacks may last for some hours.

"This affection seems to be associated with pregnancy, anæmia, chlorosis, hysteria, and the development of neuromata upon the nerves of this region. It may be persistent and remain for years, and is particularly obstinate to treatment.

"The detection of painful points is to be looked for in the region of the escape of the nerves, which supply the part, from the inter-vertebral foramina; and, in some instances, the existence of similar points may be detected upon the breast, near the nipple, and upon the sides of the gland. The attacks are particularly liable to exacerbate during the menstrual periods, and, during the height of the paroxysm, the pain may be transmitted by other nerves into the neck, down the arm, and over more extended areas upon the chest and back.

"*Paralysis of the Dorsal Nerves.*—The dorsal muscles control, to a great extent, the movements, fixation, and upright position of the vertebral column, but these conditions require such a complexity of muscular action that it is often difficult, in case of paralysis, to exactly decide as to the muscles which are affected. Various degrees of weakness of the dorsal muscles are often present in youth, sometimes on one side and sometimes on the other, and occasionally affecting the whole back to a greater or less extent.

"These paretic states are dependent upon rheumatic affections, diseases or injuries to the vertebral column, disturbances of the motor regions of the cerebrum, lesions of the various ganglia of the encephalon, and lesions of the kinesodic system of the spinal cord. In paraplegia, the motor paralysis often extends upward to the muscles of the trunk; while, in progressive muscular atrophy, the muscles of the dorsal region are not infrequently involved.

"If the muscles of both sides of the back be paralyzed, the spinal column gradually tends to assume the condition of a posterior curvature (paralytic kyphosis), and the deformity is usually most marked in the dorsal region, as the lumbar and cervical regions exhibit it to a less degree on account of their anatomical peculiarities. If the extensor muscles of the back be extensively affected, the spinal column forms an equable curve, as if the body were bent forward as in old age, and the patient becomes unable to voluntarily straighten the trunk to its normal posture. When passive straightening is attempted, the spine is easily brought into its proper curve, and this is a point of diagnosis between paralytic kyphosis and the deformity dependent upon structural disease of the vertebræ or a state of muscular contracture.

"The muscles most frequently affected are the sacro-lumbalis and the latissimus dorsi. If they be paralyzed upon one side only, the deformity assumes the type of scoliosis, as a lateral curvature is produced by the muscles of the unaffected side. In this case, as in the one before cited the patient is unable to rectify the deformity by any voluntary muscular effort, although the spinal curve can be easily removed by simple extension.

"When the extensor muscles of the lumbar region are markedly impaired, the attitude assumed by the patient is very characteristic. It consists of a bending of the upper portion of the trunk in a backward direction, so as to compensate for the bending forward of the lumbar vertebræ; this bending of the thorax backward brings the upper part of the body behind the centre of gravity of the whole body, and the balance is preserved exclusively by the action of the muscles of the abdomen. When the body is brought too far forward, it sinks and falls, as the lumbar muscles fail to support it in an erect posture. The patient cannot then bring the trunk into its former posture without the use of the hands, which are employed in a sort of climbing process, the hands being placed upon the legs; a series of peculiar movements of the shoulders and trunk then follow, which are employed to assist the arms in tossing the trunk backward to an extent sufficient to allow the abdominal muscles once more to support it. This difficulty in bringing the trunk above the level of the lower limbs is typical of this condition, but there are still other additional points of diagnostic value. The lumbar region presents a deep hollow, the head is bent forward in standing or walking, and the trunk may be seen to have a remarkable oscillating movement when the patient walks. When the patient sits down, the upper portion of the body seems to sink, and the spine presents a condition of kyphosis. In fact, it seems hardly possible that the condition can be mistaken by one well versed in anatomy."

CHAPTER V.

THE PELVIC BONES.

THE PELVIS.

THIS portion of the trunk is called "the pelvis" from its resemblance to a basin, as the derivation of the word implies (πέλυξ—a bowl). We thus find it spoken of by older English works by the name of "the basin," while the French commonly apply the term "le bassin" to this part. It serves as a connecting link between the spinal column and the femur of either side, and its construction is such (as will be shown later on) as to afford the greatest sustaining strength in a vertical direction, as well as to afford a large expanse of surface to support the viscera of the abdomen. It would naturally be supposed that this portion of the frame of bipeds would differ markedly from that of the quadruped, since, in the latter class of animals, the pelvis has little if anything to do in supporting the weight of the abdominal viscera, while much of the weight of the trunk is supported by the upper extremities, thus decreasing the weight borne by the pelvis. This supposition is borne out by comparative anatomy, and no part of the skeleton shows a more wonderful adaptation to the functions which it is destined to perform than the bony pelvis of the human race. If we saw off the wings of the ilia, leaving the spinal column and femurs attached to the pelvic bones, a fact is disclosed which is either unknown or imperfectly appreciated by the majority of anatomical students, viz., that the ossa innominata and the sacrum form a *most wonderfully constructed arch,* which rests upon the head of either femur, at its lower portion, as its columns of support, and which is completed by a key-stone, the sacrum, at its upper part. So perfectly constructed is this arch that it would be next to impossible for a force applied to the lower extremities to seriously disarrange it, as the bones are so dovetailed as to render it a piece of perfect workmanship, while the joints between the component parts afford a certain degree of elasticity which further increases its strength, and which prevents a transmission of shocks to the regions above the arch which are supported by it. It is the presence of this arch which compels the pelvis to be placed at an *oblique angle* to that of the spinal column, since the bones composing it must be placed directly underneath each other so as to have the greatest strength—an arrangement which will be seen to exist when the pelvic bones have been properly sawn, as described above, but which is otherwise not so apparent, since the projecting wings of the ilia tend to hide it.

In addition to the function of the pelvic bones as a sustaining arch for the portions of the body above the level of the sacrum, it has other equally important functions to perform, which require special modifications of these bones. In order to support the viscera of the abdomen, thus forming a bony wall at the dependent part of the truuk, the ilia are expanded into prominent wings, and thus a great strain is taken from the soft tissues which form the anterior and posterior wall of the abdomen, which would otherwise be compelled to sustain the weight of these organs. The expansion of these bones also affords a certain additional leverage for

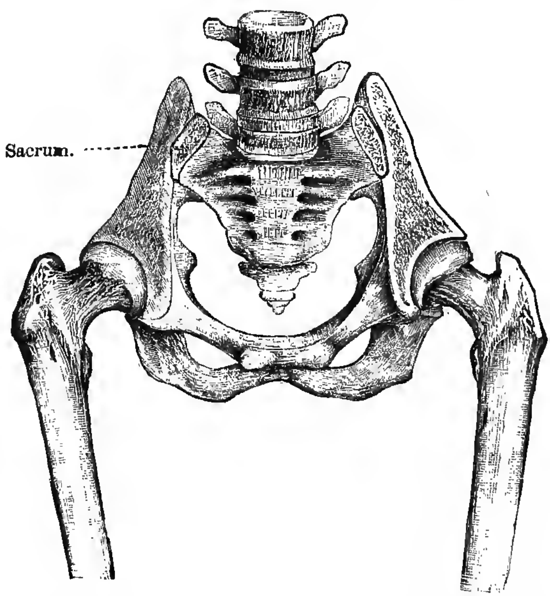

FIG. 141.—The arch of the pelvis. The wings of the ilia have been sawn through, in order to show the direct support of the body upon the femur of either side. (After Holden.)

the muscles which are attached to them, thus assisting them in their respective actions; and also in providing room for the attachment of the successive layers of muscles of the abdomen and the thighs.

The pelvis is so constructed that its centre of motion upon the head of the femur (the acetabulum) is nearly in the middle of a line drawn from the tip of the tuberosity of the ischium to the highest part of the crest of the ilium; it is thus capable of becoming a lever of the first order (where the fulcrum is in the middle and the power and resistance at either end) in all of those movements where the trunk is bent upon the thighs, as in the act of stooping, since the weight of the body is thus the resistance to be overcome, the fulcrum or movable point is in the acetabulum, while the power comprises the ham-string muscles which are attached to the tuberosity of the ischium.

Before considering the points of interest presented by the separate bones which form the pelvis, it may be of advantage to review such practical points, pertaining to the pelvis as a whole, as will enable us to more thoroughly appreciate the special points which will come up during the description of the os innominatum, the sacrum, and the coccyx. It will therefore be necessary to call the attention of the reader: 1. To the mechanism of the arch of the pelvis and the points of its construction; 2. To the obliquity of the pelvis to the spinal column; 3. To the respective axes of the pelvis; 4. To the diameters of its two outlets; 5. To the differences which may be observed between the pelvis of the male and female; 6. To its foramina.

1. The arch formed by the pelvic bones has already been alluded to in a previous page, but its construction has not been given in detail. It is more properly a ring than an arch, since the bones which form its sides the ossa innominata) are also joined at the lower portion, while they are

Fig. 142.—The lateral view of the interior of the pelvis, showing the sacro-sciatic ligaments and foramina. (After Byford.)

separated by a key-stone (the sacrum) at the upper portion. Thus the femur of either side really articulates with a ring of bone interposed between it and the vertebral column above, which is so strongly constructed as to be incapable of being crushed except by the most extreme violence, and whose component parts cannot well be dislocated. As an evidence of the marvellous strength of this bony ring, Holden records a case where a wagon containing over five tons burden passed over the pelvis without producing a fracture, which could never have occurred were it not for this arrangement of the bones. The key-stone of this arch or ring, the sacrum, by its shape, is a mechanical wedge to force the parts into close apposition, since it constantly supports the superincumbent weight of the head, trunk, and upper extremities, and is driven downward, and at the same time backward, since it is set obliquely to the lumbar vertebræ.

Now when this bone is examined more in detail, it will be perceived that the bone is so *bevelled* as to prevent it from being dislocated from the ossa innominata in a backward direction; while the ossa innominata are *lipped* over the front of the sacrum so as to prevent it from becoming displaced in a forward direction. The dovetailing of the articular surfaces of the sacrum with that of the os innominatum of the two sides is an additional precaution against the possibility of the key-stone of the arch becoming displaced by any form of external violence. It will be noticed, also, that the ring or arch of the pelvis is so directed as to bring the line of pressure of the weight of the trunk in a plane perpendicular to the heads of the thigh-bones, and that this is no accidental arrangement is proven by the additional fact that the cavity of the acetabulum is made thicker at the point of bearing of the femur in the erect attitude than elsewhere, so as to strengthen the line of pressure which passes through the axis of this arch.

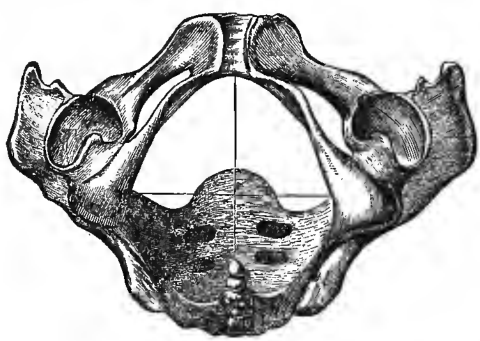

FIG. 143.—The pelvic outlet, showing the diameters of the same. (After Byford.)

In addition to this pelvic ring of bone which supports the weight of the trunk in the erect or standing posture, there are two lateral arches, one upon each side of the pelvis, designed to support. the same weight during the sitting posture. Each of these arches runs from the pubes, in front, to the ilium, behind; and the summit of each is the tuberosity of the ischium. The effect of the three joints in the main pelvic ring, viz., the symphysis pubis and the sacro-iliac joint of either side, in breaking the force of any shock transmitted from the bones of the lower extremity, has been already mentioned, but can be repeated to advantage, since the object of such joints is not alone for the purpose of allowing of movement of the pelvic bones during parturition.

2. If we trace the *line of gravity* of the trunk downward, we will perceive that it passes through the *centre of the acetabulum*, and thus directly through the heads of the thigh bones; while the obliquity of the sacrum to the spinal column is so great that it forms almost a right angle with the axis of gravity. In the standing position, the tip of the coccyx is thus placed about half of an inch higher than the symphysis pubis.

3. The axis of the pelvis to the line of gravity of the trunk, or to a perpendicular passing through the centre of the acetabulum, is about 140° in the male, and 144° in the female. It can thus be understood that the *axis of the superior plane* of the pelvis is not directed perpendicularly, but is inclined forward, as well as upward, so that, if drawn through the exact centre of the plane of the superior opening of the pelvis, a line would extend from the *second bone of the coccyx to the umbilicus.* The *axis of the outlet* would begin at the *promontory of the sacrum,* and pass through the *middle point between the tuberosities of the ischia;* while the axis of the curve of the pelvic cavity, the curve of Carus, corresponds closely to that of the inner surfaces of the sacrum and coccyx.

4. The *superior* and *inferior openings* of the pelvis are of special importance to the obstetrician, since they are subject to great variations in their measurements as the result of congenital abnormalities, or acquired defects following rickets, malacosteon, anchylosis of some of the

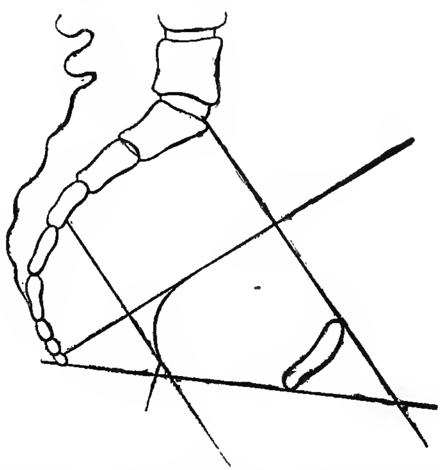

FIG. 144.—Axes of superior and inferior straits, and pelvic cavity. (After Byford.)

joints, or abnormal growths affecting the bones. The superior strait (the name applied to the upper opening of the true pelvis) differs somewhat in its measurements when the soft tissues are present from those of the bony pelvis, but a great diversity of opinion exists among different authors as to the normal diameters; and the same statement holds good in reference to the inferior strait, since the coccyx is more movable in some periods of life than in others, and since the pubic angle is not always the same, even in the female sex. It would hardly be of sufficient importance to enter into the statements of the more prominent authors upon this subject, since the variations are not so wide between them as to cause any serious discrepancy; and a general rule may be given which will be approximately accurate and which will be much more easy to retain in the memory than if the diameters be given in varying fractions of an inch. This rule may be stated as follows: "The diameters of the superior and inferior openings of the female pelvis are the same, if it be remembered that the superior strait is the longest in its transverse diameter, and the inferior strait in its antero-posterior diameter; these diameters are four inches for the shortest, four and a half inches for the oblique, and five inches for the longest diameter of either opening."[1]

It will thus be seen that the diameters of each opening form a sequence with a variable quantity of one-half of an inch, and that the oblique diameter of each opening is the same, viz., four and a half inches. The change in the diameters also shows that the longest diameter of the superior opening, the transverse, becomes twisted, as it were, into the

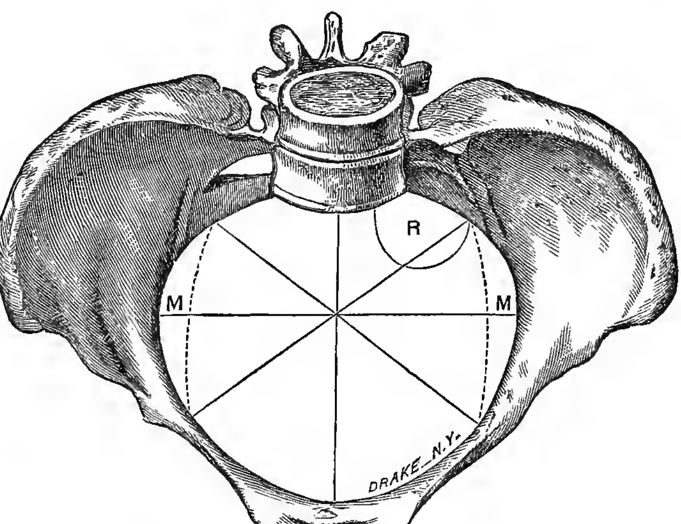

Fig. 145.—Intended to show the alteration in the length of the transverse and diagonal measurement of the pelvic cavity by the rectum and muscles at the brim. R, the rectum; M, M, muscles. (After Byford.)

antero-posterior diameter of the inferior opening, thus giving the cavity of the pelvic bones such a gradual change in its measurements as to partly assist in the rotation of the head of the child in its passage through the space between the two openings, the inlet and the outlet. There are other elements which tend to produce this important movement of rotation of the head of the matured fœtus, without which no child could ever be born, which will be considered in subsequent pages when different parts of the os innominatum are considered, but this change in the diameters of the two straits of the pelvis is an important one, in explaining the

[1] As given by Prof. T. G. Thomas in his course of lectures on Obstetrics in 1870.

inclination of the lateral planes of that bony cavity, whose importance in the mechanism of the act of labor is now taught by every lecturer on obstetrics.

5. The pelvis of the male differs from that of the female in many respects, which are evidences of design on the part of Nature and which are so marked as to enable the anatomist to discriminate between the two. These points of difference may be thus stated:

a. The bones of the female pelvis are *much lighter* than those of the male, and the *muscular prominences* are much less marked, thus giving them a smoothness which the male pelvis does not present. It can be easily understood why such a difference should naturally exist, since the absence of prominent ridges of bone, where the muscles are attached, favors the act of parturition; while the muscular structures of the female are called into action less frequently than those of the male, and the weight of the parts moved is proportionally less, thus demanding smaller muscles and less roughening of the bones at the points of their attachment.

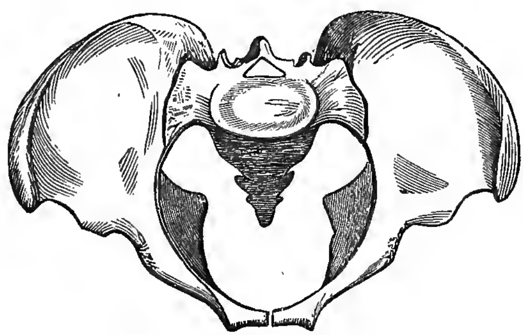

Fig. 146.—Male pelvis seen from above.

b. The *wings of the ilia are more widely separated,* causing the marked increase in the width of the hips of the woman over that of the male, and the whole pelvis is broader from side to side, while the spines of the ilia are more widely separated.

c. The *inlet* to the pelvis is *much larger* in the female than in the male, and is more nearly *circular in shape,* on account of the diminished prominence of the sacro-vertebral angle. This provision assists in an easy engagement of the fœtal head in the first stage of labor; and a serious impediment to labor is occasionally produced by a projection forward of the sacro-vertebral angle, thus causing an alteration in the shape of the pelvic inlet.

d. The *cavity* of the female pelvis is *very shallow* and is *more capacious* than that of a male; both of which tend to render the passage of a fœtus more easy than if deep or narrow. The *spines of the ischia* do not project into the cavity as in the male, since an obstruction to labor would then exist; and the obturator foramen is larger in the male pelvis, since the female needs a bony wall to assist in directing the fœtal head during its rotation within the cavity of the pelvis.

e. The *outlet* is *more expanded,* since the pubic angle is greater in the female than in the male, and is more dilatable, because the coccyx becomes anchylosed late in the female, and admits of movement during labor which greatly increases the size of the lower pelvic aperture. The *edges of the pubic arch are everted* in the female pelvis, in order to prevent injury to the soft parts during the expulsive efforts of the second stage of labor; while the *tuberosities of the ischia* are very *widely separated,* thus increasing the lateral diameter of the bony outlet.

6. The *foramina of the pelvis* are of importance, both from a purely anatomical point of view, since they allow of the exit and entrance of structures which perform important functions, and also from a practical stand-point, as they may become the seat of hernial protrusions and the means of escape of abnormal collections of pus within the pelvic cavity. They comprise the greater and lesser sacro-sciatic,[1] and the obturator foramina of either side, the latter of which is, however, partially closed by the obturator membrane. With the exception of the obturator, these foramina each transmit a muscle, which thus escapes from within the pelvic cavity in order to act upon the femur, while other important structures are also afforded a means of egress, in case they are to supply parts external to the pelvis, or of ingress, in case their region of distribution be the perinæum. Now, as all the large blood-vessels and nerves which are destined to supply the different regions of the lower extremity escape from one of these three foramina upon either side, the relation of each of these foramina to the surrounding parts and the structures which are transmitted by each becomes of great interest not only to the surgeon but also the physician, since in many ways the relation of the main nerve-trunks and the important blood-vessels can be utilized in diagnosis. The parts which pass through the foramina of the pelvis can be stated as follows:

Through the *great sacro-sciatic* foramen.	The gluteal vessels. The superior gluteal nerve. The pyriformis muscle. The pudic vessels and nerve. The sciatic vessels and nerve. The nerve to the obturator internus muscle.

[1] These are not foramina, properly speaking, in the os innominatum, since the greater and lesser sacro-sciatic ligaments help to convert simple notches in the bone into complete foramina.

Through the *lesser sacro-sciatic* foramen.	The obturator internus muscles. The pudic vessels (re-entering). The pudic nerve (re-entering).
Through the *obturator* foramen.	The obturator vessels. The obturator nerve.

It will be perceived, on looking at the tables given above, that the pudic vessels and nerve escape from the pelvic cavity by the greater sacro-sciatic foramen, and immediately re-enter it by means of the lesser sacro-sciatic foramen, having thus passed external to the *spine of the ischium* which separates these two foramina. This peculiarity, of course, naturally suggests some necessity for so marked a deviation from the rule which Nature usually adopts, viz., to send the nerve-filaments and the blood-vessels in the most direct route to their destination, unless the function of the part so supplied is thereby imperilled; and, as no branches are given off, either by the nerve or the artery during its passage between the points of exit from and entrance to the pelvic cavity, the spine of the ischium, around which the nerve and vessels wind, seems to be designated as a point to be especially avoided in its relation to the interior of the pelvis.

Starting with this guide, afforded by Nature, as to the importance of this bony prominence, we would naturally expect to find it directly concerned in some function which would be liable to cause serious injury to either a blood-vessel or a nerve, if placed in relation with its internal aspect; and we find the explanation, at once, in the important function which this bony point has upon the complete performance of the second stage of labor. During the passage of the fœtal head through the maternal pelvis, this point in that bony canal is severely impinged upon; and it is claimed by many authors on obstetrics that this point marks one of the most important agents in producing the rotation of the head of the child which is essential to its delivery. Now, if this be the case, it at once becomes evident, should the pudic vessels and nerve pass along the inner surface of this bony prominence instead of on the outer side of it, that the compression exerted by the head of the child during the second stage of labor would so affect these parts as to cause serious impairment of their function; and it would thus be possible for terrible hemorrhage to occur if the artery should chance to be lacerated; for gangrene of the perinæum to result, if the artery be so long compressed as to shut off the nutrition to the parts supplied by that artery; for paralysis of the perinæum (whose functions in the female are almost vital to the life of the patient, since its destruction makes existence a constant burden), if the pudic nerve should be destroyed; and for severe neuralgic seizures in that region if the nerve be injured but not destroyed.

I can conceive, therefore, of no greater proof of the wisdom of our construction than this simple device exhibits, since untold ills to the sex which bear the cherished names of Mother, Wife, and Daughter, would be inevitably entailed, were such a provision against danger wanting.

The femoral opening, which lies below Poupart's ligament, is not properly a foramen of the pelvis. It will be found discussed in all its practical and anatomical aspects in those pages which treat of the anterior wall of the abdominal cavity.

The pelvis may be divided into a *true* and a *false pelvis;* the former including that portion which invests the bony canal or cavity of the pelvis and which is situated below the pectineal line; while the latter includes the expanded wings of the ilia, and thus presents an incomplete bony investment, since its anterior wall is deficient between the two anterior superior spines of the ilia, while a similar opening exists between the postero-superior spines of the ilia. Certain portions of the true pelvis, viz., its brim or inlet, its cavity, and its lower opening or outlet, have already been described, but it yet remains to give the measurements of the different walls of the true pelvis.

The *anterior wall* is extremely short, being but one and a half to two inches in depth, and consists of the body of the pubes. It is made extremely short in comparison with the depth of the lateral or posterior wall, since the occiput of the fœtal head is forced to rotate underneath this arch during the second stage of labor and there to act as a point of motion during the subsequent delivery of the head through the inferior opening of the pelvis (the completing part of the second stage of labor).

The *lateral wall* of the true pelvis is somewhat broken by the sacro-sciatic foramina, but it measures about three and a half inches in depth.

The *posterior wall* of the true pelvis, if measured along the inner surface of the concavity of the sacrum, differs in its length in the two sexes, since, as before stated, the sacrum of the male is longer, narrower, and more curved than that of the female. It is customary, therefore, to find this portion of the pelvis about five and a half inches in depth in the male and about four and a half inches in the female. The necessity of an alteration in the female pelvis from the type of the male in this region is shown by the fact that it would be impossible for the male pelvis to perform the requirements of child-bearing on account of the curve of the sacrum which would offer a mechanical obstruction to the movement of rotation within the cavity of the pelvis, while it would also so diminish the size of the pelvic outlet as to markedly interfere with the mechanism of the escape of the fœtus; hence the type of pelvis resembling that which would be normal in the male, becomes, when met with in the female, a cause of surgical interference in case of impregnation having taken place.

Having now considered the pelvis as a whole, we are better prepared to consider the separate bones which enter into its formation, and to study the construction of each, so far as points of practical utility are afforded, or the special objects which are attained by the deviations from the type of the lower animals, go to prove the wisdom of the Creator.

THE OS INNOMINATUM.

This bone, the chief one composing the pelvis, since it and its fellow form all of the pelvic ring, with the exception of the key-stone to the arch, the sacrum, still goes as the bone "without a name," although the separate parts which compose it are specially designated. The three parts which compose it are called the "*ilium*," the "*ischium*," and the "*pubes*;" and they are entirely separate bones during the years of childhood, although they become united, in adult life, into one bone. The first piece mentioned (the ilium) is so called because it supports the flank (ilia); the second, because it supports the trunk while in the sitting posture, since its derivation implies "the buttock;" while the third is named from the fact that hair appears on that region. It is a curious fact that these three portions of the os innominatum should enter into the construction of its main cavity, *the acetabulum*,[1] with which the femur articulates, and which has, therefore, to support the entire weight of the trunk and the upper extremity, when the subject stands erect.

The *ilium* is situated above the line of the "true pelvis." It is so constructed as to form a broad expanse of bone surface for the support of the viscera of the abdomen, while it is also intended to give a powerful leverage to the muscles which are attached to it. This latter function is particularly important in the case of those muscles which tend to balance the pelvis upon the head of the femur. The attachment of the glutei muscles is made doubly strong by the presence of roughened lines upon the exterior surface of the bone, since these muscles are essential to the biped in order to maintain the erect posture of the trunk upon the extremities; hence the contrast in the attitude of a horse taught to stand upon his hind legs from that of man or monkey, in which the extensor muscles are more powerfully developed.

The fossa which exists in the internal surface of the ilium, the "*iliac fossa*," is one of the distinguishing characteristics of the human skeleton. It is intended as a support to the viscera of the abdomen, which are constantly tending toward displacement downward from their weight alone. When this fossa is turned to the light it will be perceived that a remarkable thinness of the bone exists at the bottom of this fossa, which would, at first, seem as a refutation of this theory as to its function; but, when the bone is placed in its proper relations to the surrounding parts, it will at once become evident that the thin portion of the bone is outside of the line of gravity and does not therefore have to sustain weight, and

[1] So-called from its *resemblance to a wine-cup*. The ilium forms about two-fifths of it, the ischium about two-fifths, and the pubes, the remaining one-fifth.

hence Nature dispenses with unnecessary bone-tissue at this point in order to save all weight, for the muscles to act upon, which is not absolutely required.

Another fossa is formed by this portion of the os innominatum which is called the "*gluteal fossa*," and which is situated upon its exterior surface. It is intended to afford additional room for the lodgment of the glutei muscles which are very extensively developed in man, for reasons previously given. The presence of the iliac and gluteal fossæ gives to the ilium, when viewed from above, a *convexity outward* in its anterior part, and a *concavity inward* in its posterior part, thus causing it to assume a curve similar to an elongated letter S.

The *anterior border* of the ilium presents two bony prominences called the anterior-superior and the anterior-inferior spines, for the attachment of muscles of the thigh; and beneath the latter, a deep groove or notch, around which the iliacus muscle and the accompanying psoas muscle pass to be inserted into the femur. Still lower down the ilium joins the pubes, thus forming the so-called pectineal eminence which is of interest from the fact that the femoral artery passes over it to reach the thigh, and against which it can be compressed, in case of hemorrhage from an opening below that point.

On the *posterior border* of the ilium, similar bony prominences exist, called the posterior-superior and the posterior-inferior spines, which serve for the attachment of ligaments; while below them, the notch of the ischium, which assists to form the great sacro-sciatic foramen, may be perceived, through which many important structures pass, as mentioned on page 262. As we pass downward from this point, we meet the spine of the ischium, separating the greater sacro-sciatic from the lesser sacro-sciatic notch, the latter of which is also transformed by a ligament into a complete foramen, for the transmission of important parts.

The articular surfaces of the os innominatum pertain to the ilium and the pubes. The ilium joins the sacrum posteriorly, and thus assists to complete the arch of the pelvis, while the pubes joins with its fellow in front, to form the "symphysis pubis." The sacro-iliac joint is wonderfully constructed to prevent any possible displacement of the bones which form it, since the integrity and strength of the pelvic arch, upon which so much depends, is thus insured. This fact is clinically illustrated as well as by the anatomical construction of the joint itself, since, while an inflammation of the sacro-iliac synchondrosis is one of the most uncommon of accidents, and one which requires the most extreme form of violence to create it, I have never seen nor do I know of a well authenticated case where these bones have suffered a dislocation. This joint is provided with a layer of interposed cartilage, shaped somewhat like a human ear, which acts as a buffer to break the force of any shock transmitted to the joint; while the bevelling of the sacrum prevents it from being forced away from the ilia in a backward direction, and a lipping of the ilia over the sacrum in front prevents it from being forced out of place into the cavity of the pelvis.[1] Besides these mechanical safeguards against displacement, the ligaments of the joint are so strong that, as before said, the most extreme violence is required to create sufficient stretching of them as to induce inflammatory action within the joint, setting entirely aside the possibility of displacement. I once met with a case where a lad fell from a high fence, while his feet were firmly wedged between the iron spikes projecting from the top, in which the sacro-iliac joint was so strained as to produce disease of that articulation, but the violence was so severe as to create amazement that the limbs were not torn from their attachment to the ossa innominata.[2]

The ISCHIUM is that portion of the os innominatum upon which the trunk is supported while the subject is in the sitting posture. As mentioned in a previous page, the prominent portion, or tuberosity of the ischium, is supported upon two projections of bone which form a lateral arch upon the side of the pelvis; so that the weight of the trunk is borne, while the subject is sitting, upon two lateral arches, whose curve is directed downward, and which are capped by the tuberosities of the ischia upon either side. The object of such an arrangement is evidently to distribute the weight more evenly over the entire pelvis.

The ischium is marked posteriorly by the *two notches* which assist to form the greater and lesser sacro-sciatic foramina, and also by the spine of the ischium, which separates these notches and which is of great importance to the obstetrician. The special points of interest which pertain to these three localities have already been referred to in those pages descriptive of the pelvis in general, and need not be again repeated. It is of importance, however, in this connection to call attention to the ligaments which convert the notches of the ischium into complete foramina, the *sacro-ischiatic ligaments,* since they serve other important functions as follows:

1. They contribute to the fixation of the sacrum as the key-stone of the pelvic arch, by their great strength and inelasticity.

2. They afford a larger surface for the attachment of the gluteus maximus muscle, which contributes chiefly to form the buttock, than the os innominatum could itself afford.

3. They assist in forming the floor of the pelvic cavity, and thus help to sustain the weight of the pelvic organs without adding much to the weight of the pelvis.

4. They convert the notches of the ischium into complete foramina for the transmission and protection of those structures which are forced to escape from or enter the pelvic cavity in the gluteal region.

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[1] For a full description of the construction of this pelvic arch, see page 256.

[2] For the differential diagnosis between sacro-iliac disease and disease of the hip-joint, the author would respectfully refer the reader to his work on Surgical Diagnosis. New York, 1880.

The *ramus of the ischium*, by joining with the ramus of the pubes, helps to complete the anterior portion of the lateral arch, upon which the tuberosity of the ischium is placed; while it also assists to form the obturator foramen, which allows of and favors movement of the fœtal head within the cavity of the pelvis during labor, since it is covered with a membrane which naturally yields more than would a solid wall of bone. In addition to this object, Nature has also lightened the weight of the pelvis by providing this opening, while the membrane which covers it in the recent subject affords an equally effective attachment for muscles.

The *spine of the ischium* affords attachment to the lesser sacro-ischiatic ligament, the gemellus superior muscle, the coccygeus, and a part of the levator ani. It should not be forgotten that the internal pudic artery, vein, and nerve pass over this bony prominence, since they thus manage to avoid the possibility of pressure during parturition;[1] and, in very thin subjects, it might be possible to compress the pudic artery against this portion of the ischium, should hemorrhage occur, of a serious character, from wounds of the perinæum, or during the operation of lithotomy.

The *tuberosity of the ischium* has already been mentioned as presenting a mechanical arrangement, in reference to its attachment to the other portions of the os innominatum, which admirably fits it to act as the chief point of support of the trunk during the act of sitting; but its other functions which have as yet been omitted, are possibly of even greater importance in controlling the various attitudes which the trunk is called upon to assume, in its relations to the thighs. Since it is the most dependent portion of the human pelvis, when the trunk is supported by the lower extremities in the erect attitude, it becomes one end of a lever[2] when the trunk is flexed upon the thigh, as in the act of stooping; the weight of the trunk, head, and upper extremities becoming the resistance, the hip-joint being the fulcrum, and the powerful ham-string muscles which are attached to the tuberosity of the ischium being the power which raises the weight. It can be readily understood, therefore, why the muscular attachments to this prominence of bone are roughened to afford a firm attachment to the pelvis, since they have to control a great weight with a short leverage. The great sacro-ischiatic ligament, whose functions have been already referred to, is also attached to the tuberosity of the ischium; while the pudic vessels and nerve lie about one inch and a half anterior to its inner margin.[3]

The *internal surface of the ischium* is smooth, since it helps to form a portion of the pelvic cavity. It has a gentle slope toward the lower

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[1] See page 263.

[2] This lever is one of the first order, since the *fulcrum is in the middle*, the power at one end, and the weight at the other.

[3] This may be used as one of the surgical landmarks of the pelvis, in determining the situation of the pudic vessel in the living subject.

opening of the pelvis, and it is this portion of the os innominatum which is the chief cause of the rotation of the fœtal head during its passage through the cavity of the pelvis. It is this rotation that constantly tends to bring the long axis of the head of the child in relation with the longest axis of the maternal pelvis, after its engagement at the superior opening.[1] From this surface of the ischium, the obturator internus muscle takes a large portion of its origin. The tendon of this muscle passes out of the pelvis by winding around the lesser sciatic notch, to be inserted into the femur, thus using this depression *as a pulley.*

The *external surface of the ischium* assists to form the acetabulum, but, as the ilium and pubes also enter into its formation, this cavity will be considered after the separate bones have been individually described. It gives attachment to muscles which act upon the femur and the leg; but they have no bearing upon the medical anatomy of the trunk, and are, therefore, out of the scope of this volume.

The PUBES is that portion of the os innominatum which helps to form the front of the pelvis. It is usually divided into a body and two branches, called "rami," one of which lies horizontally,[2] and connects the body to the ilium; while the other descends to join the ramus of the ischium and thus completes the inferior boundary of the obturator foramen. The ramus which connects the body of the pubes with the ilium—the so-called "horizontal ramus"—assists to form a part of the true pelvis, and also the upper boundary of the obturator foramen, while the so-called "descending ramus" leaves a gradually increasing space between it and its fellow of the opposite side, the "arch of the pubes."

It has been already stated that the *arch of the pubes* differs in its angle in the two sexes, since more room is required between the rami of the pubes in the female than in the male, in order to facilitate the delivery of the head of the fœtus. It will also be observed that the edges of this portion of the pubes are sloped outward to excess in the female, —another evidence of the adaptability of the sexes to the functions for which they were designed. We can also see, in this region, the grooves which are provided for the attachment of the crura of the penis in the male pelvis, and for the crura of clitoris in the female pelvis.

The *body of the pubes* is of great interest to the anatomist, and also to the surgeon, since it assists to form the joint in front of the pelvis, called the "symphysis pubis," while it is also the region where hernia most frequently develops, and, therefore, one of special surgical importance. In the construction of the symphysis, every precaution has

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[1] See page 263.

[2] The terms "horizontal ramus" and "descending ramus" are only correct when the pelvis is held so that the plane of the superior strait is horizontal. During life, when the pelvis is very oblique, the terms are absurdly incorrect, since they *might be reversed* with an approach to accuracy.

been taken to insure strength and elasticity. The bones have not been placed in direct apposition, but a plate of cartilage some three-eighths of an inch in thickness has been interposed as a buffer against shocks transmitted from below by the thigh-bones. This arrangement is strongly analogous to the separation of the vertebræ by means of the intervertebral disks, and is one of the devices found in every joint which is exposed to the liability of excessive strain, or severe shocks. We see also that the symphysis is provided with strong ligaments which are arranged in front, behind, below, and above the bones of either side.

Upon the body of the pubes is a small prominence of bone which is called the *spine of the pubes,* on account of its pointed shape. This little bony prominence is one of the most important surgical guides in the human body, since it acts as a point of attachment for Poupart's ligament. It is not in accordance with the plan previously adopted, to discuss here the subject of hernial protrusions of the inguinal and femoral regions, since they will be found to be fully discussed in the chapter upon the anterior wall of the abdomen; but it can be stated in this connection, that the ligament of Poupart is the great dividing line between the inguinal canal and the femoral opening, and that since it is attached to the spine of the pubes, that bony prominence becomes a most valuable guide in determining the character of all hernial protrusions in the immediate neighborhood of Poupart's ligament.

The muscles which are attached to the body or the rami of the pubes are inserted into the thigh-bone, and are of interest chiefly in their relation to the movements of the hip-joint, and to their effect upon fracture of the femur. They do not properly belong to those regions of the body which possess special interest of a purely medical character; and the surgical points, to be readily understood, would require more space than the limits of this work will allow of.

The SACRUM forms the key-stone to the pelvic arch, and supports the weight of the trunk, head, and upper extremities. It also completes the cavity of the pelvis, since its interior surface forms the posterior boundary of that space. It will be seen, on viewing the spinal column laterally, that the sacrum forms a rounded angle with the last lumbar vertebra, thus giving rise to the so called "promontory of the sacrum." The object of this angle is evidently a double one, since it increases the capacity of the cavity of the pelvis, and also serves to assist in breaking all shocks transmitted from the pelvis to the spinal column.

The *triangular form* of the bone renders it admirably adapted for its use as a key-stone to an arch, since it prevents its displacement downward between the ossa innominata, while its sides are so bevelled as to render its displacement in a backward direction impossible. It is also held still more securely in place by a lip derived from the ilium of either side, which laps over it anteriorly.

The *bone is curved* and not straight; otherwise we would be un-

unable to sit, on account of a projecting bone similar to a tail seen in animals, but lacking its flexibility. It is composed of five vertebræ so amalgamated as to form one bone, although the evidences of most of the constituent parts of a vertebra are to be discerned upon its surfaces.

This bone is pierced for its whole length by the *sacral canal,* which is a continuation of the canal of the spinal column and which affords protection to the sacral nerves, which subsequently form the sacral plexus after their escape from it. It is also provided with *five anterior* and *five posterior foramina* upon either side, which afford exit for the sacral nerves and which are so placed as to allow a pencil of small size to be passed through both the anterior and its corresponding posterior foramina in the skeleton; hence it might be possible, during life, for a small pointed instrument to be plunged into the pelvic cavity through the sacral region, and thus inflict a most serious wound.[1]

The sacral canal is *not completely invested with bone* for its entire length, since the spinous processes and a part of the laminæ of the last two sacral vertebræ are often deficient, thus leaving the posterior part of the canal open. This anatomical fact is used by some authors to explain the serious spinal symptoms which occur in connection with bed-sores, since it is certainly not impossible for the putrid secretions of such local sores to enter the spinal canal and set up inflammation of the spinal cord or its coverings.

The joint between the sacrum and the ilium of either side is often called "the *sacro-iliac symphysis,*" in contradistinction to the pubic symphysis. This point is one of the most secure of the body, since every mechanical device has been employed by Nature to so dovetail the bones as to prevent dislocation. It is occasionally so wrenched by accidents of the most extreme character, as to excite an inflammatory process, to which the term "sacro-iliac disease" is applied, and which affords many symptoms in common with a similar condition of the hip-joint.

The articulation of the sacrum with the last lumbar vertebra is so constructed as to admit of a slight amount of rotation, since the articular processes of the sacrum are directed backward and inward, and are made concave. They are also set very wide apart, so as to afford as broad a base as possible upon which the spinal column could rest.

CLINICAL POINTS PERTAINING TO THE REGION OF THE PELVIS.

We have now considered the peculiarities of the construction of the pelvic arch, the variations which exist in the sexes, the diameters and axes of the different portions of the pelvis, the functions which this portion of the human skeleton is designed to perform,

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[1] Béclard reports such a case as having been presented to his notice, in which the pelvic organs were transfixed by the penetrating instrument.

and the various points of interest which each of the separate bones of the pelvis present to the anatomist. There still remain, however, the acetabulum and other bony points whose clinical bearings have not been fully shown; and certain medical and surgical landmarks, which pertain to this region and which are of the greatest value to the diagnostician.

The *acetabulum*, so called from its fancied resemblance to a wine-cup, is the socket in which the head of the femur is so articulated as to permit of the various movements of the hip-joint. It is formed by a part of each of the three subdivisions of the os innominatum, the pubes forming the smallest portion; and it is directed downward and outward, in the erect attitude, so as to bring the bearing of the pelvis directly upon the head of the thigh-bone. It will also be noticed that the part formed by the ilium, which is at its uppermost part, is thickened in excess over the other parts of the cavity, since, in the erect attitude, this portion is subjected to the greatest strain, as it supports the weight of the entire trunk, the head, and the upper extremity. That this is an arrangement specially provided for the biped, is proven by comparing the pelvis of the quadruped with that of man. The margin of this cavity is not a continuous ring of bone, since a notch exists in its lower part, the *cotyloid notch*, for the transmission of blood-vessels and nerves to the interior of the joint; but this incompleteness of the bony margin is unimportant, from a mechanical point of view, as no strain comes upon that part of the circumference, and as the notch is converted into a foramen by a ligament which supplies the absence of bone.[1] The acetabulum appears deep in the skeleton, but it is made still deeper, in the recent subject, by a ring of fibro-cartilage which surrounds its margin, the cotyloid ligament, whose function is to embrace the head of the femur more closely than the bony cavity could possibly do,[2] while it also deepens it, and thus renders the articulating surface increased.

When we look into the bottom of the acetabulum, in the recent state, we will perceive that it is everywhere incrusted by cartilage except at the lower part; and, at that portion, an irregular excavation exists. This excavation is for the purpose of allowing free movement of the ligamentum teres within the cavity of the joint, and it is partly filled also by fat, and fringe-like projections of the synovial membrane. The most internal part of the cavity, when the person stands erect, is extremely thin, and is almost translucent in the skeleton; hence it is that severe concussions, transmitted to the pelvis by means of the lower extremities, are liable to

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[1] The transverse ligament of the hip-joint.

[2] The *cotyloid ligament* of the hip-joint acts as a "sucker" upon the head of the femur and thus tends to prevent displacement of that bone. So perfect is the construction of this joint, that, when all the muscles and also the capsular ligament have been severed, atmospheric pressure will still support the weight of the entire lower extremity, unless the acetabulum be perforated from within the pelvis, when it will immediately drop.

be followed by symptoms of injury to the pelvic organs, as the bladder, rectum, vagina, uterus, urethra, etc., as this portion of the acetabulum may be fractured.

The *anterior superior spine of the ilium* is an important point in the detection of disease of the iliac bone or of the sacro-iliac joint. In case a fracture of the os innominatum is suspected to exist, pressure over this bony prominence upon the two sides of the pelvis will often enable the physician to detect the presence of crepitus, while mobility of the fragments can be sometimes perceived. In a similar way, pressure made over this point upon the two sides, will enable the physician to control the movement within the sacro-iliac joint, in case disease of that articulation is suspected, since the os innominatum of the affected side is thus rendered immovable and no longer allows motion at the hip-joint to create movement in the sacro-iliac articulation. This bony point is one of the greatest importance in the discrimination between the conditions of morbus coxarius and sacro-iliac disease, since movement of the hip may create pain referable to the gluteal region in either case, while concussion on the end of the femur of the affected side will also create pain referable to the same region in both diseases. Now, if the ossa innominata be rendered immovable by pressure made upon the anterior superior spines of the ilia, no pain will be experienced in hip-joint disease, since the force is not perceived by the inflamed surfaces of the affected joint; while, on the other hand, the same pressure will cause the inflamed surfaces of the sacro-iliac articulation to be approximated and thus increase the pain, if any exists, or produce it, if previously absent. Should, however, the pressure be so applied to the pelvis as to separate the inflamed surfaces of the sacro-iliac joint, while, at the same time, the os innominatum of the side corresponding to the affected joint be prevented from participation in the movements at the hip-joint, movement of the thigh upon the pelvis will no longer create pain; a point of the most positive kind in the diagnosis of this diseased condition.

It is customary with surgeons, in examining the lower limb for suspected fracture, to measure between the anterior superior spine of the ilium and the internal malleolus, and thus to detect the *presence* or *absence of shortening* by comparing the measurement so obtained with that of the corresponding limb, and the same steps are, or should be, taken by careful practitioners in case of recovery from a fracture of the lower extremity, in order to properly record and appreciate the results of treatment. Now it is a fact, to which almost every surgeon of experience will attest, that it is the rarest of coincidences to find any three or four men agree in the measurements of a leg, even when made in each other's presence and at the same time, and this is to be attributed, not to the carelessness of the observers or the desire on the part of any one present to increase or diminish the existing deformity, but to a lack of method in properly performing this very simple procedure. If we are to expect perfect accuracy in such measurements, we must insure two important factors: first, that the points to which the measurements refer are absolutely the same, and, secondly, that the two points are immovable. We can effect both of these if we will use the following rule:—Use a tape which is inelastic, and so crowd the finger tips *underneath the bony prominences* as to render it impossible for either end of the tape to move upward; if the tape is tightly drawn between the fingers in this position, error is impossible.

The *anterior superior spine of the ilium* is also used as a point of measurement in the detection of displacement of the head of the femur from the acetabulum. The so-called "Nélaton's guide" which is employed for this purpose is thus applied: A line is first drawn from the anterior superior spine of the ilium to the most prominent portion of the tuberosity of the ischium. This line should pass through the centre of the cavity of the acetabulum, if properly drawn, and should also cross the top of the trochanter of the femur, in the living subject, provided the thigh be semi-flexed and slightly adducted;[1] so that all of the trochanter which projects behind or above that line indicates the extent of the displacement due to dislocation or fracture.

The drawing of such a line as suggested by Nélaton is not always easy in a fat subject where the bony prominences are often detected with some difficulty; hence it is customary with surgeons to use their hands as a means of estimating the relative distance of the trochanter from the anterior superior spine of the ilium by placing the thumbs upon that latter point and feeling with the fingers for the edge of the trochanter. Thus Winslow says, in his work upon the structure of the human body, "*Feel* whether the injured member answers to the sound."

The *spine of the pubes* is often used as a guide to determine whether the trochanter of the femur is normal in its relation to the pelvis, since that bony prominence lies on the same level as the top of the trochanter, in the erect attitude. This prominence of the pubes is the most reliable guide to the external abdominal ring, and it is therefore often appealed to as a means of discrimination between femoral and inguinal hernia, the spine lying to the outside of the sac of inguinal hernia, and to the inner side of the sac of the femoral variety. It is sometimes difficult to feel the spine of the pubes through the subcutaneous fat of the abdominal wall, but this difficulty can be most readily overcome by slipping the finger up along the upper portion of the scrotum or labium, when the subcutaneous fat is forced away from the pubes and its spine distinctly felt. The subject of hernia will, however be fully discussed in the chapter upon the wall of the abdomen.

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[1] The rule given as to the application of Nélaton's test has been modified by the author, since he has found that the test, as originally described by its originator, does not hold good unless the thigh be in a state of *semi-flexion and slight adduction*.

Below the line of Poupart's ligament, a *fold in the groin* may be perceived when the thigh of a recent subject is flexed upon the abdomen. This fold is one of importance, since it lies directly over the hip-joint; and it is often used by surgeons as a guide in inserting the knife in amputation of the leg at the hip-joint, since if the knife be inserted at one end of this furrow and brought out at the other end, the *capsule of the hip-joint* is almost of necessity opened, a point of the greatest importance in performing this operation with rapidity and ease. Furthermore, if the hip-joint become the seat of effusion, as occurs in the first stages of morbus coxarius, this furrow is usually obliterated; hence the value of this fold in the diagnosis of diseases of the joint underneath it. If we press firmly at a point just below this furrow, we can detect the presence or absence of tenderness in the hip-joint; a diagnostic sign often of the commencement of inflammatory action.

When we examine the *gluteal region* of the living subject, we can detect the following bony landmarks: 1, the posterior superior spines of the ilium; 2, the spines of the sacrum; 3, the tuberosities of the ischia; 4, the apex of the coccyx, situated in a deep furrow leading toward the anus.

The *posterior superior spine of the ilium* is a guide to the sacro-iliac joint, since it lies on a level with the middle of that articulation; and it is at this point that direct pressure, when the patient is lying upon the abdomen, reveals disease of this joint, as the inflamed surfaces are thus brought into closer apposition, and pain is therefore produced. It is opposite this point also that the bifurcation of the common iliac artery takes place within the pelvis, while the internal and external iliac arteries naturally arise from the same point.

The *third spine of the sacrum* denotes the lowest level to which the cerebro-spinal fluid, whose function has been mentioned in a previous portion of this work, descends; hence it would be an impossibility for a spina bifida to appear below this level, even if the spinous processes of the sacrum were congenitally absent throughout its whole length.

The *tuberosities of the ischia* can be felt through the gluteus maximus muscle which covers that bony prominence upon either side. Nature has considerately protected these supports of the trunk, in the sitting posture, by a large collection of fat, and a bursa which is placed between this deposit of fat and the bone: hence the weight is distributed through a cushion of fluid, fat, muscle, and skin. It is considered as indicative of health when this portion of the body is firm and rounded in form, when the subject is in the standing posture, since, in the infirm, the soft tissues of this region tend to become loose and flaccid, while wasting of this region is a frequent accompaniment of disease of the hip-joint. So important is the comparison of the so-called *"fold of the nates"* of the two sides, when the presence of morbus coxarius is suspected, that it is considered as one of the most valuable guides in the detection of that disease, since its direction and character is often greatly altered.[1] This fold is also a guide to the situation of the *great sciatic nerve*, which we can reach by pressing deeply between the tuberosity of the ischium and the great trochanter of the femur. This situation of the nerve protects it from injury, while it also tends to explain why the sitting posture is liable to produce a sense of numbness in the leg and foot, if the trunk be long inclined toward one side, as it frequently becomes pressed upon.

The *apex of the coccyx* forms the posterior boundary of the perineal space, while the tuberosities of the ischia, the sacro-ischiatic ligaments, and the rami of the pubes and ischia help to complete its boundaries. The coccyx is liable to displacement, in occasional instances, so as to impinge upon the rectum. Its mobility and late anchylosis to the sacrum has already been mentioned as peculiar to the female, since it is thus enabled to modify the size of the inferior opening of the pelvis. In some rare instances, the coccyx becomes the seat of a neuralgic affection, and subcutaneous division of the muscles attached to it becomes demanded in order to prevent its motion.

In connection with the region of the buttock, there are two important vessels whose course is admirably defined by certain bony points which have been discussed in the previous page; these are the gluteal and the pudic arteries. These vessels, especially the latter, have to supply parts with blood which are of the utmost importance in the construction of the body: probably no region is of greater importance, from an anatomical, physiological, and surgical stand-point, than the perinæum of the male or female. It is important to every physician, therefore, that he be acquainted with the surgical guides to these vessels, in case any type of injury called either for compression or ligation of them.

The *gluteal artery* escapes from the pelvis by the great sacro-sciatic foramen in company with its nerve. Its point of escape may be designated upon the surface of the hip by drawing a line from the *posterior superior spine* of the ilium to the *trochanter* of the femur, after the foot has been rotated inward; the artery lies at the junction of the *upper* and *middle thirds of this line*.

The *ischiatic artery* also escapes from the cavity of the pelvis by the same foramen as the gluteal, and can be found, at its point of escape, about one-half of an inch lower down than the gluteal artery; hence the same line will answer as a guide for both of these vessels.

The *pudic artery* and its nerve, as previously mentioned, escape from

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[1] The diagnosis of morbus coxarius, and a careful and accurate discrimination between it and the many other conditions which closely simulate it in its various stages, is of the utmost importance before treatment be attempted. The author would refer his reader to his work on Surgical Diagnosis, where all the points of contrast and the latest means of diagnosis of hip-joint disease are given in full detail.

the greater sacro-sciatic foramen and enter at the lesser sacro-sciatic foramen, thus passing over the exterior surface of the spine of the ischium, upon which it may be compressed in a thin subject. The guide to it consists of a line drawn from the *posterior superior spine* of the ilium to the *outer side of the tuberosity* of the ischium, since the point of junction of its *middle* and *lower thirds* lies directly over this vessel. It may also be remembered with profit that the ischiatic artery lies in close relation to the pudic at its escape from the pelvis, but nearer to the middle line of the hip.

Now, the situation of these vessels has more than a purely surgical importance. When we sit upon a hard and unyielding support, the weight of the superincumbent parts is borne by the bony prominence of the ischium, and all pressure is, therefore, taken from the lateral portions of the gluteal region; but, when we sit upon cushioned chairs, the soft tissues become pressed upon, and the arteries, veins, and nerves of the gluteal region are forced to bear a compression which may result in the development of disease. It is stated by Holden that the compression of these vessels tends to create congestion of the pelvic organs and the development of hemorrhoids and uterine disorders, while the same author makes use of the following statement: "A celebrated accoucheur used to say that the fashion of high waists, tight lacing, and easy chairs brought him many thousands a year."

CHAPTER VI.

THE ABDOMEN, ITS VISCERA, AND SURGICAL GUIDES.

In previous chapters of this volume, we have discussed the bones which assist to form the cavities of the thorax, abdomen, and pelvis, and we are now prepared to consider the organs of the two last cavities, as well as such points of practical value as are suggested by their relations to each other, or to the soft tissues which help to complete the walls of the abdomen and the floor of the pelvis. Many hints have already been thrown out, when the bones of the vertebral column and of the pelvis were under consideration, relating to the organs of the abdomen, which will bear repetition here; but a careful study of the external contour of the abdominal walls is required in order to fully grasp all of the guides which are of use to the physician in determing abnormalities of the organs beneath them. There are elements of difficulty in the examination of the abdominal cavity for abnormalities of its contained organs which are not present in similar efforts made in reference to the lungs and heart, or the contents of the mediastina. These difficulties have been very clearly stated by my colleague, Professor A. L. Loomis in his excellent work on "Physical Diagnosis,"[1] and I cannot do better than to give a résumé from him, as follows:

First. Thoracic diseases involve the examination of only one or two organs; while an abdominal affection may require for its diagnosis an examination of ten or twelve organs.

Second. The action of the thoracic organs is regular and rhythmical, and their contents unvarying; while the action of the abdominal organs is irregular and intermittent, since it may be distended with fluids, air, or solid material, or be entirely empty.

Third. The organs of the abdomen are loosely packed in a cavity whose walls are distensible; this allows of great alterations in the relative situation of any organ to surrounding parts. In addition to this cause of uncertainty, the abdominal organs vary in size during health. The uterus (normally the smallest organ of the abdomen) may in pregnancy become the largest of them all; the spleen alters its size with the vascular engorgement of the alimentary canal; and the bladder is constantly enlarging and decreasing in its size, as the urine accumulates or is voided.

Dr. Bright, one of the pioneers of abdominal investigation as a means of scientific diagnosis, suggested the mapping out of this region of the

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[1] Lessons in Physical Diagnosis. N. Y., 1880.

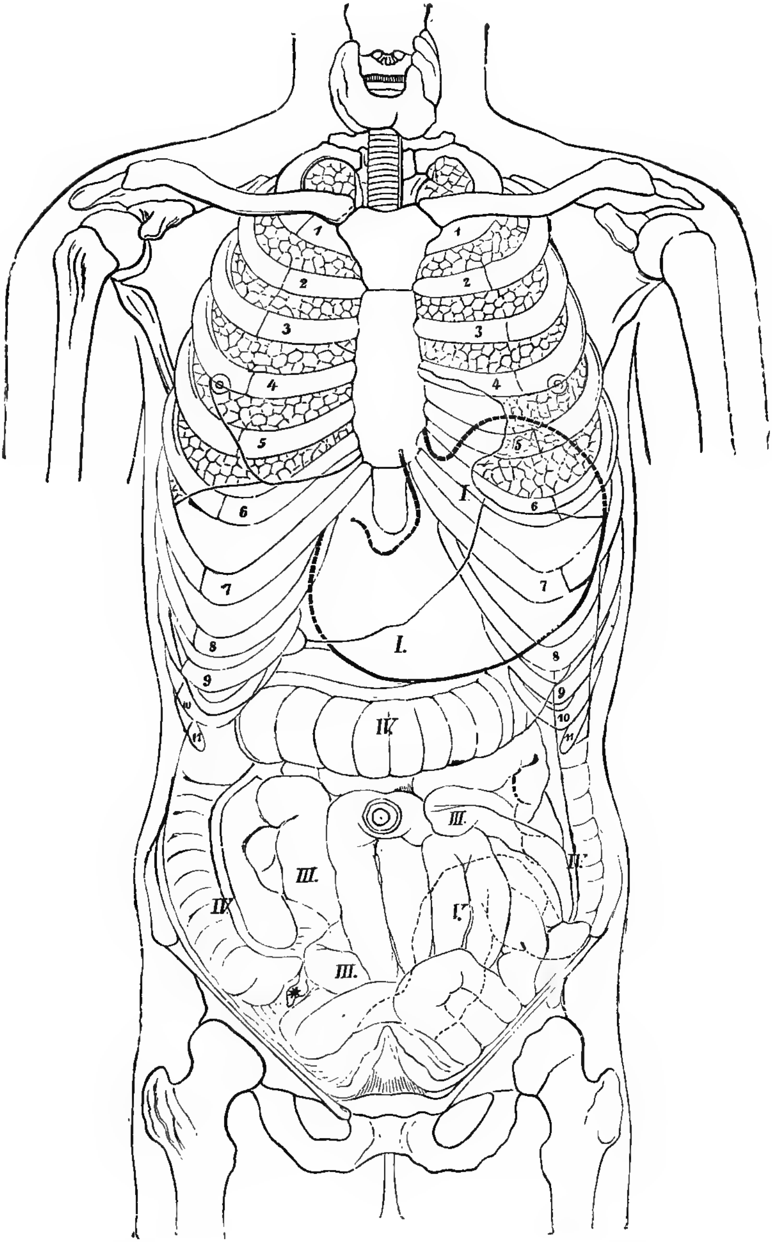

FIG. 147.—View of the abdominal organs from in front. (After Luschka.) The numerals are placed upon the respective ribs. I, The stomach, whose outline is represented darker than those of the surrounding parts; II, Duodenum; III, Ileum; IV, Colon; V, Sigmoid flexure.

trunk into well-defined subdivisions, and a careful study of the content of each in the state of health. These subdivisions are now commonly employed by most of our anatomical teachers, and are essential to the examination of the abdomen for diseased conditions, as they help (by a knowledge of the contents of each) to make our inferences more certain. Dr. Sibson has shown, in his excellent work upon medical anatomy, that the abdominal organs are altered, in their relations to each other, during the acts of inspiration and expiration by the displacement downward during the contraction of the diaphragm, and their return to their former position during its relaxation. While this displacement must of necessity be most marked in the organs which occupy the upper regions of the abdomen—the liver, stomach, and spleen—still the fact further illustrates the difficulties which are encountered by the physician in abdominal examinations.

ANATOMICAL SUBDIVISIONS OF THE ABDOMEN.

By a reference to the cut, showing the lines which mark the abdomen into regions, it will be perceived that the space between the lower ribs and the pelvis—the abdomen—is not of the same height in all of its parts. The notch beneath the xyphoid cartilage of the sternum is formed by the diverging cartilages of the lower ribs, which tend to separate with inspiration and approach each other during expiration, thus causing the abdomen to apparently shorten and lengthen as the ribs move upward and downward.

The EPIGASTRIC ZONE comprises that part of the abdominal cavity which lies above an imaginary line connecting the extremities of the tenth ribs. An imaginary plane passing through the abdominal cavity at this level will intersect the first or second lumbar vertebræ, and the organs contained within it must be situated between the level of such an imaginary plane and the under surface of the diaphragm. The extremity of the tenth rib can usually be felt in the living subject as a distinct projection on its convex border; hence it is a guide easily detected. The diverging lines formed by the free borders of the ribs of either side subdivide this zone into three regions, called the epigastric, and the right and left hypochondriac regions.

The UMBILICAL ZONE includes that portion of the abdominal cavity which extends from the epigastric zone, above, to an imaginary plane passing through the abdomen on a level with a line which shall connect the two anterior-superior spinous processes of the ilia. Such a plane would intersect the second or third sacral spine.

The HYPOGASTRIC ZONE lies below the umbilical, and is bounded upon either side by Poupart's ligament, and, in the middle, by the upper margin of the pubes. As it embraces all of the lower portion of the abdomen, it includes the cavity of the true pelvis and its contained organs. The subdivision of the umbilical and hypogastric zones is marked by two vertical planes which are supposed to pass through lines on either side which shall intersect the spines of the pubes and the points on the tenth ribs previously designated as indicating the lower level of the epigastric zone. The names, *right* and *left lumbar regions,* are applied to these parts of the umbilical zone which lie external to these planes, while the hypogastric zone is subdivided into the middle or *pubic,* and the *right* and *left iliac regions.*

Now a study of the diagrammatic cut previously referred to will enable the reader to appreciate the contents of each of these regions in health; and thus assist him to detect the presence or absence of any abnormality

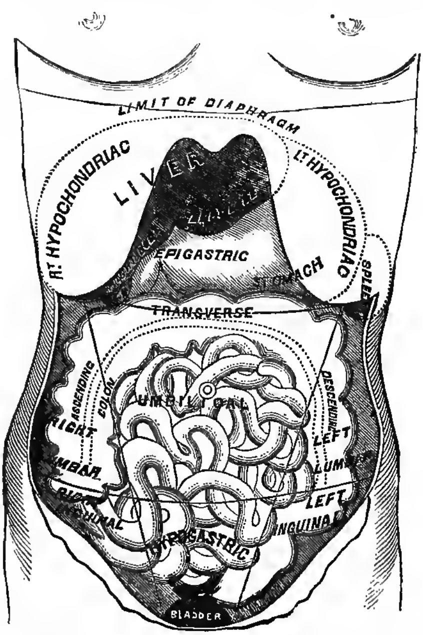

FIG. 148.—A diagram showing the different regions of the abdomen, and the organs contained in each, which are visible on the removal of the abdominal walls. (After Loomis.)

in individual cases, when sufficient dexterity in auscultation, percussion, and palpation has been acquired by practice. The following tables will perhaps further enable the reader to follow this diagrammatic chart, while it may also assist him in memorizing the various contents of the individual localities.

The right hypochondriac region.	The right lobe of the liver. The angle formed by the ascending and transverse colon. The greater portion of the duodenum. The upper part of the right kidney and its supra-renal capsule.

The epigastric region.	Left lobe of the liver. Part of the right lobe of the liver. Gall-bladder. Pyloric orifice of the stomach. The commencement of the duodenum. A portion of the colon The pancreas. The abdominal aorta. The cœliac axis.
The left hypochondriac region.	The cardiac end of the stomach and a very large portion of that organ when in a state of distention. The angle formed by the transverse and descending colon. The spleen. A small portion of the left kidney and its supra-renal capsule.
The umbilical region.	The transverse colon, omentum, and convolutions of the small intestine. The mesentery and its glands. The abdominal aorta. The inferior vena cava.
The right lumbar region.	The cæcum and ascending colon. The lower and middle portions of the right kidney. Some convolutions of the small intestine. A portion of the ureter.
The left lumbar region.	The descending colon. The larger part of the left kidney. The ureter. Some of the small intestine.
The hypogastric region.	The bladder, in children. Portions of both ureters. Convolutions of the small intestine. The uterus and its appendages.
The right iliac region.	The vermiform appendix of the colon. The iliac vessels. Part of the cæcum.
The left iliac region.	The sigmoid flexure of the colon. The iliac vessels.

THE EXTERIOR OF THE ABDOMEN.

Having mastered the contents and boundaries of these different regions, we are prepared to consider the appearance which the abdomen of the healthy subject presents to the eye of the educated physician. When the subject is placed upon the back, with the head and thorax raised and the legs and thighs slightly flexed so as to relieve the muscles of the abdomen of undue tension, we perceive that the shape of the abdomen is oval and that it is marked by elevations and depressions which correspond to the abdominal muscles, the subjacent viscera, and the navel, which sometimes protrudes and again may present a depression.

In children, it is relatively larger to the chest than in adults; while in women, it is usually more rotund and broader in its lower part than in the male sex. Its density is modified by the condition of the abdominal muscles, the pliability of the skin, and the condition of the lungs, since it is rendered most tense during a full inspiratory effort by the displacement of the viscera and the elevation of the lower ribs.

It may be seen to perform movements which are synchronous with respiration; and these are more marked in males than in females, on account of the expansibility of the upper ribs in women, and also from the customs of the two sexes as to dress. Abnormalities of movement may be an indication of disease, as the movements are exaggerated in those conditions which interfere with the full expansion of the lungs—such as pleurisy, pericarditis, pneumonia, emphysema, mediastinal tumors, etc.—while they are, as a rule, markedly diminished in peritonitis, and other diseases of the abdomen which are accompanied by severe pain.

Retraction of the abdomen may indicate extreme emaciation, in which the omental fat has been absorbed for the nutrition of the patient; it often exists markedly in cerebral diseases, especially in the tuberculous meningitis of children. In lead poisoning, the abdominal walls may be rigid and unyielding, resembling a board. A uniform enlargement may accompany ascites, tympanites, and tumors of the ovary of extreme size; while an irregular enlargement may exist in tumors, when hypertrophy of organs is present from the accumulation of gas in some isolated portions of the intestine, from aneurismal enlargements, from hydatids, and other causes.

The superficial veins of the abdomen may present abnormalities which have a clinical value. Their engorgement is often a valuable guide to those diseases which tend to obstruct the return circulation of blood through the liver or the portal vein; hence we may expect to meet with it in connection with the abdominal tumors which press upon that vein, enlargement of lymphatic glands in the transverse fissure of the liver, cancer of the stomach, duodenum, or liver, hepatic abscess, waxy degeneration of that organ, hydatids of the liver, cirrhosis, portal thrombosis, etc. The same condition may exist from obstructed circulation in the inferior vena cava, as a result of regurgitation at the tricuspid orifice, since the portal vessels are thus engorged from interference with the escape of blood into the vena cava.

In those cases where the tricuspid valve is insufficient, and the pulsation of the right ventricle of the heart is transmitted into the venæ cavæ, abdominal pulsation (which may be mistaken for an aneurismal throb), may be detected over the liver in the right hypochondriac and epigastric regions, since the engorged portal and hepatic veins may transmit the pulsations of the heart itself to the tissue of the liver.

In the median line running from the xyphoid cartilage to the pubes is a white line—the linea alba—which marks the point of union of the aponeuroses of the muscles which form the anterior abdominal wall. Its white color indicates the absence of vessels of large size, and this fact, coupled with the fact that it is the thinnest part of the abdominal wall, renders it the seat of election in incisions made for the removal of intra-abdominal growths, or in supra-pubic lithotomy, while it is the point usually selected for tapping the distended bladder and the fluid of ascites.

In the median line may be seen the umbilicus or navel. This point is rather nearer the pubes than the ensiform cartilage, and is placed slightly above the centre of the height of the individual; it usually corresponds to the level of the third lumbar vertebra, although the obesity of any subject may tend to bring it to a lower relative plane. When it becomes necessary to compress the abdominal aorta, the point selected is usually situated about one inch below and a little to the left of the navel, since the aorta is most easily controlled at the fourth lumbar vertebra. Pressure made above the umbilicus would find the aorta farther from the surface of the abdomen and there would also be a danger of compressing structures which might endanger life. In very corpulent subjects, the navel is often crossed by a transverse line or fold of integument, and a similar fold often exists in front of the pubes; in tapping such a subject, it should be remembered that the linea alba is the line of greatest safety.

As we descend along the linea alba from the ensiform cartilage, the following organs lie in contact with the anterior wall of the abdomen: 1. The left lobe of the liver which crosses the line at a distance of two or three fingers' breadth below the xyphoid cartilage; 2. The stomach, which lies in close contact with the abdominal wall below the edge of the liver, when in a state of moderate distention, while, if fully distended, it may occupy the whole space between the lower edge of the liver and the navel; in a state of contraction (when empty), it lies behind the liver upon the pancreas, and may give rise to a hollow—the pit of the stomach—which corresponds to the region filled by it when moderately full; 3. The middle part of the transverse colon (which occupies a space about two or three inches in a vertical direction according to its distention) crosses just above the level of the umbilicus; 4. Finally, below the navel, lie the convolutions of the small intestine, the omentum, and also the bladder, when

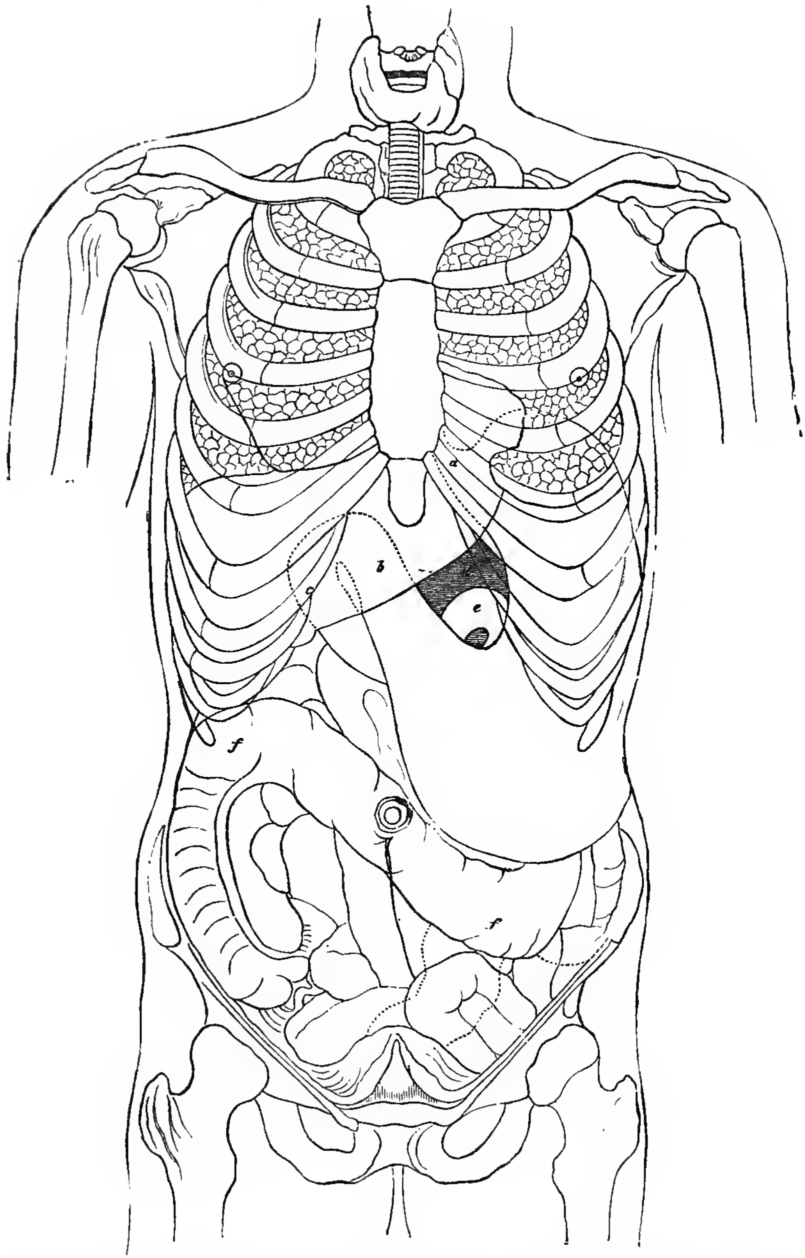

FIG. 149.—A diagram to show the condition of excessive dilatation of the stomach, the intestines having slipped beneath it. (After Penzoldt.) *a*, cardiac end of stomach; *b*, the pylorus; between the two run the greater and lesser curvatures; the former extends at its most inferior part to below the umbilicus; *c*, the enlarged duodenum; *e*, the first convolution of the jejunum; the shading around *d* represents the pancreas; *f*, shows the abnormal course of the colon.

in a state of distention, but not when empty and contracted. It will be perceived that the hollow organs vary in their relative position to the abdominal walls when distended or empty, while, as has been mentioned in preceding pages, the stomach and colon are also affected by the condition of the diaphragm in inspiration and expiration. When any of these organs gain in their weight by hypertrophy, tumors, cancer, etc., an additional source of displacement below their proper level in the cavity of the abdomen is present, since gravity tends to drag them downward during the erect posture.

The close relation of the peritonæum to the linea alba, and in fact to the whole of the anterior wall of the abdomen, gives to all wounds through the abdominal parietes a surgical importance far in excess of the simple danger attached to incisions in other parts. When the bladder is empty, this serous coat of the organs lies in close relation to the whole length of the anterior wall, but, when the bladder is greatly distended with urine, the peritoneum is raised, and thus separated from the linea alba halfway to the umbilicus; this anatomical fact explains why the supra-pubic operation for stone in the bladder can be performed without injury to the peritonæum, and why the distended bladder can be tapped above the pubes without great risk. It is always advisable in performing this latter operation, to insert the needle as close to the upper border of the pubes as possible, and to use the vacuum chamber to assist in withdrawing the urine through the small trocar, as less danger of subsequent infiltration exists, and as the organ can be completely emptied without changing the position of the patient. I have performed this operation daily upon a patient when the introduction of a catheter was impossible, without exciting any inflammatory symptoms. Percussion becomes an indispensable aid in determining whether the bladder is distended, and should always be practised before aspiration is attempted, since the case may be one of suppression of urine rather than of simple retention.

Before we leave the median line of the abdomen, let us review the points which may be gained in this locality by the ordinary means employed in such examinations, viz., inspection, palpation, percussion, and auscultation. The general rules which will be given in this connection apply with equal force to all the other regions of the abdomen, although the organs examined must, of necessity, change with each locality.

Inspection enables us to estimate the size of the abdomen, its respiratory movement, the evenness or unevenness of its surface, the presence or absence of local enlargements, the pliability and color of the skin, the size of the superficial veins, the amount of fat, the presence of abnormal folds or lines on the abdomen, etc., etc.

Palpation should be made with the patient upon the back, with the head and thorax raised and the thighs slightly flexed. It should never be performed with the finger tips, as they tend to excite muscular contraction, but with the palm of the hand, and with a slow, firm, undulating motion. Both hands may be used, and the pressure may be continuous or alternating. In some instances, the erect posture or an attitude where the body is inclined forward, will assist the diagnostician in palpation of this region. Since the most valuable information is gained through palpation and percussion, it is important that the various regions be carefully and thoroughly explored. Mensuration by the graduated tape may assist palpation in determining the relative size of different regions of the abdomen, and the increase or decrease of existing lesions, as a case is watched during its stages of development.

Percussion of the abdomen[1] requires a familiarity with the different notes afforded by the various organs in health, to be of much value in diagnosis; but, when these are once gained, the note affords us most positive evidences of the size and condition of the structures over which percussion is made. The chief notes obtained in the regions of the abdomen are of the *dull, flat,* and *tympanitic* quality. The former is present where the organ is solid, but is either overlapped or in proximity to the intestines which contain air; the second is detected over solid structures which are so separated from the intestine as to yield a note subject to no modification from its contained air—as the central part of the liver, spleen, and kidneys; while the latter is present over the intestines and stomach, since they contain air and have thin walls. Flat percussion will also be present over fluid, as in ascites, except the intestines happen to be displaced by it or float upon its surface; it can thus be found over the distended bladder, the enlarged uterus, fluid ovarian cysts, aneurismal tumors, etc. Some diseased conditions have a characteristic percussion note, but the scope of this work does not admit of a discussion of all the field of physical diagnosis. Of late, some experiments have been made by my friend Dr. McBride,[2] of this city, which seem to point to the extensive employment of wooden stethoscopes, combined with percussion, as a more certain way of deciding as to the exact limits of viscera which are overlapped by intestine, than simple percussion alone; his experiments upon the cadaver seem to prove that the most skilful could not detect delicate shades of distinction with the naked ear which were very distinct when a wooden stethoscope was applied over the seat of percussion or at a spot slightly removed from it.

Auscultation is of value in detecting the fœtal heart, the bruit of aneurismal tumors, the gurgling of imprisoned intestine, and the utero-placental murmur when pregnancy is suspected.

Now, in the median line, we may feel the free edge of the liver midway between the xyphoid cartilage and the umbilicus, and possibly the head

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[1] The reader is referred to the cuts on page 214.

[2] Archives of Medicine, 1880.

of the pancreas, when the patient is emaciated; we may detect the size of the stomach and the situation of the colon and small intestine by percussion; we may discover the distended bladder or the enlarged uterus by three of the methods, viz., sight, touch, and percussion; while hearing may enable us to detect the fœtal heart and the placental bruit. In this region, the abdominal aorta lies in close relation to the spinal column, and hence deeply placed; but we can still often perceive the pulsation of aneurismal tumors and the enlargement of the vessel by palpation; we may be able to map out its exact dimensions by auscultatory percussion; and, finally, the aneurismal bruit may be detected by auscultation, which confirms the diagnosis. Cancer of the stomach may present itself to the touch as a tumor of the median line, and by dragging the organ downward, greatly alter its area of resonant percussion; when the tumor cannot be felt, auscultatory percussion may enable us to detect an abnormal area of deep dulness. The cœliac axis is often the seat of aneurismal disease, when a tumor will be probably detected, by some of the means mentioned, high up near the diaphragm. The head of the pancreas[1] has been mistaken for disease of the transverse colon and for abdominal aneurism involving the aorta.

Upon the exterior of the abdomen, other points may be specially designated as of importance to the physician besides those mentioned in the median line. Prominent among these may be enumerated: 1, certain bony prominences which have been discussed in their clinical relations when the bones of the pelvis were described; 2, the crural arch, or Poupart's ligament; 3, the abdominal rings; 4, the inguinal canal, with its contents; 5, the epigastric artery.

The line which corresponds to the *crural arch* or *Poupart's ligament* is revealed, in most subjects, as a crescentic-like furrow in the skin, at the junction of the thigh and abdomen, its curve being a gentle one, whose convexity looks downward, extending from the anterior spine of the ilium to the spine of the pubes. As the inguinal canal lies immediately above Poupart's ligament, and as the external and internal abdominal rings are but the two openings of this canal, the furrow indicated may serve as a valuable guide to any one of these parts.

The *inguinal canal* connects the two abdominal rings and lies parallel with and immediately above Poupart's ligament. Its most anterior opening—*the external abdominal ring*—is situated immediately above the spine of the pubes; hence the importance of this bony prominence in the diagnosis of hernial protrusions through this opening. It is an oval aperture, whose long axis is directed obliquely downward and inward, and is formed by the two diverging pillars of the ring, the point of meeting of these pillars being concealed by the intercolumnar fascia. Its size varies slightly in different subjects, but the forefinger can generally be intro-

[1] Sir Wm. Jenner, Med. Gaz., 1869.

duced into the normal aperture of the adult. The most direct way of examining this opening for the purpose of determining its size or the presence of hernial protrusions, is to slip the finger tip under the thin skin of the scrotum, and follow up the spermatic cord till the finger perceives the crest of the pubes and the sharp margins of the ring itself. The other opening of the inguinal canal—*the internal abdominal ring*—cannot be felt with the finger unless the inguinal canal is excessively dilated. Its situation may be determined by measuring two-thirds of an inch above Poupart's ligament, at a point midway between the anterior superior spine of the ilium and the symphysis pubis. It will thus be perceived that the name of the opening refers to the portion of the abdomen with which the opening communicates rather than to its relation with the mesial line of the trunk, since the external ring is the most internal.

The length of the inguinal canal in the well-formed adult varies from one and a half inches to two inches, according as we include the openings or not; while in the child, the inner ring is situated almost directly behind the external opening, thus making the canal much shorter and less oblique. The growth of the pelvic bones, which causes a separation of the anterior spines of the ilia, tends to draw the soft tissues outward and thus to affect the internal ring more than the external, since the latter is securely fastened to the pubes.

Within the inguinal canal may be felt the *spermatic cord,* which escapes from the external abdominal ring and supports the testicle, while the *vas deferens,* which is the functional duct of that organ, may be felt in the posterior part of the cord, since it can be distinctly separated from the other component parts. Within this canal, the testicle may become lodged during its descent from the abdomen into the cavity of the scrotum, thus causing a tumor which may be mistaken for a hernia; the intestine and omentum may be protruded; and, finally, the peritoneal fluid may gravitate into it from defective closure of the tunica vaginalis, creating a fluctuating sac.

The *spermatic veins* are sometimes ligated for the relief of varicocele, and it is of great importance that the surgeon become so familiar with the "feel" of the vas deferens as to distinguish between it and the adjacent veins. A patient lately shot and killed a physician who ligated the vas deferens by mistake and thus produced impotency.

The *deep epigastric artery,* which is of special interest from its close relation to the interior surface of the abdominal wall in the immediate neighborhood of the inguinal and femoral canals, may be severed in surgical attempts to relieve strangulation of a hernial protrusion at any of the openings in the vicinity of Poupart's ligament. Its course can be mapped out upon the wall of the abdomen by drawing a line from a point corresponding to the inner border of the internal abdominal ring (whose situation has been already given) to the central portion of the rectus abdominis muscle and thence upward toward the xyphoid cartilage. The rule generally given to students in operating for strangulated hernia of the inguinal region, is to "cut upward and slightly inward."

The *fibres* of the *abdominal muscles* exhibit, to a marked degree, the simplicity of arrangement which Nature always takes to insure against possible accident. If we examine the three abdominal muscles—the external and internal oblique, and the transversalis—we will see that the fibres of each are directed in such a manner as to oppose each of the other two, and thus to render the danger of an aperture occurring by a separation of the muscular fibres extremely small if not impossible. It is, therefore, the most uncommon of accidents to find a hernial protrusion of the contents of the abdomen through its walls, except at some one of the normal openings, unless some previous diseased condition or traumatism has weakened the resisting power of the muscles.

THE ABDOMINAL VISCERA.

The study of the situation and relations of each of the abdominal viscera is essential to the appreciation of diseased conditions. The investigations of Sibson[1] have shown that, when the lungs were artificially inflated, the relations of the viscera in a recent subject became so altered from the state in which they are usually represented in anatomical works, as to make the study of visceral relations one of great difficulty and proportionate interest. He discovered that the organs of the abdomen, like those of the thorax, were constantly changing their situation, due to the combined influences of gravity and diaphragmatic pressure during each inspiratory effort, and that, in some instances, this unceasing activity was an agent in the proper performance of their physiological function. It may, therefore, add to the general interest of this volume to note some of the more important features which each organ of the abdomen presents, and the guides which will be found most reliable in attempting to decide as to the presence or absence of disease. The general steps of a physical examination of this portion of the trunk have been given[2] in previous pages and need not be here repeated.

THE STOMACH.—This organ presents greater variations in size than any of the abdominal viscera, excepting the uterus. It may, when empty, resemble a piece of curved intestine, and in this state its long axis is *nearly vertical* (a fact not generally recognized). When fully distended, its long axis becomes *nearly horizontal,* and it projects far below the free edge of the liver. Its large or "cardiac" end occupies the left hollow of the diaphragm, and is separated from the anterior abdominal wall by the liver; hence this latter organ occupies the greater part of the epigastric space. When empty, the cardiac part of the stomach does not fill the left

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[1] Medical Anatomy. London, 1879.

[2] See page 286 of this volume.

hollow of the diaphragm; convolutions of the small intestine, and the transverse arch of the colon may thus fill its place, while the spleen may slip in behind the stomach. The apex of the heart and the lower part of the left ventricle actually overlap the cardiac end of the organ; hence the pain referred to the heart, and the palpitation after a flatulent meal. The distended stomach may so compress the heart cavities as to interfere with the return of venous blood from the head; this explains the occurrence of stupor, epileptic fits, and coma, after eating excessively of indigestible food.[1] The distended stomach may, by compressing and emptying the blood from the liver, so distend the right auricle of the heart as to produce the swollen veins of the neck and forehead seen after eating to excess, since the return of venous blood from the head is thus impeded; and, by creating a difficulty in the movements of the diaphragm, it is further possible for the stomach, when distended, to impair the usefulness of the lungs. Patients affected with dyspepsia usually labor under the delusion that they are suffering from disease of the heart, from the palpitation, cardiac pain, and symptoms of impeded return of venous blood. If we percuss over the stomach when the patient lies upon the back, the note is resonant, since the food contained in it gravitates to its most dependent part, but, if the patient be in the erect posture, the food fills the part of the organ which lies below the free border of the liver, and a dulness takes the place of the former resonance; this point is of practical value in estimating the size of the stomach or of the liver, since the trunk should not be raised, if we hope to get resonant percussion over the entire area of the stomach.[2]

THE LIVER.—This organ is extremely variable, both in point of size and in its relative position to other parts. Its position within the abdomen is greatly affected by the filling of the lungs during inspiration, when it is displaced downward by the diaphragm; while the ribs are raised at the same time, thus apparently adding to the downward displacement. For this reason we find the liver low in the abdomen in those subjects who have a robust development of the chest, and high in those whose chests are contracted and the lungs small. Distention of the intestine by air tends also to add to the upward displacement of the organ, and the size of the stomach, as well as its distention, is also liable to markedly affect its position within the abdomen. This displacement of the liver during each inspiratory act has a physiological function, since the *compression* of the organ by the diaphragm tends to squeeze the blood from the hepatic vessels, and thus to favor the return of portal blood to the right auricle of the heart at a time when the heart cavities are best adapted to receive it, as the lungs are expanded and the chest enlarged, thus reliev-

[1] Sibson reports a case where a fit always occurred after eating pork.

[2] The cuts on pages 279 and 285 depict the relations of the stomach to adjoining viscera in its normal and abnormal conditions.

ing the heart of undue pressure and favoring the reception of large quantities of blood. The play of the liver, stomach, intestine, and, to a less extent, of the spleen and kidneys, during respiration, and the alternate compression and expansion which they necessarily undergo, since they are all more or less elastic, constitutes a perpetual *churning motion*, which unquestionably assists in the proper performance of their physiological functions. When the stomach is empty, the liver may be found to reach the left hypochondrium, while, when distended, it may be crowded upward and to the right; the intestines, when empty, favor its fall, while, when they are distended, the liver may be raised; emphysema

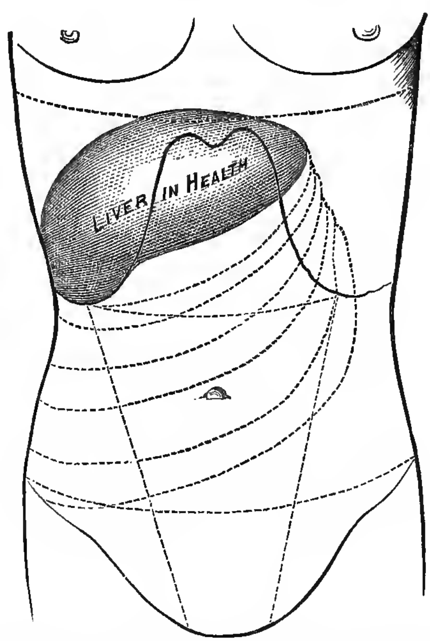

FIG. 150.—A diagram to show the normal position of the liver within the abdomen, and the extent of its enlargement in disease, as well as the areas in which pressure from such enlargements would be exerted.

and fluid in the right cavity of the pleura tend to create a downward displacement; finally, in phthisis, when the lungs are seriously impaired and their full inflation rendered impossible, the liver may be found so high as to be completely behind the ribs. When the liver is the seat of malignant disease, an abscess, or hydatid cysts, the diaphragm is raised, the right lung is encroached upon, and the heart is displaced to the left of the thorax, and is also raised; but, when congested, or increased in size by fatty or waxy degeneration, the organ tends to sink in the abdomen and to present a marked increase below the ribs without encroaching to any marked extent upon the thoracic cavity.

The extent to which the liver may be detected below the margin of the ribs may indicate either disease of that organ or some abnormal condition of neighboring structures. Thus, the liver may be found to lie in close contact with the abdominal walls (without any enlargement of the organ itself) from pressure of pleuritic or pericardial effusion, or when the conditions of emphysema or mediastinal growths are present; while the same displacement may exist when the intestinal canal is empty or the stomach collapsed. We can understand from these facts why the pain and sense of oppression created by a diseased liver may be referred either to the costal walls or to the abdominal parietes, and why the fric-

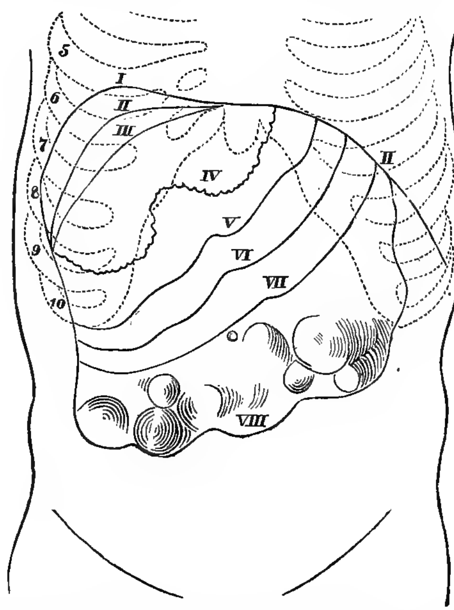

FIG. 151.—The volume of the liver in various diseases. 5–10, Ribs. 1, Position of the diaphragm in the highest degree of tumefaction of the liver (carcinoma). II, 11, Normal position of the diaphragm. II, III, Relative dulness III, Position of the diaphragm at the anterior wall of the chest, at the same time the line of dulness of the normal liver. IV, Edge of liver in cirrhosis. V, In the normal liver. VI, Fatty liver. VII, Amyloid liver. VIII, Cancer, leukæmia, adenoma. All of proportional size. (After Rindfleisch.)

tion-sound heard over a local peritonitis at the seat of the liver may simulate a pleurisy when that organ has risen high up in the thorax, thus lying entirely behind the ribs. The pain produced by diseased conditions of the liver may be referred to the right shoulder; a fact whose explanation lies in the anastomoses of fibres contained within the splanchnic nerves, with the cervical and brachial plexuses.

From the facts which have been given in reference to the situation of the liver within the cavity of the abdomen, it is plain that no organ offers more opportunities for error in diagnosis, if the physician is not skilful in percussion and thoroughly familiar with the note of liver dulness. It is not sufficient for one to ascertain by palpation and percussion the lower limit of the organ alone, since the entire organ may be displaced downward without any disease of its structures; but the upper limit of the organ must also be determined, and, by comparing the two lines of dulness thus obtained, the thickness of the liver may be estimated and the question of increased volume of the organ decided. It is well, therefore, to start with some preconceived idea of the usual limits of liver dulness in the state of health, since due allowances can be made in special cases for displacement.

If *percussion* be made over the thorax from the right nipple downward, the dulness of liver tissue will usually be reached at about the fifth intercostal space; while the line will reach to nearly the level of the xyphoid cartilage in the median line, and to the seventh rib in the axillary space. Now, this upper line of dulness tells you whether the liver is displaced upward or downward, or is normal in its position; and the lower limit of hepatic percussion will decide, by comparison with the line first mapped out upon the chest, whether the liver is of its normal thickness, decreased, or increased. The normal liver should measure about three inches in thickness in the median line in front; about four inches in the line dropped through the right nipple; four and a half inches in the centre of the axillary space; and, finally, about four inches in the dorsal region.

Sibson puts the *upper limit* of the liver in the region of the level of the eighth dorsal spine, and he designates the tenth dorsal spine as the guide to the point of contact of the liver with the wall of the abdomen posteriorly. The *lower edge* of the liver, in front, corresponds closely in health to the free border of the ribs, and it is customary to employ palpation along this free border in determining the character of the liver edges, the presence of nodosities, etc. If this be employed, the patient should relax the abdominal wall, and the fingers should be crowded well beneath the ribs until the edge of the liver can be readily perceived. The lower border of the liver can be perhaps more readily felt in the epigastric space, midway between the xyphoid cartilage of the sternum and the umbilicus, where even the untutored hand can hardly fail to detect it.

The *upper surface* of the liver being convex and overlapped by the edges of the right lung, while its highest point is beneath the dome of the relaxed diaphragm, it becomes evident that a wound of the right side of the chest with a pointed instrument,[1] between the sixth and seventh ribs, would first penetrate the right lung, then the diaphragm, and, finally, the tissue of the liver itself.

[1] Many facts of clinical interest pertaining to the liver have been already discussed in those pages which treat of the relations of the thoracic walls to the organs beneath.

THE SPLEEN.—This organ, when healthy, is subjected to all the modifications in position which have been enumerated as affecting the liver and stomach, and they are the mechanical results of about the same general causes. Although a deep inspiration may tend to displace it downward, it rarely, if ever, is thus pushed below the free border of the costal cartilages; hence the spleen, if normal in size, cannot be felt by the hand under any of the varying circumstances of life. In those conditions where the spleen enlarges, the organ expands chiefly in an anterior direction, thus gradually passing more and more in front of the axillary line, but, while it grows also in a downward direction, it seldom appears below the costal cartilages (even when quite large) except at the end of a full inspiration, when it can sometimes be felt. It may be

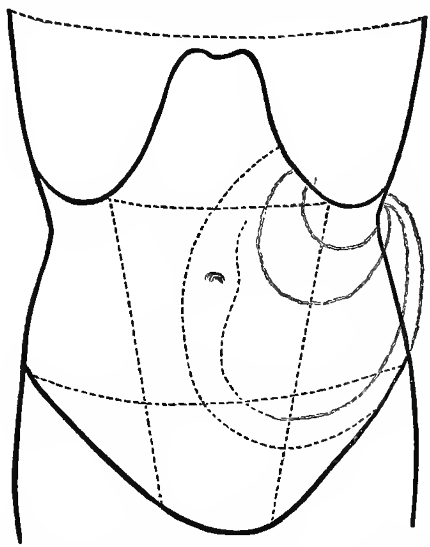

FIG. 152.—Diagram representing the different areas occupied by the spleen in its various enlargements into the abdominal cavity. (After Bright.)

regarded as a most positive evidence of an enlarged spleen, even when percussion leaves the examiner in doubt as to the exact size of the organ, if a solid mass can be felt to protrude from underneath the costal cartilages of the left side during a full inspiration, and to recede with expiration.[1] There seems to be more uncertainty in the minds of many practitioners as to the anatomical situation of the spleen than of any other organ; I have often witnessed percussion made in the space below the ribs and above the ilium by intelligent men for the purpose of estimating the size of the spleen which was suspected to be enlarged. It should be remembered that the organ lies on the left side beneath the ribs, and that

[1] Sibsor Medical Anatomy. London, 1879. Sir W. Jenner: Medical Gazette. 186l

percussion should be made, with the patient lying upon the right side, only in the axillary line from the level of the ninth rib downward, if its size is to be accurately determined. Auscultatory percussion (as described on page 287) will often enable the examiner to detect delicate shades of splenic dulness when the unaided ear might fail to perceive it.

It is important to discriminate between splenic enlargement and (1) cancer of the stomach, (2) abcess of the abdominal wall, (3) diseased omentum, (4) enlargement of the left lobe of the liver, (5) fæcal accumulation in the colon, (6) disease of the left kidney, and (7) ovarian tumors.[1]

In the first instance, the line of dulness will be circumscribed, and firm percussion will yield a resonant percussion note, since air is contained in the cavity of the stomach; in the second, the tumor will be detected by palpation and will fluctuate when the pus becomes superficial; in the third, the line of dulness will be carried to the right and across the abdomen, and cannot be traced backward or upward beneath the ribs, while the growth will be nodular and uneven; in the fourth, the line of dulness will be carried to the right and join liver dulness; in the fifth, the action of enemata and cathartics will prove the only way of making a positive diagnosis; while, in the sixth and seventh, the history of the patient, sex, and the situation of the growths will aid in their discrimination.

The six lower ribs and cartilages protect the liver, stomach, and spleen during expiration, all of which organs rest upon the muscular fibres of the diaphragm, in front of the lower ribs and the wedge of the lungs at the posterior portion of the thorax. These viscera, therefore, occupy the hindermost part of the body, and, as the wedge of the lungs descends during the inspiratory act, they are displaced forward as well as downward, since the lungs are interposed between the chest-wall and the diaphragm. This forward displacement of the spleen, liver, and stomach constitutes one of the most striking effects of the inflation of the lungs, although in the case of the spleen, the forward movement is less marked than that of descent, while in the case of the stomach, the forward movement is in excess.

The doubt that still exists as to the physiological functions of the spleen creates difficulties in the diagnosis of affections of that organ, since few symptoms of a general character point directly to disease of its substance. Its isolated position furthermore tends to render palpation almost impossible, except when excessively enlarged, and the presence of adjacent organs, which may, at times, contain solid matters, renders the detection of the exact outline of splenic dulness on percussion a point of difficulty. Some of the points of diagnosis between an enlarged spleen and other conditions which simulate it have been considered in a previous page.

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[1] A. L. Loomis: Lessons in Physical Diagnosis. N. Y., 1878.

THE PANCREAS.—This organ, whose right extremity or "head" is embraced by the curving duodenum (and whose duct, in common with that of the liver, opens into the cavity of that portion of the alimentary canal) lies transversely across the abdomen behind the stomach. It crosses in front of the abdominal aorta and the bodies of the lumbar vertebræ, usually on a level with the first or second. If the organ is normally situated, therefore, it should be found about two inches above the navel and in the median line of the abdomen. Now it is only under the most favorable circumstances that abdominal palpation can detect the pancreas, since the subject has to be emaciated, all omental fat absent, and the abdominal organs empty; in this case, firm and deep pressure may enable the educated touch to map out the outline of the pancreas. In an interesting article written by Sir William Jenner,[1] the point was made that in some few instances the normal pancreas had been mistaken for aneurism of the abdominal aorta (since pulsation had been communicated to it from the close proximity of that vessel), and also for disease of the transverse arch of the colon. The difficulties in reaching it even under favorable circumstances, and the infrequency of such conditions, render the organ one of little clinical interest.

THE INTESTINAL CANAL.—All of the space below the umbilicus is occupied by the convolutions of the intestine, the jejunum lying nearer to the navel; hence the fatality which is associated with umbilical hernia. The coils of the ileum are situated lower in the cavity of the abdomen. If we view the subject posteriorly, the duodenum may be said to wind around the head of the pancreas on a line situated in the space between the spines of the last dorsal and first lumbar vertebræ, being contiguous to the point of entrance of the vena porta into the liver at its transverse fissure, and the hepatic artery as it emerges from the same organ. From this point, the duodenum descends along the side of the ascending vena cava, then curves to the left and crosses the aorta at the level of the second lumbar spine, then ascends along the left side of that vessel, and disappears among a mass of convoluted intestine.

The *large intestine* lies superficially in the anterior part of the abdomen, and for the greater portion of its course it is accessible to pressure; hence hardened fæces can usually be detected by external manipulation, if the physician be familiar with its general course. The cæcum and the ilio-cæcal valve lie in the right iliac fossa, the ascending colon passes through the right lumbar region in nearly a vertical direction, lying over the kidney of that side; the transverse colon crosses the abdomen, in a horizontal direction, two or three inches above the navel; the descending colon descends through the left lumbar region, lying in front of the kidney of that side, and finally, the sigmoid flexure occupies the left iliac fossa. Fæcal matter in the ascending colon and sigmoid flexure may be

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[1] Medical Gazette, 1869.

mistaken for malignant disease, and, if in the cæcum, the diagnosis between it and perityphilitis is often difficult. A tumor in the abdomen

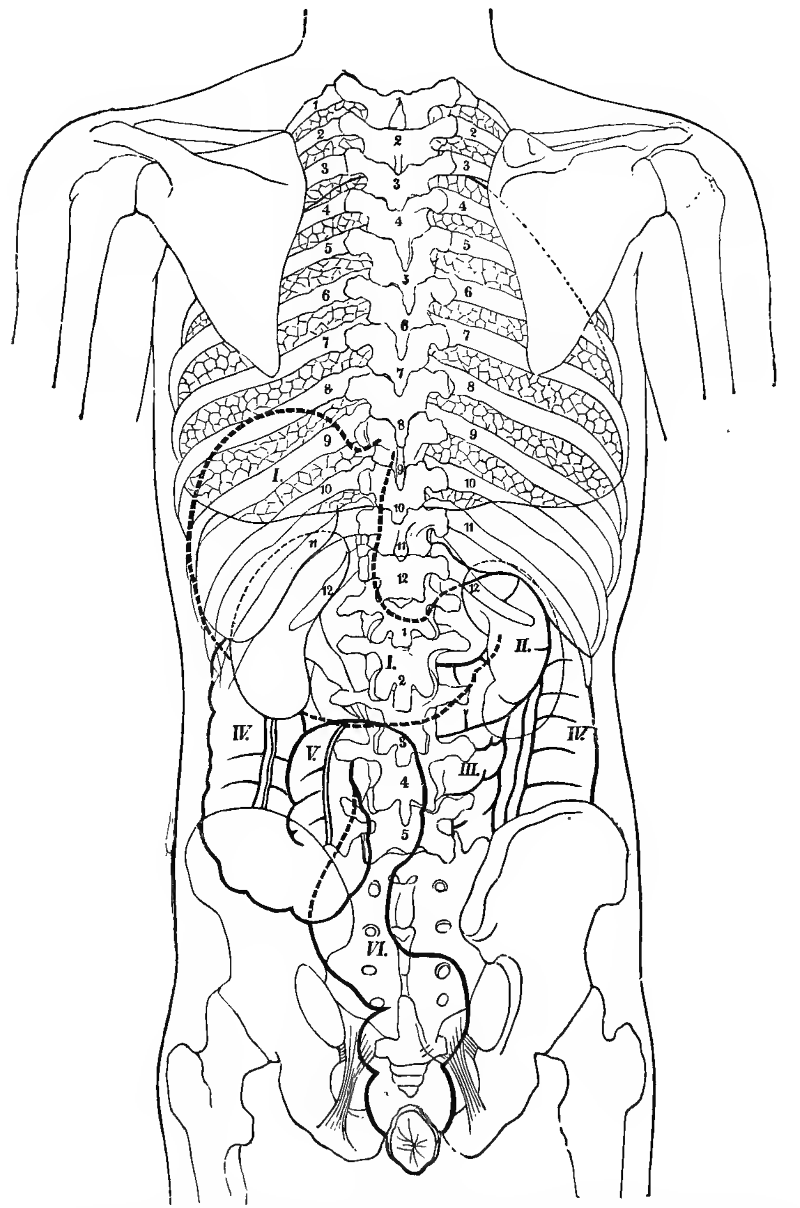

FIG 153.—View of the abdominal organs from behind. (After Luschka.) I, Stomach. II, Duodenum. III, Ileum. IV, Colon. V, Sigmoid flexure. VI, Rectum.—The vertebræ are numbered according to regions, and the ribs are numbered from above downward. The relative situation of the lungs and kidney to adjacent structures is also shown.

may be apparent when the transverse portion of the colon is so distended, while, if it be confined to the point of junction between the transverse and descending portions, the diagnosis between it and enlarged spleen can only be made by the use of repeated injections of olive oil, ox-gall, or other enemata, or the employment of cathartics. On the right and left side of the body, the colon is uncovered by peritonæum, below the kidney and above the crest of the ilium, and it is in these two situations that the operation of colotomy is performed for the relief of malignant disease or congenital absence of the rectum.

Holden[1] gives the following landmarks for this operation: "1, the last rib, of which we feel the sloping edge; 2, the crest of the ilium; 3, the outer border of the erector spinæ muscle. The incision should be about three inches long, midway between the rib and the ilium. It should begin at the outer border of the erector spinæ muscle, and should slope downward and outward in the direction of the rib. The edge of the 'quadratus lumborum' muscle, which is the guide to the colon, is about one inch external to the edge of the 'erector spinæ,' or three full inches from the lumbar spines. The line of the gut is vertical and runs (for a good two inches) between the lower border of the kidney and the iliac crest."

In *typhlitis,* the presence of a tumor, which bears a resemblance to a sausage in its general outline, may be detected in the right iliac fossa, since impaction of fæces in the cæcum is usually the result of a paralysis of the muscular fibre of the gut, which follows catarrhal inflammation. The presence of the ileo-cæcal valve in the right iliac fossa further assists in producing impaction of fæces in that region of the abdomen more commonly than elsewhere, and the direction of the colon may also be taken as another factor, since the contents of the bowel have to oppose the force of gravity in order to reach the transverse colon.

The *right iliac fossa* is the most frequent seat of tenderness, to pressure or manipulation of the abdomen, in typhoid fever and its allied conditions. This may be accounted for by the presence of the solitary glands and Peyerian patches of the intestine in great abundance in the lower part of the ileum, near to the ileo-cæcal valve: since, in typhoid fever, these glands, and the patches of Peyer especially, are the seat of morbid changes of the greatest pathological interest, resulting in ulceration of the intestine and a liability to perforation.

That distressing condition, and one which oftentimes has a clinical value of the greatest significance—*tympanites*—is the result of over-distention of the intestine with accumulated gas. A certain amount of air is always present in the intestinal canal, since, by it, Nature protects the coats of the intestine from injury; the air keeping the canal inflated and thus separating the walls from each other, while it also enables the intes-

[1] Surgical Landmarks.

tine to bear considerable compression or even violence without the walls being brought into contact or their structure impaired.

The *mesentery*, which contains glands, blood-vessels, lymphatic vessels, and connective tissue, in addition to the peritonæum which forms it, may be the seat of tumors of a simple fatty or malignant type; while, in the course of a severe type of typhoid fever, each of the mesenteric glands may enlarge to the size of a walnut or even a hen's egg. The danger which exists in this disease from manipulation of the abdomen (since perforation of the peritoneal coat may be induced, and death from shock or peritonitis ensue) renders it unwise to attempt to search for these tumors as a confirmatory point in the diagnosis.

THE KIDNEYS.—These organs lie on either side of the body in the back part of the abdominal cavity, on the quadratus lumborum and psoas muscles, in a space defined by the two lower dorsal and the two upper lumbar spines. It is customary to find the right kidney placed about three-quarters of an inch lower than that of the left side, as the liver tends to push it further down into the abdomen. During a deep inspiration, the diaphragm depresses the kidneys of each side about half an inch below the situation mentioned above as a normal one; this movement being transmitted indirectly to them by means of the liver, stomach, and spleen. The first lumbar spine is regarded as perhaps the best guide to the level of the pelvis of the kidney, although the outer extremity of the last floating rib is the point usually selected for aspiration of the pelvis for pus, or retained secretion in hydronephrosis.

Despite the statements made by some authors that the kidneys can be felt, in some cases where the abdominal walls are flaccid, by bimanual manipulation (one hand being placed on the anterior and the other on the posterior surface of the abdomen, so as to include the organ between them), I am frank to say that I have never been able to feel certain that I could detect the outline of the kidney even under the most favorable conditions, provided it was of normal size and in its proper position within the abdomen. I believe that bimanual palpation, as described above, is of use in determining the amount of renal tenderness which exists in any given case, but I rely more upon auscultatory percussion than on touch to determine the exact outline of the organ.

These organs are retained in their place partly by connective tissue and partly by means of the blood-vessels connected with them. They are sometimes movable within the abdomen—the so-called "movable kidney"—and, if on the right side, such a tumor is to be diagnosed from an enlarged gall-bladder, an ovarian tumor, or omental disease, while, if on the left side, it may be confounded with an enlarged spleen, impacted fæces, an ovarian growth, or malignant disease.

Care should always be used in the discrimination between the normal outline of renal dulness and the dulness afforded by an enlarged liver or spleen, or an accumulation of fæces within the colon. It can be *made to disappear*, by gentle pressure, so that it cannot be felt.

The kidneys may be increased in size by calculi within the pelvis of either organ, which tend to the development of pyelitis and thus convert the kidney into a bag of pus; by cancerous and tubercular deposits; by the formation of hydatid cysts within its substance, and by the obstructed escape of its normal secretion—the condition known as hydronephrosis—the result of obstruction to the ureter by calculi or pressure,

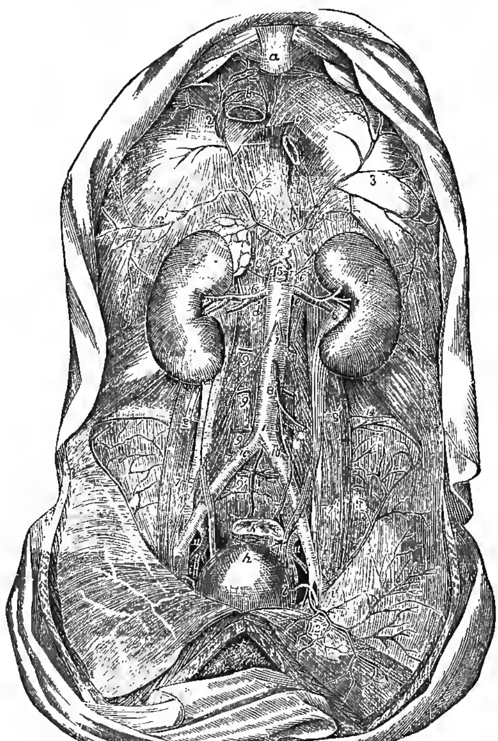

FIG. 154.—The structures which lie deep within the abdomen. 1, the abdominal aorta; 2, the phrenic vessels; 3, the diaphragm; 4, the cœliac axis; 5, the superior mesenteric artery; 6, the renal artery; 7, the spermatic arteries; 8, the inferior mesenteric artery; 8, the lumbar arteries of either side; 10, the common iliac arteries; 11, the internal iliac arteries of either side; *a*, xyphoid appendix; *b*, inferior vena cava cut across; *c*, œsophagus cut across; *d* and *e*, psoas muscles; *f*, kidneys; *g*, ureters; *h*, bladder; *i*, rectum, lying behind the bladder.

an abnormal course of the renal artery which encircles the ureter like a cord, the presence of a congenital valve-like flap in the pelvis of the kidney, or the development of tumors of the ureter itself. Disease of the supra-renal capsule may also tend to create an enlargement of the organ and thus confuse the diagnostician. In determining the size of the kidney by percussion, the patient should be placed upon the abdomen and chest, so as to allow any fluid, if present, to gravitate to the most dependent portion, and thus to float the intestine in the region of the kidneys, and to surround them with viscera whose resonant percussion assists greatly in enabling the physician to detect the outline of renal dulness.

THE BLADDER.—The position of this organ, when empty, cannot be determined by any of the means employed in the physical exploration of the abdomen. When it is fully distended, it rises above the pubes nearly as high as the umbilicus, carrying the peritonæum with it, and thus separating that membrane from the linea alba below that level. A smooth oval tumor is thus formed above the pubes, which may distend the whole of the hypogastric region, and its outline is easily made out by contrasting the tympanitic resonance of the intestine upon either side of it with the dulness on percussion obtained over the fluid contents of the organ. Since, in infants, the bladder normally assumes a higher plane than in the adult, a smaller quantity of urine can be perceived by percussion over the hypogastrium. The only thing liable to be confounded with the distended bladder are the gravid uterus in the female and extensive malignant disease of either sex, and the employment of the catheter will remove all doubt at once.

When the bladder has become impaired in its contractile power from the atony of over-distention, local inflammation of the organ, or the paralysis which accompanies some forms of spinal affections, an incontinence of urine often occurs from an overflow of the highly distended bladder which is too often mistaken for a true incontinence, the physician supposing erroneously that the bladder is empty, since the urine flows off continuously. Such cases as these are always subjects for an examination of the bladder by catheterism, and the only hope of relief depends on the regular use of this instrument until the bladder can regain its normal power of contraction, provided it is not permanently impaired. Patients afflicted with true paralysis of the bladder often apparently regain control of it, since the urine is voluntarily but hastily expelled; such an occurrence must be considered, however, as an evidence of increased reflex excitability of the spinal cord, in which case the presence of the accumulated urine creates a reflex spasm of the organ, and the physician should be extremely guarded in giving a favorable prognosis.

THE UTERUS.—The unimpregnated uterus, although its fundus reaches the lower part of the hypogastric region, is still inaccessible to the touch and its outline cannot be made out by percussion. It is only after impregnation has produced such an increase in the size of the organ as to bring it well above the pelvic cavity that physical examination is of aid in diagnosis. As early as the second month of pregnancy, the upper limit of the uterus may be detected by percussion just above the pubes, but it is still too small to be felt; by the fourth month, however, the increase in the womb begins to be very perceptible, both to sight and touch, while percussion is a valuable aid in accurately determining the steady increase in the area of dulness as gestation progresses.

After the fifth month, auscultation becomes even more reliable as a means of determining pregnancy, since the fœtal heart and the placental bruit may be then detected. To properly auscultate the uterus, the woman should be placed upon the back with her thighs flexed, so as to relax the wall of the abdomen, and, in some instances, it is well to rotate the patient to the side, so as to draw the womb away from contact with the pelvic arteries, if the question of transmitted sound from an aneurism be worthy of consideration. I always prefer the stethoscope to the naked ear for this purpose, as the sound can then be limited to a circumscribed area. The special characters of the placental bruit, the funic souffle, and the fœtal heart can be ascertained by a reference to the excellent work of my colleague, Prof. Loomis,[1] and to other similar works.

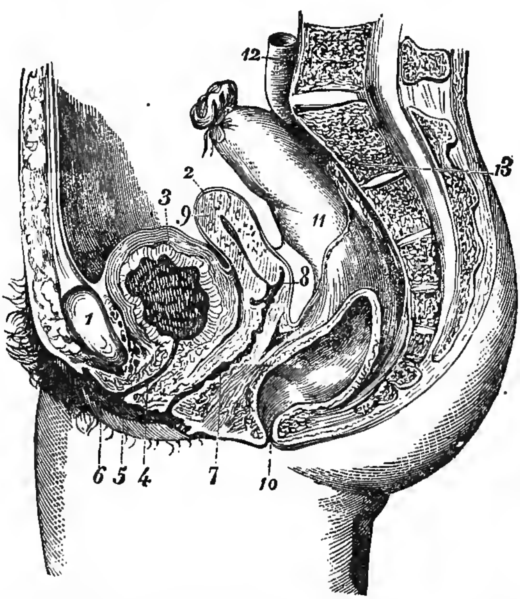

FIG. 155.—Section of the pelvis showing the relations of the organs.—1, pubis; 2, peritoneal covering to the uterus; 3, bladder; 4, urethral canal; 5. meatus urinarius; 6, labia majora; 7, vagina; 8, os uteri; 9, fibrous structure of the uterus; 10, anus; 11, rectum; 12, aorta; 13, sacrum. (After Byford.)

It may be well to mention here that the *fœtal heart-sounds* may be confounded with the pulsations of the aorta and iliac arteries of the mother, and, in the early months of pregnancy, this pulsation may even render the heart-sounds of the fœtus inaudible. Twin pregnancies may often be detected by heart-sounds heard over the womb at distant points, and by an absence of synchronism between the two pulsations. If the pulsations be heard below the line dividing the enlarged uterus in its

[1] Lessons in Physical Diagnosis. Wm. Wood & Co., 1880.

centre, a vertex presentation may be suspected, while, if above this imaginary line, the probability of a breech presentation is a strong one. The fœtal heart may be absent in pregnancy when the fœtus is dead—a point not to be forgotten in discriminating between pregnancy and other tumors of the abdomen. The character of the fœtal heart during labor may often be a valuable guide to the time when instruments are demanded to save the life of the child, since, if feeble and intermitting, impending death of the fœtus is indicated.

There are many *abnormal states* of the uterus which cause enlargement of that organ, and which require the most careful study of symp-

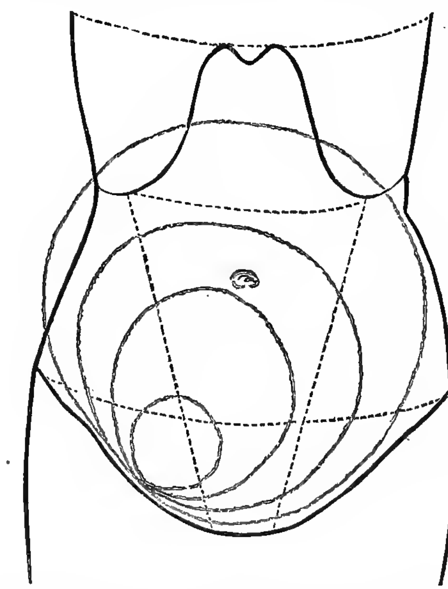

FIG. 156.—Diagram showing the gradual enlargement of a tumor of the right ovary till it fills a large portion of the abdominal cavity, forcing the intestines into the lumbar region. (After Bright.)

toms, as well as the aid furnished by palpation, percussion, and auscultation, to make an accurate diagnosis; but these are too numerous to decribe here in detail, and the author respectfully refers his reader to his more exhaustive work upon Surgical Diagnosis for all the points of differentiation between them.

The various *displacements* of the uterus, while associated with many symptoms of a serious character, are not to be determined by abdominal examination, although the use of one hand applied to the abdomen may prove of great assistance in some instances when combined with vaginal or rectal touch. The points of diagnosis of these more common disorders of the uterus cannot, therefore, be incorporated in this volume.

THE OVARIES.—In the normal state, these organs lie within the cavity of the pelvis, and cannot be perceived by abdominal exploration; it is only when they have become enlarged from disease and been forced out of the pelvic cavity into the abdomen, thus displacing adjacent organs from their normal situation, that they become a source of error in diagnosis, and often of great perplexity to the physician. When they are of small size but still large enough to be perceived through the abdominal walls, they are confined to the iliac fossa of the side corresponding to the organ affected; as they continue to grow, they gradually reach the median line; still later, the tumor seems to fill the entire width of the abdomen, and the point from which it started becomes a subject of the greatest difficulty to determine, except from the history of the patient. The preceding diagram will show the positions assumed by such a tumor in different stages of its growth.

These tumors are liable to be confounded with enlargements of the uterus, such as pregnancy, fibroid tumors, etc., hydatids of the omentum, ascites, enlargements of the spleen, liver, and kidney, and fæcal accumulations within the intestine. The differential diagnosis of these affections will be found arranged in tables for ready reference in another work by the author.[1]

CLINICAL POINTS PERTAINING TO THE NERVES OF THE ABDOMEN AND PELVIS.

The ilio-hypogastric and ilio-inguinal nerves are sometimes the seat of a severe form of neuralgia. It may be produced by disease of the lumbar vertebræ, structural changes in the parts investing the lumbar plexus, pelvic diseases, exudations in the substance of the psoas muscle, strains, contusions, exposure, and an hysterical condition. The pains are usually of a paroxysmal character, and radiate in the course of these nerves; they are of a lancinating type, and often extremely severe. Painful points may be detected in one of the following regions, or possibly in all of them: 1, a *lumbar point*, near the spinous processes of the lumbar vertebræ; 2, an *iliac point*, near to the middle of the crest of the ilium, where the ilio-hypogastric nerve pierces the transversalis muscle; 3, a *hypogastric point*, slightly above the external ring, where the ilio-hypogastric nerve pierces the aponeurosis of the external oblique muscle; 4, an *inguinal point;* and 5, points upon the *scrotum* or *labium*. It is stated by Notta[2] that this type of neuralgia may be occasionally accompanied by an increase in the sexual appetite, and a spasmodic contraction of the cremaster muscle.

This form of neuralgia is to be diagnosed from rheumatic myalgia of the longissimus dorsi and sacro-lumbalis muscles; and from those types of chronic affections of the uterus which induce pain in the back. It might also be possibly mistaken for an attack of renal or biliary colic.

[1] A Practical Treatise on Surgical Diagnosis. New York, 1880.

[2] As quoted by Erb.

The diagnosis will be made chiefly by the *"puncta dolorosa"* [1] previously described, by the course of the pain, and by its intense paroxysmal and lancinating character.

The nerves which are distributed to the skin of the abdominal walls may be considered as comprising two distinct sets, based on the physiological action of the abdominal muscles which are supplied by them. According to Hilton, the abdomen may be divided, on a line corresponding with the situation of the umbilicus, into an upper or respiratory portion, and a lower or abdominal portion. The upper or respiratory portion is supplied, in great part, by the lower intercostal nerves, which are distributed also to the muscles of the chest, and which, if taken with the other intercostal nerves as a group, are essentially respiratory in their function. The lower or abdominal portion of the abdomen is supplied chiefly by the ilio-hypogastric nerve, although the ilio-inguinal, the genito-crural, and the posterior branches of the lumbar nerves assist in furnishing motor power to the muscles of that region.

The subjacent peritonæum is unquestionably supplied from the same sources of nerve-power as the muscles and skin of the individual regions of the abdomen, and it is considered probable, by the author above quoted, that the spinal nerves which are distributed to the skin, muscles, and parietal peritonæum may be also associated with the visceral layer underneath, by means of communications with the sympathetic nerve. The abdominal muscles unquestionably assist the colon in its endeavors to force the fæces, by its peristaltic action alone, throughout its length, since the force of gravity has to be overcome in its ascending portion, and the curves of the sigmoid flexure in its terminal portion. It would therefore be an additional confirmation of a general nerve distribution, if the distribution of the abdominal nerves to the intestinal covering of peritonæum could be fully verified; since the structures which assist in moving the adjacent organs—the abdominal muscles—would be supplied from the same source as the organs as well as the skin over those muscles.

A careful study of the distribution of the various branches of the pudic nerve will show that it is the source of motion to the muscles of the perinæum and urethra, and of sensation to the integument of the perinæum, scrotum, labium, penis, and the mucous covering of the clitoris, as well as that lining the urethral canal. The friction made upon the cutaneous nerves of the external genital organs in the acts of sexual intercourse and masturbation creates a reflex act within the spinal cord, which maintains the turgidity of the penis and clitoris during the first portion of those acts; and, later on, a series of muscular contractions in the perineal muscles and the involuntary muscular fibre of the urethral canal

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[1] A name applied by Valleix to the spots of extreme local tenderness found along a course of a nerve which is the seat of neuralgia.

are produced, which assist in the expulsion of semen in the male and the secretion of the glands of Bartholin in the female. That this is the true explanation of emission is evidenced by the fact that onanism is most effectually prevented by blistering the cutaneous covering of the penis and the mucous covering of the clitoris.

In some cases of fracture of the spine, in the dorsal region, where a part of the spinal marrow is left intact below the seat of fracture, you may be able, by repeatedly pinching the skin of the scrotum and penis, to produce spasmodic contractions of the muscles of the perinæum and urethra, and often to effect a turgidity of the genital organ to such a degree as to make it resemble an imperfect erection or priapism.[1]

The ejaculation of the last few drops of urine from the urethra is unquestionably effected by a reflex act through the sensory and motor fibres of the pudic nerve, in consequence of the irritation produced in the sensory fibres of the urethral mucous membrane from pressure of the urine or the contact of its saline ingredients.

It is not uncommon for rectal disease to produce sympathetic manifestations in the genito-urinary organs, in the form of neuralgic pains, involuntary emissions, incontinence of urine, etc.; such effects can only be explained by the distribution of the pudic nerve to the integument about the anus (and, I believe, to the walls of the rectum also), which allows of reflex motor impulses to be sent from the spinal cord, in response to rectal irritation, to the genito-urinary organs and perineal muscles.

The recognition of the perineal branch of the small sciatic nerve is sometimes important in practice. If you care to trace this nerve upon the dead subject, you will find that it escapes from beneath the perineal border of the gluteus maximus muscle, runs along the outer portion of the perinæum, and, finally, sends cutaneous filaments to the sides of the penis. The perineal region is also supplied by the perineal branches of the pudic nerve, which escape posteriorly to those of the sciatic, from beneath the same muscle. Now, either of these two nerves may be the cause of a pain referred to the perinæum and the penis, and their points of escape from beneath the gluteus maximus muscle are so placed as to render them frequently subjected to pressure from sitting upon hard or uneven seats. It is thus possible for pains, referred to the penis, to be wrongly attributed to diseases of the bladder, calculus in the bladder, urethral troubles, and all other types of disease which are commonly indicated by more or less pain in that locality, when the cause may be found and correctly diagnosed by following up the course of the perineal branch of the small sciatic. Such a case is reported by Hilton,[2] where prominent surgeons of Europe, among them Mr. Key, had diligently and unsuccessfully searched for the cause of a pain (referred to the penis),

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[1] Hilton, op. cit.

[2] Rest and Pain. London, 1876.

along the course of the pudic nerve, and where the patient had been treated for disease of the bladder; a careful examination subsequently revealing the true cause to be a spot of hardened tissue pressing upon the perineal branch of the small sciatic nerve, which was cured (as well as the pain which it created) by the application of nitric acid over the seat of thickening. It is, therefore, well to remember the course of this branch, as well as those of the pudic nerve, when investigating for the cause of pain in the penis or perinæum.

POINTS OF SURGICAL INTEREST PERTAINING TO THE REGION OF THE ABDOMEN.

There are *numerous openings* through the abdominal walls, among which may be mentioned the inguinal canals, the femoral canals, several through the diaphragm (which may be regarded as the superior wall of the abdomen, as well as the floor of the thorax), and numerous small openings for the passage of vessels in various parts of the abdominal parietes. It is through some of these openings that the viscera, in most cases, pass and form hernial protrusions. The looseness of the cellular tissue which closes many of these openings rather predisposes to such displacements, but, in contrast, their oblique direction, which is similar to that of the passage of the ureters through the walls of the bladder, seems an evident attempt of Nature to guard against such protrusions.

When a person tends to become very fleshy, adipose tissue is formed in these canals, which helps to destroy the elasticity of the parts; hence, when these subjects suddenly lose their fat, hernia is easily produced, as the adipose tissue which filled the openings in the parietes is gone. In cases of extreme obesity, the fat deposited on the outside of the abdominal walls may, by its weight alone, so draw the muscles and skin downward, as well as the subjacent peritonæum, as to form a true sac into which the viscera will protrude. This same condition is observed in pregnancy, when the weakened walls of the abdomen are unable to sustain the weight of the intestine and uterus.

The *anterior region* of the abdomen may, in some rare cases, be partially or entirely deficient from an arrest of development; we see this in those cases of so-called extroversion of the bladder, in which the bladder appears as a red tumor of the hypogastrium, which allows urine to trickle through its walls. In most of these subjects, the genitals are malformed or deficient. The intestine and other viscera may escape through such a congenital opening, if the abdominal wall is extensively involved.

Wounds of the anterior abdominal wall are always serious, because the cicatrix which follows is weaker than the injured wall, thus tending toward hernial protrusions. Penetrating wounds have an additional danger from the liability of wounding some of the viscera, and the lower their situation in the abdomen, the greater the liability of some of the viscera escaping from the wound, since the weight of the superincumbent organs adds to the tendency to displacement; hence, the rule among surgeons to always divide these wounds upward instead of downward.

Contusions of the abdomen may produce either rupture of the muscles, extravasation of blood, rupture of the peritonæum, rupture of the diaphragm, rupture of the stomach or intestine, lacerations of the liver and spleen, rupture of the gall-bladder, or lacerations of the kidney and ureter. If uncomplicated by injury to the subjacent viscera, they may result in abscess or recovery.

Death has occurred from concussion of the solar and cardiac plexuses without any internal lesion being discovered. Concussion of this region may be received from flying missiles (such as cricket balls); from blows received during an altercation, from falls upon the abdomen, and the passage of heavy bodies over the body.

True wounds of the abdomen may be superficial or deep, and associated with protrusion of or injury to the viscera lying beneath the wound. They may occur from sharp and pointed instruments, from being impaled upon iron spikes, caught upon iron hooks, tossed by the horns of cattle, injured by bits of glass, china, or missiles, or by the bites of carnivorous animals. They may produce serious internal hemorrhage even when the viscera escape injury.

The anterior wall of the abdomen is often tapped for ascites in the linea semilunaris at the outer side of the rectus muscle, or in the median line, since both of these localities are less vascular than other parts. The danger of wounding the bladder, if the trocar is inserted in the median line near to the pubes, should not be forgotten, and the abdomen should not be tapped below the level of the umbilicus, as a rule. In all operations upon the abdomen, the incisions should be made in a line more nearly horizontal than vertical, since the vessels of the abdominal walls have a transverse direction in most instances. An exception to this rule may be made to incisions made in the linea alba.

In disease affecting the portion of the abdomen below the umbilicus, the lymphatic glands of the groin are usually enlarged, while, if above the umbilicus, the glands of the axilla are liable to manifest enlargement.

The *inguinal canal* is larger in the male than in the female, and inguinal hernia is therefore more common among the male sex. The extent to which the internal structures of the abdomen pass through this canal modifies the appearance of the tumor; since, if the hernia does not pass through the external abdominal ring, the condition may be confounded with enlarged lymphatic glands of the groin; while, if it passes the external ring, it may enter the scrotum. The different forms of inguinal hernia are named from their general direction through the walls of the abdomen, from their contents, and from the relation of the neck to the deep epigastric artery. The points of differential diagnosis between the different forms, and between hernia of the inguinal region and bubo, hydrocele of the spermatic cord, and the femoral variety can be found in a form adapted for ready access, in a treatise by the author referred to in previous pages.[1]

The anterior wall of the abdomen is the seat of incision to reach the larger blood-vessels of the abdomen and pelvis—the aorta and the external and internal iliacs—but the steps taken to reach each of them, with the special advantages claimed for the several incisions advocated, can be best obtained from any of the later works on operative surgery.

The *region of the umbilicus* is often marked by an engorgement of veins, giving to that region a peculiar blue color—the so-called "caput Medusæ"—which is pathognomonic of some obstruction to the portal circulation, and to be explained as an effort on the part of Nature to establish a collateral circulation with the superficial veins of the abdomen. In the fœtus, this region is imperfectly developed in some instances, thus causing a hernia at the normal seat of the navel—the condition called "exomphalos." The same condition may be developed after birth, since the linea alba is perforated by numerous vascular openings, which are nearer together in the child than the adult. In females who have borne many children, the normal openings in this region become dilated; hence the frequency of hernial protrusions in this locality.

The *testicle* may be arrested within the inguinal canal during its descent into the scrotum, and thus give rise to a tumor of that region which might easily be mistaken for a hernia.

The escape of omentum or some convolutions of intestine below the arch formed by Poupart's ligament—the so-called "femoral hernia"—is much more common in women than in men, in which respect it makes a striking contrast to hernia of the inguinal region. These protrusions tend to curl upward, after they escape from the saphenous opening of the thigh, and thus appear to lie above the level of Poupart's ligament, so that they often afford extreme difficulty in deciding as to their character. Such a diagnosis is most important, as the methods employed in reduction of the femoral and inguinal varieties differ, and the steps of surgical relief are modified by the anatomical relations of the neck of the sac.

The *aorta* divides into the right and left common iliac arteries at a point situated about one and a half inches below the umbilicus. Perhaps a more reliable guide to the seat of its bifurcation may be given by mapping out the level of the highest point in the crest of the ilium, and determining where it would cross the median line of the abdomen; a slight distance to the left of this point of crossing will lie immediately over the bifurcation. If a line be drawn from the highest point of the iliac crest to that portion of the groin where the pulsations of the femoral artery can be felt (a slight curve outward being given to the line), it will correspond

[1] A Practical Treatise on Surgical Diagnosis. N. Y., 1880.

to the course of the common iliac and external iliac arteries. The point where the femoral artery can be most easily detected by its pulsations lies rather nearer the spine of the pubes, in the region of Poupart's ligament, than the spine of the ilium. It is in the exact curve of this line, if properly drawn, that the incision, first suggested by Cooper for the ligation of the external iliac artery, is made; and, if the incision be carried upward beyond the anterior spine of the ilium for a greater distance, the same opening will allow of the ligation of the common iliac artery.

The length of the *common iliac artery* may be given as about two inches in the majority of subjects, but it admits of extreme variations. Holden records, as the result of a large number of dissections made in reference to this point, that the length of this vessel varied from three-quarters of an inch to three and a half inches, and that it seemed to be in no way influenced by the height of the individual.

The *iliac region* may be entirely deficient at the time of birth, and the corresponding limb is usually wanting in these cases. The sigmoid flexure of the colon has been brought to the surface in this region on the left side, by Duret and others, and an artificial anus formed, although the operation in Duret's hands seems to have involved wounding of the peritonæum; this might, however, be avoided by opening the gut on its posterior surface where the peritonæum does not invest it. The hypogastric artery has been ligated in this region, and the operations upon the external and common iliac vessels are most commonly performed in the region of the crural arch. Caries of the ilium and of the bodies of the lumbar vertebræ may result in sub-peritoneal abscess in this region, which usually point upon the inner aspect of the thigh, near to the insertion of the psoas muscle. Fæcal impaction in the cæcum and the lower part of the ascending colon may show itself as a "sausage-shaped" tumor of the right side which indents on firm pressure. The condition of hernia, which is most common in this region, has been already considered at some length in previous pages.

The *region of the loins* may manifest a lateral curvature of the vertebræ in rickets, usually in antagonism to the deflection perceived in the thorax. It may also exist in those subjects who are accustomed to carry heavy weights upon the shoulder. Spina bifida may exist, if the spinous processes of the vertebræ are so deficient as to permit an extrusion of the investing membrane of the spinal cord. Wounds of this region with pointed instruments may possibly enter the spinal canal and sever the cauda equina or the lower end of the cord itself, thus producing severe symptoms. The superficial and exposed position of the spines of the lumbar vertebræ explains their frequent fracture. Such fractures are liable to produce not only paralysis of the lower limbs (provided the spinal cord or its nerves are implicated), but also impairment or actual loss of the control of the pelvic organs. Lumbar hernia has been seen by Petit, Cloquet, an others; the protrusion occurring at the point between the limits of the external oblique and the latissimus dorsi muscles, since this point offers less resistance to pressure than the surrounding parts. Cases are on record of the occurrence of urinary renal fistulæ in this region. Abscesses may form either in the tissues forming the posterior wall of the abdomen, or as a result of caries of the bodies of the lumbar vertebræ, perinephritis, simple contusion, or phlegmon. The condition known as "psoas abscess" is usually due to disease of the lower dorsal and upper lumbar vertebræ, and the pus so formed may follow the psoas muscle and point at the inner aspect of the thigh; hence it is to be confounded in some cases with a femoral hernia. The operations of "nephrotomy," in which the kidney is removed, and that upon the colon for the establishment of an artificial anus in case of malignant disease of the lower bowel, are both performed in this locality. It is possible to ligate the abdominal aorta without opening the peritonæum by a vertical incision made in the loins on the outer side of the sacro-lumbalis muscle; but, although in dogs the aorta can be tied without necessarily destroying life, the operation in man affords little, if any, hope to the patient.

It is customary to apply wet and dry cups to the loins in order to relieve those conditions of the underlying kidney which are associated with marked engorgement. The explanation of the efficacy of this step lies in the anastomosis which exists between the superficial lumbar vessels and the vessels of the renal capsule, so that blood is directly abstracted from the kidney by drawing it to the surface at this point. A practical point is suggested in this relation, viz., to apply dry cups in preference to the actual abstraction of blood by means of wet cups, since the former tend to increase the rapidity of the circulation in the vessels of the lumbar region, and thus act as a long-continued remedial measure, while the latter affords a benefit for a time, but one which ceases when the opened vessels have become choked by blood-clots.

Foreign bodies which are proof against the action of the intestinal or gastric juices are often introduced into the stomach either by accident or design. The foreign bodies which have been more commonly detected, include bullets, fruit-stones, coins, pebbles, marbles, hair, string, oats, pins, fish-bones, etc. The results of the introduction of such foreign bodies vary with the size, shape, and character of the body introduced. Small, flat, or oval bodies may be passed throughout the length of the intestinal canal, and thus voided without delay, pain, or other symptoms of disturbance. If hair, string, or other similar substance be present within the stomach, they may attain an immense size from the accumulation of food and mucus, and thus not only prevent their own expulsion, but create serious symptoms by causing ulceration or even perforation of the organ. Irregular-shaped or globular bodies often become arrested at the pyloric orifice of the stomach, or, provided they pass that outlet, they are liable to become again impacted at the ileo-cæcal valve. Sharp or pointed bodies are best voided by plentiful eating and the avoidance of cathartics, since, by so doing, the foreign body is more liable to become inclosed in the abundance of fæcal material. Needles, when swallowed, often penetrate the walls of the alimentary canal, and are sometimes transported to distant parts before their removal.

Abscess of the abdominal region is sometimes dependent upon an artificial aperture in some part of the alimentary canal. It may arise from perforation of the bowel, as the sequel of simple ulceration of its coats, from the lodgment of a foreign body in the intestine, from ulceration of the gall-bladder, from stricture or malignant disease of the bowel, and finally, from fæcal impaction, as a result of muscular atony or paralysis, dependent upon previous catarrhal inflammation of the intestine.

Perhaps no subject pertaining to the abdominal cavity has more interest to the operative surgeon than intestinal obstruction. The results of opening the abdominal cavity for the relief of such cases have been so remarkable, and the diagnosis is so often one of extreme difficulty, that I feel that this work would be incomplete without some reference to it. Intestinal obstruction may develop suddenly or slowly. The symptoms of the two varieties vary somewhat with the suddenness of the attack, but even more with the exciting cause and the seat of obstruction.

Sudden impairment of the normal calibre of the intestine may result from the following causes: 1, foreign bodies, either artifically introduced or formed within the gut; 2, congenital stricture, or some other malformation of the intestine; 3, twisting of the intestine, a condition termed "volvulus;" 4, the presence of peritoneal adhesions, acting as a ligature around the intestine; 5, invagination of the intestine, called "intussusception," as the result of intestinal tumors, worms, or other causes not understood; 6, thickened peritoneal covering or mesenteric attachment of some old hernial protrusion; 7, strangulation of a hernia from the sudden forcing down of new intestine into the sac, œdema of the surrounding soft tissues, or muscular spasm at the point of constriction.

Gradual impairment of the normal intestinal calibre may result from the following causes: 1, tumors pressing upon the intestine, and thus gradually occluding it by the slow development of the growth; 2, simple stricture of the bowel, from ulceration, injury, etc.; 3, malignant disease of the bowel, occluding its normal calibre; 4, tubercular peritonitis, by creating pressure on the intestine by the deposit; 5, abscess, from traumatism of the abdominal walls; 6, obstinate constipation or impaction of fæces; 7, inflamed and thickened intestine as the result of injury.

The chief symptoms by which intestinal obstruction may be recognized during life are: 1, a tumor, which may be detected by careful palpation of the abdomen, and which usually indents on firm pressure, if due to impacted fæces; 2, a pain which is usually local and deeply seated, and most marked over the situation of the tumor; 3, a dull percussion note over the tumor or the seat of obstruction in case the tumor cannot be felt; 4, obstinate constipation which withstands all attempts at removal; 5, vomiting, which, when stercoraceous in character, is pathognomonic of obstruction; when it occurs late in the attack, it may often be a guide to some obstruction low down in the intestinal canal; 6, tympanitic distention of the abdomen is liable to be very marked if the large intestine be occluded, but it is less prominent when the small intestine is the seat of obstruction; 7, in those cases which are of sudden advent, some authorities lay great stress upon the symptom of "visible peristalsis," as indicative of intestinal obstruction.

The connective tissue about the cæcum may become the seat of suppurative inflammation—the condition known as "*perityphlitis*"—when a tumor will usually be detected in the right iliac fossa, which is to be differentiated from the condition of typhlitis and fæcal impaction in the cæcum and ascending colon. It occurs from traumatism, pyæmia, ulceration of the vermiform appendix, the extension of inflammation from surrounding parts, etc. It is accompanied by numbness of the right lower extremity, an inability to raise the right thigh, a deep-seated pain in the iliac fossa, fluctuation and suppuration, and a tympanitic percussion note over the tumor when the patient lies upon the back, since the inflated cæcum lies over it.

In rare cases, the viscera of the abdomen may be protruded through some of the normal openings in the diaphragm, or that muscle may be lacerated, and thus allow of their escape into the cavity of the thorax. A want of the proper muscular tone may, in some instances, allow of such a protrusion without either a dilatation of the normal openings or laceration of its muscular fibres. It may follow a fall from a height, the passage of heavy weights over the abdomen, or even a sudden spasm of the muscles forming the abdominal walls, caused by a sudden slip or a slight fall. If the diaphragm be extensively lacerated, a violent pain is usually produced, and the stomach, transverse colon, omentum, or small intestine may be crowded upward into the thorax and possibly ruptured. In all hernial protrusions in this region, irrespective of their cause, the chest will usually be rendered prominent on the side where the organs are displaced; the heart may be pushed out of its normal relations to the chest-wall, respiration may be seriously impaired, the respiratory murmur will be absent over the hernial protrusion, vomiting and thirst will be developed, and death may follow from rupture of the displaced viscera, strangulation of the part, compression of the structures within the thorax, pleurisy, or peritonitis. If the intestine be protruded into the thorax, a resonant percussion note may be detected low down in the mediastinal region; while, if the more solid viscera be forced upward, the percussion note will be dull, and the diagnosis between a diaphragmatic hernia and some form of mediastinal tumor will be difficult. Auscultation over the seat of the suspected hernia may yield a gurgling sound, provided the intestine be displaced, and intestinal embarrassment may further assist in the diagnosis. If strangulation be developed, the hernial protrusion will probably be followed by symptoms of a general peritonitis, and the same may also be produced rapidly, if the protruded organ has undergone rupture.

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