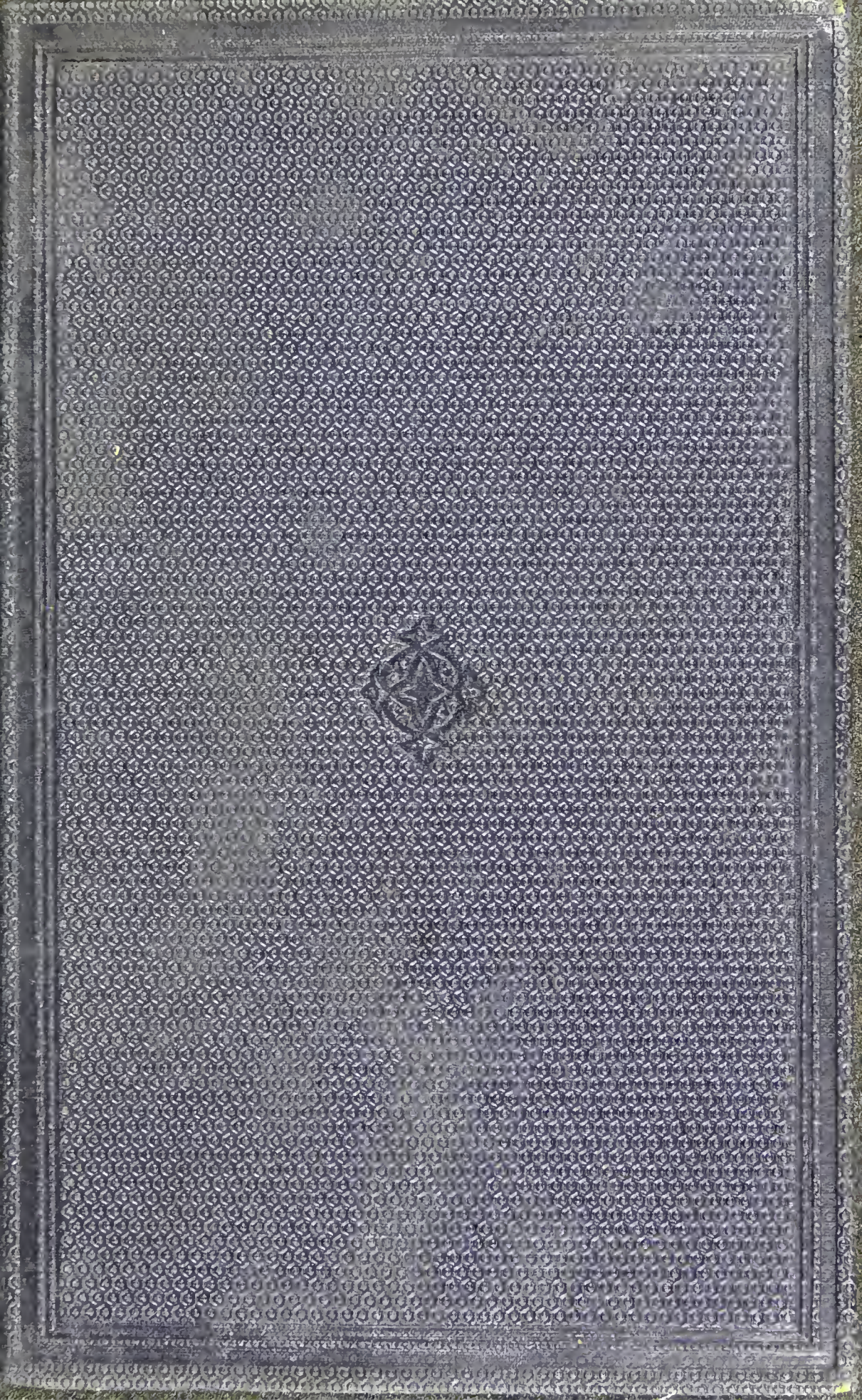

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PHILADELPHIA.

GUNSHOT WOUNDS

AND OTHER

INJURIES OF NERVES.

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AND OTHER

INJURIES OF NERVES.

BY

S. WEIR MITCHELL, M.D.

GEORGE R. MOREHOUSE, M.D.

AND

WILLIAM W. KEEN, M.D.

ACTING ASSISTANT SURGEONS U.S.A.,

IN CHARGE OF U.S.A. WARDS FOR DISEASES OF THE NERVOUS SYSTEM, TURNER'S LANE HOSPITAL, PHILADELPHIA.

PHILADELPHIA:

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PREFACE.

THE cases upon which this little volume is founded were studied during about fifteen months, beginning in May, 1863. At that date, Dr. Wm. A. Hammond, then the Surgeon-General, ordered that certain wards should be set apart for the treatment of Diseases of the Nervous System in the U. S. Army Hospital, Christian Street, Philadelphia. Two of the authors of this volume were placed in charge of these wards; and the third, Dr. Keen, was subsequently added as resident surgeon. Many difficulties and embarrassments naturally arose at the outset of an undertaking so novel as that of a special hospital meant to receive only a limited class of cases. As the Surgeon-General increased the number of such hospitals, creating distinct wards for various classes of diseases, these obstacles soon disappeared, and the good results of the system became apparent.

The authors of this essay desire to thank Dr. Hammond for the steady interest with which he regarded their inquiries, and to acknowledge the watchful care with

which he fostered the interests of scientific medicine, while organizing and perfecting that vast system of hospitals for which the country owes a debt of gratitude to a genius alike enterprising, intelligent, and laborious.

For constant and courteous attention to their special requisitions, they are also much indebted to Surgeon-General Barnes, M.D., U. S. A.; and for the unfailing zeal with which he has aided their purposes, and forwarded the scientific and benevolent objects of their wards, they are glad of the opportunity to thank the able and assiduous Inspector of this Department, Lieutenant-Colonel Le Conte, M.D., U. S. A.

October, 1864.

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CHAPTER I.

DIVISION OF SUBJECT.

When the U. S. A. Hospital for Diseases of the Nervous System was organized in May, 1863, it was at first proposed to limit its usefulness so that only those cases should be received. It soon became plain that it would be advisable to include also wounds and other injuries of nerves, and accordingly an order to that effect was issued.

No sooner did this class of patients begin to fill our wards, than we perceived that a new and interesting field of observation was here opened to view. Before long, so many of these cases were collected that, for a time, they formed the majority of our patients. Among them were representatives of every conceivable form of nerve injury,—from shot and shell, from sabre cuts, contusions, and dislocations. So complete was the field of study, that it was not uncommon to find at one time in the wards four or five cases of gunshot injuries of any single large nerve. It thus happened that phenomena which one day seemed rare and curious, were seen anew in other cases the next day, and grew commonplace as our patients became numerous.

Whatever may be wanting in this essay is, therefore, due alone to its authors, since never before in

medical history has there been collected for study and treatment so remarkable a series of nerve injuries.

To this general remark there are but two exceptions. In a year of this vast experience of wounds of nerves, paralyses, and epilepsies, we have not witnessed a single death, so that thus far no opportunity for the study of pathological anatomy has been presented.

The great bulk of our patients has consisted of men who have been shifted from one hospital to another, and whose cases have been the despair of their surgical attendants. As the wounded of each period of the war have been cured, discharged, invalided, or died, every large hospital has had left among the wards two or three or more strange instances of wounds of nerves. Most of them presented phenomena which are rarely seen, and which were naturally foreign to the observation even of those surgeons whose experience was the most extensive and complete. Nowhere were these cases described at length in the text-books, and, except in a single untranslated French book, their treatment was passed over in silence; while even in the volume in question but a limited class of nerve lesions was discussed. In the great monographs on military surgery, this defect is still so complete, that wounds of nerves are there related rather as curiosities and as matters for despair, than with any view to their full clinical study and systematic treatment.

When a number of cases were collected in our own wards, the want of some guide to treatment became manifest, and it was only after a long

and large experience that the indications for treatment grew to be well defined. Even then, there were certain obstacles to a successful system of therapeutics, obstacles which are purely technical in their nature, and which affect only the inmates of military hospitals so burdened and crowded as ours have sometimes been; for it must be borne in mind that it is not always possible with propriety to retain all cases which might need for cure or relief a treatment extending over many months, and, perhaps, even years. In fact, we have but too often had to lament the loss of sufferers, whom we felt we could no longer hold as pensioners upon the bounty of the government, even with the prospect of affording them a larger but too distant relief. Every surgeon will recognize the antagonistic workings of these military and medical needs, and will charitably interpret their effects upon the results of our hospital record.

The mode of considering so wide a subject has been the occasion of much reflection. It was finally resolved to treat of Nerve Injuries under the following heads, some of which will find or have found fuller consideration in our papers upon Reflex Paralysis, Epilepsy, Malingering, Muscular Hyperæsthesia, and Choreal Affections.

Primary effects of wounds and other injuries of nerves.

Injuries of nerve centres.

Injuries of the sympathetic nerve.

Wounds of fifth and seventh nerves.

Injuries of nerve trunks or branches, and their results, including—

Alterations of nutrition.
Lesions of sensation.
Lesions of motion.
Alterations of calorification.
Electric condition of the parts.
Treatment of nerve lesions.

Keeping in view the divisions here laid down, we shall treat each head of our subject in turn, illustrating every important detail with such cases as represent it in the most striking manner.

Our materials for this study consist of about one hundred and twenty cases, all of which have been carefully reported in our note books during the past year. No labor has been spared in making these clinical histories as perfect and full as possible. Those only who have devoted themselves to similar studies will be able to appreciate the amount of time and care which have been thus expended. We indulge the hope that we shall leave on record a very faithful clinical study of nerve injuries, and that we shall have done something at least toward lessening the inevitable calamities of warfare.

CHAPTER II.

PRIMARY EFFECTS OF WOUNDS OR OTHER INJURIES OF LARGE NERVES.

It has unfortunately been impossible accurately to determine the amount of nerve lesion in most individual cases. A ball passing above the brachial plexus, or just over any large nerve, will sometimes inflict injuries as severe and lasting, with reference to the destruction of functions, as the bullet which severs the nerve fibres themselves. For this reason we have been unable to classify nerve wounds so as to study the relation between the extent of the nervous injury and the amount of the consequent shock.

When, therefore, we state a case as one of injury to a nerve, we intend to assert merely that this nerve was the principal one whose distribution finally remained affected.

We have selected for this especial study, forty-eight cases of severe gunshot wounds of nerves. We propose to examine these statistically, with reference to the immediate effects of injuries of nerves. We desire to ascertain what are the first impressions of an individual so injured; the nerves wounded; the amount of shock, and the extent of the primary derangement of the functions of motion and of sensation.

Of the forty-eight cases before us, thirteen were lesions of the brachial plexus or axillary nerves.

One was a wound of the spine in the cervical region.

Two were injuries of the portio dura nerve.

One involved the inferior maxillary branch of the fifth pair, and one the cervical sympathetic nerve.

Eighteen affected the nerves of the arms, below the axilla, and twelve those of the lower limbs.

Of these by far the larger number felt, when shot, as though some one had struck them sharply with a stick, and one or two were so possessed with this idea at the time, that they turned to accuse a comrade of the act, and were unpleasantly surprised to discover, from the flow of blood, that they had been wounded. About one-third experienced no pain nor local shock when the ball entered. A few felt as though stung by a whip at the point injured. More rarely, the pain of the wound was dagger-like and intense; while a few, one in ten, were convinced for a moment that the injured limb had been shot away.

In wounds of the neck, involving directly or not the brachial plexus, the wounded man sometimes feels pain which is distinctly referred to the elbow or to some other portion of the arm. In two instances of neck wounds, the pain at the moment of wounding was intense, and was referred to the insertion of the deltoid muscle. Captain Stembel, U. S. N., whose case we have elsewhere related, (Reflex Paralysis, Circ. No. 6, U. S. A. Med. Dept., March 10th, 1864,) was shot in the right neck, and felt instant pain in both elbows. Lieutenant G., 14th Infantry, never felt any pain of moment in the

wounded limb, and so vivid was his impression of a wound in the other leg, that he found it difficult at first to get rid of the erroneous idea.

Shock.—In determining questions connected with the constitutional disturbance caused by bullet wounds, it is necessary to observe the proportion of those who fall with or without loss of consciousness, the feeling of general weakness, and the amount of blood lost.

What proportion then of men who receive severe nerve injuries—and all here were of this class—fall when struck, and how many lose consciousness from other causes than hemorrhage? To answer this, we will consider, first, the instances of wounds of the lower limbs, and then, excluding these, study the rest; for, as every man who is badly hurt in the legs falls, we can in these cases rely only upon the loss of consciousness and the feeling of weakness to tell us of the amount of general disturbance. The question of bleeding, as influencing the fall, or the subsequent feebleness, need not trouble us here or elsewhere, because the symptoms now being studied are of instant occurrence, and could not be due to any hemorrhage except from the great vessels.

Every case of wound of nerve trunks in the legs fell instantly, and not one of the whole twelve lost consciousness; yet in gravity and in the size of the nerves injured, these were among our worst cases.

Of the remaining thirty-one, seven fell instantly, unconscious: one only of these bled very largely. All of the seven were wounded in the neck, face, or arms.

Of the total number of arm cases, (eighteen in all,) two were of the class described above as falling senseless. Of the remainder, two only fell, but with entire consciousness and in full possession of their senses; fourteen continued standing, or walked away, falling, it might be, after a time, from loss of blood.

Of the wounds of the lower neck and axilla, brachial plexus, or axillary nerves, one fell senseless, four fell conscious, and the remaining eight suffered no immediate fall.

Finally, we may add that in nearly every case of severe nerve wound which did or did not fall, there was more or less general and nearly instantaneous weakness. If, then, we regard the fall with loss of consciousness as the most marked expression of the condition known as shock, we shall have some right to infer that it is most likely to be severely felt in wounds about the upper third of the body. At the same time we may add, that it has chanced to us to see a considerable number of cases of gunshot wounds of the upper regions of the chest which recovered, and in which the phenomena of shock seemed to have been unusually slight, considering the supposed gravity of such wounds.

Thus far we have studied the set of symptoms known as shock, from a purely clinical point of view, without discussing their causes. For the authors' views on this latter subject, and for the relation between states of shock and the more permanent condition of reflex paralysis, we beg to refer the reader to our paper on Reflex Paralysis, which was issued March 10th, 1864, from the Surgeon-General's office, as Circular No. 6.

As the result of further and considerably larger experience, we have seen good reason to abide by the conclusions therein stated.

As regards the relative extent of "shock" which occurs in wounds of nerves and in flesh wounds, we are unable to speak from any extensive observation. The whole subject, however, requires, and would well repay, a more careful clinical study on the field and in the operating room.

Paralysis of Motion and Sensation.—Next in order among the immediate symptoms, are the losses of voluntary control and of sensation which follow instantly upon all grave wounds of nerves.

To study these phenomena, we reject five cases, namely, the wounds of nerves of single function, as of motion or sensation alone; the wounds of a nerve centre; and that of the sympathetic. We have remaining forty-three. In many of these there were direct nerve wounds, in a large proportion there was probably injury due alone to the near neighborhood of the ball in its passage through the part; and here again we would state that, although it is easy in some cases to say whether a ball touched a nerve or not, in the mass of cases it is impossible so to do. This point becomes of moment here, because, when we examine the cases under study, with reference to the amount of immediate paralysis of sensation and motion, we find among them many in which there was instant annihilation of the functions of the part, with the utmost certainty that there could have been no direct wounding of a large nerve. Thus, of forty-three cases, thirty-two exhibited total loss of

motion with defective sensation, or entire loss of that function. In the remaining eleven, there were partial loss of motion, and usually slight loss of sensation.

When we define a case as one of total loss of motion, it is to be understood that the whole limb became powerless at once. Sometimes the volitional control was regained very rapidly, and in a few cases very completely.

This condition of local shock is very curious. A man is shot in the thigh, the ball passes near the sciatic nerve, and instantly the limb is paralyzed; within a few minutes, or at the close of a day or a week, the volitional control in part returns, but finally there may be left some single group of muscles permanently paralyzed. Where we speak of the primary motor or sensory palsy as slight, it is meant either that it was slight in degree, or limited in extent.

The most difficult fact to explain in this connection, is the great frequency with which a gunshot injury of a nerve causes total loss of motion and very little of sensation. It would be natural to suppose that a ball striking a nerve, or passing near it, would equally damage its motor and sensory fibres. Practically, it is the motor filaments which suffer most severely, most often, and most extensively. Nor is this less true of the case in all stages, for we find that the lesions of motion are always the least readily relieved and the last to improve. As yet no plausible explanation of these facts has occurred to us. Nor can we conceive why, as sometimes happens, a ball should seem to have respected altogether the

sensory fibres of a great nerve trunk. All of our anatomical views incline us to the belief that the two orders of nerves are intimately blended in the large nerves. Yet it appears scarcely possible that this could be, and one set escape the loss of function which the missile inflicts on the other. Is it possible that the fibres of motion and sensation may be grouped in bundles, and thus be liable to insulated disturbance, if we may so describe it? Or, if this view of the case be inadmissible, must we then concede to the two orders of nerves some difference in constitution or sensitiveness to foreign impressions, which makes one more liable to suffer than the other?—a conclusion which we should certainly hesitate to adopt. We shall have such constant occasion to illustrate these facts in the cases hereafter to be stated in detail, that it is scarcely necessary to dwell upon them more minutely at present.

Pain.—The last of the immediate symptoms of grave lesions of nerves, is pain elsewhere than in the wound. When the wound paralyzed tactile sensation altogether in the whole limb, there was rarely pain in the extremities of the wounded member; but this rule was not without exceptions. In some, neuralgic pains began instantly, and were general throughout the part, or were confined to some one nervous trunk in its ultimate distribution. In others, the pain was of that strange burning nature, as to which we shall hereafter have so much to say. It was rare, however, to observe this peculiar and agonizing form of suffering among the immediate consequences of a nerve wound. Finally,

it may be stated that, as a rule, acute pain elsewhere than in the wound is not frequent among the earliest symptoms of nerve lesions.

Should it be asked, how so full a knowledge of these early phenomena was attainable off the battle-field, we reply, that the utmost care was exercised in ascertaining from the patient the state of his functions, and that it was common to find that wounded men who are not weakened by loss of blood or excessive shock have a very natural curiosity as to the condition of the wounded part, and are apt almost immediately to handle it, and to try to move it. When we found a case in which any of the above-stated symptoms could not be made clear to us, we excluded it from consideration in this present connection. The large mass of our patients being Americans, they were usually possessed of at least some education, and often of considerable intelligence and power of observation, which was certainly not dulled by the interest with which such men regarded their own cases.

CHAPTER III.

WOUNDS OF NERVE CENTRES.

All the cases of wounds of the head which have reached us have been at a late date. In every instance they have been sent to our wards on account of epilepsy, chorea, or insanity—the consequence of the original injury. Their histories will be given in connection with the general subject of Epilepsy; and to the paper, by us, bearing this title, we beg to refer the reader.

The spinal injuries have been either wounds of the spine—concussion of that chain of nerve centres—or blows upon the lumbar or dorsal vertebra.

The first and second classes of spinal lesions we shall consider here as fully as our limited means will enable us to do.

The third class is altogether peculiar in its nature. Of late, especially, malingerers have shammed diseases of the back to such an extent that "back cases" in general are a matter of utter disgust to hospital surgeons. Among the numbers thus familiarly classed together are the real spinal congestions, etc. from blows, fevers, etc.; cases of neuralgia, rheumatic affections, kidney diseases, lumbar pains from strains, piles, and diseases of malassimilation, such as the so-called oxaluric diathesis. No wonder that among them the recreant soldier finds

a safe chance for deception. Dr. Woodward has well discussed this subject in his recent volume on Camp Diseases, and we trust to add something at least to his well stated experience. For the relation of the diagnosis of the class of cases now before us—to the matter of malingering, we refer to our paper on Malingering*—and for a general study of cases of falls, blows, and kicks on the spine, to our papers upon Muscular Hyperæsthesia, and Spinal Affections.

So few have been the lesions or injuries of the spine which we can relate here, that it is of course impossible to generalize from them. We can only relate them as fully as possible, with such comments as they may seem to demand.

The first case which we shall detail, admits of some slight doubt as to whether there was or was not a direct injury of the spinal column. The general history of the case inclines us to believe that the spine was wounded or that the missile lodged within the vertebræ in such close proximity to the nerve centres as to cause compression of the anterior columns.

Ball wound of face and neck, probably affecting the anterior columns of the cervical spinal marrow. Paralysis of the right and left arms and right and left leg. Recovery of the right and left leg. Partial recovery of the left arm, and almost entire of the right arm.

Case 1.—S. Johnson, æt. 18, Pennsylvania. No previous business. Private, Co. I, 8th Pennsylvania Cavalry. En-

* Am. Jour. Med. Sci., Oct. 1864.

listed for three years, Aug. 1861. Health good previous to enlistment, except a typhoid fever four years before.

Six months after enlisting he had a fever, probably of a malarious character. Three weeks before he was wounded he suffered with pain in the right leg, made worse by movement, but unaccompanied with any rheumatic swelling of the joints.

May 3d, 1863.—He was wounded by a small ball in the left cheek while riding at a trot. It entered at the middle of the ramus of the jaw, a little below the level of the teeth. From his position, as well as the after evidence, it seems that the ball passed backward and inward, and finally lodged in the spinal column. The edge of the jaw was somewhat injured, and probably was the source of the small fragments of bone which afterward escaped from the neck. When shot, the man fell forward on his horse's neck; says he was confused, though conscious, and felt as if he had been struck in the ear, and then lifted up in air. He also felt instant pain in the back of his neck, and in all of his limbs. There were no spasms. He was removed from his horse, and carried to a house near by. The motion increased his pain, especially any movement of the neck. He now became aware of the total motor paralysis of the arms and legs. He is not sure whether sensibility was also extinct or not. Two days after being wounded, he became delirious, but gradually recovered his senses, after three or four days. He was finally sent to Douglas Hospital, Washington, then under charge of Assistant Surgeon Thompson, U. S. A., and was transferred to our own wards July 19th, 1863.

The wound healed in nine weeks, after the discharge of a few small fragments of the jaw. Meanwhile his left leg improved slightly.

July 19, 1863. Present state.—A more wretched spectacle than this man presents can hardly be imagined. He lies in bed, motionless, emaciated to the last degree, and with bed-sores on both elbows and both hips. His hands lie crossed on his chest, perfectly rigid; the fingers extended; the skin congested and thin; the nails curved; false anchylosis of all the joints of the upper limbs; the head and neck rigid, with acute pain in these parts on movement. The right leg has motion of a feeble nature in

all of the joints; the left only very slight voluntary movement. The hands, the appearance of which has been already alluded to, present certain characteristics which belong usually to cases in which there have been wounds of the brachial nerves. In the present instance, as in many others, these peculiarities have been modified by the long-continued rest of the limbs in one posture. The results of the nerve injury and its consequent effects on the nutrition of the part may, however, be partially discriminated, so that what is due to them and what is due to mere rest may be discerned to some extent. Thus, the shining palm, the slight eczema, the burning pain, the atrophy, and the swollen joints, whose appearance simulates subacute rheumatism,—these, with the contractions of certain muscles, are all owing to the nerve lesion; while the anchylosis and the peculiar flattening of the hand are perhaps owing to this and to the long rest and disuse, the arms meanwhile lying crossed on the chest, the fingers in extension. The disuse alone would have caused anchylosis, but never to such a degree as occurs when the joints have been subacutely inflamed at the same time. The loss of the lateral palmar arch is owing to both causes, and the monkey-like appearance of the hand, the thumb rotated outward, and its nail looking upward and even toward the forefinger, is caused first by the subluxation of the metacarpo-phalangeal articulation, and secondly by the weakening and atrophy of the adductor and short flexors of the thumb. The nerve lesion, affecting the muscles and the general nutrition of the part, has so relaxed the unused tissues of the limb as to make the pressure of its own weight an effective aid in thus altering its form. Specimens Nos. 9 and 10, in the Army Medical Museum, are casts of both arms, and exhibit admirably their condition soon after they began to improve.

Sensation.—Tactile sense enfeebled equally in both arms, worse in the left. Feeble in both legs, worse in the left. Confused power of localizing sensation in the legs. Mistakes right for left, but not left for right.

There is muscular hyperæsthesia of the upper members, shoulders and neck; none in the legs. The left brachial plexus is sensitive to pressure, and this causes pain in the left arm and hand. The palms prickle, and burn a little, the feet not at all.

Every attempt at passive motion causes exquisite pain in the arms, hands, and shoulders, but most of all the back of the neck, about the first and second vertebræ. This is due, first, to the hyperæsthesia of the muscles, and, secondly, to the state of false anchylosis, owing to rest in one fixed posture.

He either is too weak to move the body, or is really paralyzed in the spinal muscles. The biceps, flexors, and wrist muscles are very rigid, as well as the trapezius, and the atrophy of the muscles throughout the upper limbs is singularly well marked.

His condition was too grave to allow of an electric examination.

There was no inflammatory swelling about the neck, and it was, therefore, resolved to treat him with free passive motion, breaking the adhesions, and forcing him to exert himself as far as he could. Tonics, porter, and liberal diet were ordered, and the shampooing and passive movement was vigorously carried out, despite his pain and most earnest supplications to be let alone.

The bed-sores were treated with alternate applications of iced-water for ten minutes, followed by a poultice as hot as could be borne. This local means, recommended by Brown-Séquard, succeeded marvelously, as it always does, the bed-sores healing easily within ten days.

August 25.—Still losing flesh. Great pain in the neck. Moves head and legs a little better. No change in the arms. Despite his prayers and protestations, the shampooing was continued; and, on October 15, he was greatly improved. He is fatter; the legs can be voluntarily crossed; appetite voracious.

December 7.—Great gain. Can move right arm freely. Can raise his head, bend and turn the neck. Sits up daily.

December 29.—Motion returning in right hand. No gain in left; but in both the malpositions have been relieved, and the hyperæsthesia reduced. From this time the improvement was manifest and rapid.

On January 7, 1864, the case was carefully reviewed, with the following results:—

Nutrition.—Much fatter; atrophy lessened. The hands have lost their smooth, shining look, so expressive to us of

a nerve lesion. The nails are less curved. The temperature is better.

Sensation.—Right arm and hand. Tactility and localizing sense good. Left arm rather less perfect. Tactility and localizing sense in legs normal, or nearly so. Sense of pain more perfect than at first, but even now a pinch causes a feeling of prickling only, rather than the usual sensation. There has been some burning of the right face, neck, and arm within the past week.

Voluntary Motion.—Left leg normal in extent of action, but still feeble. Right leg healthy. The right arm has regained all the shoulder and elbow motions, except that, owing to a remnant of contraction in the biceps, extension is not quite entire. Flexion, pronation, and supination are perfect. Extension of wrist incomplete, owing to contracted state of flexors. Flexion of wrist perfect. The thumb has lost abduction, owing to contraction of the adductor. Fingers, extension perfect, as also flexion of first phalanges.

The joints being still stiff and swollen, the second and third joints possess but two-thirds of their healthy extent of flexion.

Left Arm.—For ten days past the shoulder has begun to exhibit voluntary power. Elbow, no movement. Pronation and supination slight. Flexion and extension of wrist also slight. Fingers, feeble, tremulous movements.

For the first time we now examined the electric state of the muscles. The electro-muscular contractility was good in the right biceps, feeble in the left. Good in the right supinator longus, feeble in the left. Good in the extensors of both hands. Good in the flexors of the right hand, feeble in the left. The interossei on both sides showed great loss of this property. The abductor pollicis on the left had no electro-muscular contractility. As a rule, this property was lessened in the left arm and shoulder, while the electro-muscular sensibility was scarcely altered in the two members, except, perhaps, some diminution in the thumb muscles of the left hand, and in the flexor group of the left forearm. The whole left arm was still very stiff.

Ordered the patient to be etherized daily, and the adhesions to be forcibly broken. Passive motion to be continued, and the limbs to be faradized daily.

The future progress was inconceivably rapid. On Jan-

uary 20, he could rise to his feet; and by February 20, could walk a few steps. March 20, walks well without a cane or any aid; the left hand alone has not gained to any great extent, although the malposition of the hand has been much relieved. The patient was discharged in March, slightly shuffling in his walk, but with nearly entire use of all his limbs, except the left hand and forearm.

No one acquainted with lesions of nerves could have hesitated for a moment to class this case among them. It possessed every symptom usually attendant upon their worst forms, and must clearly have been due to some affection of a single nerve centre, which, being wounded, would affect the whole economy below the head. For these reasons, and from the course of the ball and the early signs, we have been led to consider it as an instance of injury to the spine. Whether it is to be looked upon as a nerve concussion or as a direct wound, is a point which we can scarcely determine. The phenomena do not enable us to class it as a case of reflex paralysis, and, if not this, it must be regarded as a direct or indirect spinal lesion. Why there should have been so little disturbance of breathing, it is not easy to see. The patient occasionally had slight dyspnœa; but he affirmed that it never was a well-marked symptom. His urine and stools were voided, without his being able to control himself, for some time after the wounding occurred, and even much later, his sphincter ani acted feebly. Had he been abandoned to his own wishes, he certainly would have remained a helpless cripple; but it is quite sure that nowhere, except under military rule, could he have been relieved; since, if allowed to do so, he would eagerly have escaped from the

painful ordeal of shampooing, passive movements, and the use of the battery.

Many of his symptoms will be elsewhere discussed, in connection with other cases, and in the chapter upon treatment.

The second case of wound of the spine is of almost equal interest, and is no less instructive as showing how perfect may be the recovery from injuries of the spinal column.

Gunshot wound of lip, tongue, and back of throat from Minié ball. Immediate paralysis of sensation and motion in all the limbs. Recovery of motion and sensation in lower limbs within an hour and a half, of sensation and motion in the left arm, within twenty-four hours. Continued palsy of the right arm. Gradual recovery of sensation, and partial, of movement. Removal of a tooth from the tongue and of the ball from the body of the third vertebra, followed by rapid and complete recovery.

Case 2.—Charles Cleland, æt. 19, farmer, enlisted for three years, August, 1861, Co. G, 7th Wiseonsin Volunteers. Healthy previous to date of wound. On July 1, at Gettysburg, while standing, about to load, a Minié ball entered the upper lip, a quarter of an inch to the right of the middle line, broke off or knocked out all the teeth in the upper jaw on the right side, except the second molar, and, passing backward, buried itself in the back of the pharynx, at the middle line, and on a level with the tip of the soft palate. The ball struck neither the palate nor the tongue. He fell senseless. Thinks he revived after a half hour or more. He felt the wound in the throat and the pain in the jaw, and was astonished to find that he could not move any of his limbs. He believes that an hour or more may have passed after the infliction of the wound, when a prickling was felt in the legs, and motion and sensation reappeared in them

at the same time. Within the next forty-eight hours, the left arm also regained its volitional movements and sensation. In this, as in many other cases, there was difficulty in assuring ourselves of the extent to which sensation had been lost. We have no doubt that it was affected in the present case, but we think the evidence of its entire absence is defective. His tongue and gums were very painful while healing, but within a few weeks this process was complete, except as to the pharyngeal wound, in which we supposed the ball to be, and from which pus was copiously discharged up to the date of his admission, August 9, 1863, when we found his condition as follows:—

Head carried erect and rigid. No lateral or antero-posterior motions of head or neck attempted, or, if attempted, causing excessive pain. The right arm has improved, so that the shoulder movements are normal, except those of the deltoid, which can only move the arm two or three inches from the side. The biceps is much enfeebled, and can only flex the forearm to a right angle. The posterior muscles are equally weak. In the forearm pronation is complete as to extent, but imperfect in power, and supination is limited by contraction of the pronator radii teres. The wrist and finger movements are all so feeble as to make them practically useless. Sensation slightly impaired in the forearm and hand. In the left hand there is still slight numbness of the cushions of the finger tips. He also complains of numbness on the lateral regions of the chest. The only absolute loss of tactility and of the sense of pain is in a space below and behind the right ear, forward to the chin, and half-way down the neck. (Superficial cervical nerves.)

Immediately after his admission, a tumor on the top of the tongue was observed. It fluctuated distinctly, and was therefore opened, when about a third of an incisor tooth escaped with a quantity of pus. This fragment must have been driven into the tongue by the ball.

At the back of the throat, on a level with the third vertebra, a mass of soft granulations, one-half inch high and three-quarters inch wide, projected forward. From the centre pus oozed freely out by a single orifice.

Upon examination with a Nélaton probe, which was readily thrust through this mass of soft tissues, we detected

a ball lying loose and apparently surrounded by fragments of the broken body of a vertebra. On consultation with Drs. Walter F. Atlee and Vandyke, we decided to remove the ball. It was accordingly extracted, August 10, by Dr. Morehouse, without any great difficulty. Two small splinters of bone were also taken away with caution, the patient ordered a full dose of morphia, and a nurse left to watch him. The ball, a Minié, was curiously mashed and flattened, and was dotted with bits of broken teeth.

No bad symptoms followed the operation. Small morsels of bone escaped from time to time, and a general change for the better ensued. The movements and sensation improved rapidly, and he felt so well that authority was needed to keep him in bed. Up to the thirtieth day, he had been enjoined to keep his head fixed, and had obeyed the order sufficiently well. About September 13, this restriction was removed, and he found that movement no longer gave pain. About this date he had a slight renewal of the numbness of the left arm, without any apparent loss of motor function. On September 13, two fragments of bone escaped from the wound: one was a part of the carotid foramen of the third vertebra,—as to its identity we could have no doubt; the other was a piece of the body of a vertebra, showing on one side of the fragment the surface which looks toward the interior of the canal.

October 24.—The arms are well and strong, and sensation is everywhere perfect, except in the space below the right ear, already mentioned.

October 30.—Wound healed.

November 1.—The man acted as orderly. He was transferred to the 2d Battalion of the Veteran Reserves, on May 19, 1864. Since then he has re-enlisted in the 1st Battalion.

We have met with few cases which seemed so unlikely as this one to get well without accident. There can be no doubt that the body of the third vertebra was crushed, in part at least, and it is not easy to see how the vertebral artery could have escaped unharmed, or the anterior columns of the cord have suffered so little.

Spinal Commotion.—The next class of spinal injuries to which we shall call attention is of the utmost interest.

In these a ball has passed over or alongside of the spine, and, in so passing, has caused paralysis of one or more of the members. In some of the cases seen by surgeons, who have related them to us, the ball chipped slightly the spinal processes. In others, as in all we have seen, there was no fracture, yet the results were as grave and as lasting as in the former cases.

We have searched the various works on military surgery without meeting with any cases precisely like those which we are about to relate. If we may judge from our own experience, they cannot be very uncommon.

Case 3.—It will be needless to relate this case at length, since it has been already given at page 5 of our paper on Reflex Paralysis. It was there quoted to show that paralysis, other than of reflex nature, might occur without direct lesion of nerve substance.

Morgan Emory, private, Co. C, 9th New York Cavalry, October 20 was shot through the neck, posterior to the vertebral column, without injury to the bones. All four extremities were paralyzed; but he recovered rapidly, with exception of the right arm, which was speedily restored by faradization. He returned to duty five months after being wounded. He had, as an early symptom, cutaneous hyperæsthesia in the trunk and arms. He also suffered, later in the case, with burning pain in the right hand, and a hyperæsthetic state of the muscles of the right arm and shoulder. There was no atrophy of the muscles, owing probably to the brief duration of the paralysis of motion.

Case 4.—Thomas Carroll, æt. 21, plumber, New Jersey. Enlisted November, 1863, Co. D, 3d New Jersey Cavalry. Healthy to date of wound.

December 15, 1863.—While seated on a fence rail, a pistol ball, accidentally fired, took effect on the back of his neck. It entered at the middle line, exactly over the interspace between the spines of the sixth and seventh cervical vertebræ, and was cut out on the left side of the neck, one inch below the angle of the jaw. No bone escaped at any time, and the surgeon, who explored the wound at the time of the injury, felt assured that there was no fracture.

The patient thinks that he was looking to the left when hit, but is not sure. If he be correct as to his position, the ball could have come near to no part of importance except the spine, and, in any case, it would be difficult to assert that it could have wounded the cervical and still less the brachial plexus. He fell senseless, was removed to a hospital tent, and finally recovered his reason within two hours. As he became aware of his condition, he found that although he could talk, see, and hear, he had neither motion nor feeling in any of his limbs. The trunk was equally powerless. He describes himself as at first unable to feel the bed on which he lay, but as having good feeling in the head and face. About the second day he had severe pain and tenderness in the right shoulder and neck. Gradually, sensation first, and then voluntary power returned to the whole right side. Within a month the left side also improved, with the exception of the left arm. Within two months the right side was well, and the left leg nearly so. About May 1, 1864, he began to be able to stir the left thumb.

Present state, May 14, 1864. (Admitted May 12, 1864.) General loss of flesh. Left arm exhibits marked atrophy. Measurements: Left biceps, $8\frac{1}{4}$ inches; right biceps, $9\frac{3}{4}$ inches. Forearm, left, $8\frac{1}{2}$ inches; forearm, right, $9\frac{3}{8}$ inches. Legs, no notable difference. The left shoulder muscles are fearfully atrophied, especially the deltoid. The arm has dropped, owing to want of support, so that a thumb may be laid in the furrow between the head of the humerus and the acromion process. This subluxation of the bone increases the apparent length of the left arm nearly half an inch. Specimens Nos. 1 and 2, in the Army Museum, are casts of both shoulders, which exhibit well the deformities. There are no contracted muscles. The hand is swollen and congested, the cuticle thickened, and hanging in yellow scales. Nails not curved. No acid sweat.

Sensation.—Slight burning of the left palm, a recent symptom. Tactile sensation and sense of pain absent in left ulnar distribution, and defective everywhere else in the arm below the shoulder. Normal in the right arm. Sensation alike in the legs, and normal in both.

Motion.—The right arm is weak. The left arm powerless, except slight ability to abduct the thumb. The left leg is weaker than the right, and his gait is awkward, from his swinging his right leg outward and forward.

If the paralysis and atrophy of the arm muscles in this case had been owing to a lesion of spinal centres, several must have been implicated, and the disease must have been not only extensive but also severe. How could we account, under these circumstances, for the escape of the lower limbs from permanent injury to function? It would be more rational to suppose that the ball caused slight spinal commotion and temporary paralysis of the legs, and that the more lasting effect on the arm was due to a more violent commotion of the nerves, where they pass out of the intervertebral spaces. Their position and relations would justify this belief, since they are here just emerging from bony canals, and are therefore the more liable to feel the shock of any contusing body.

Indeed, as a rule, nerves which are bruised or hurt otherwise, near to their point of exit from a bony canal, are apt to suffer more seriously, because they cannot yield easily to pressure, and because any after inflammatory swelling, confined as it is by bony walls, is certain to compress the contained nerve. For a somewhat similar reason, the ulnar nerve at the elbow and the musculo-spiral in its

curve around the humerus are liable to be easily hurt, and suffer greatly from contusion.

Case 5.—This so nearly resembles the last related as to require no minute statement. The ball entered the right neck, on a level with the hyoid bone, and over the inner edge of the right sterno-cleido mastoid muscle. It passed out at the back of the neck, just three-fourths of an inch from the middle line and a little lower than its point of entrance. He fell, insensible, and, reviving in about half an hour, found his right arm paralyzed as to motion and sensation. The mobility improved rather suddenly about the third week, and is now nearly normal. The sense of touch grew better gradually only, and is still quite defective in some parts of the forearm. The electric examination proved the muscles of both arms alike, as to their electro-muscular properties. He grew well rapidly and returned to duty. In this, as in the last case, no bone escaped. The ball must have gone very near to the vertebræ, but it is still possible that it may not have touched them.

The cases just related illustrate well enough what may be called commotion or concussion of the spine. The balls in each case passed through the neck in such tracks as to make it inconceivable that they could have touched any large nerves; we are, therefore, confined to two theories to account for the results.

Either these are cases of reflex paralysis or of spinal commotion. If, now, we study the circumstances belonging to Case 3, we shall see that the ball passed across the back of the neck, not very deeply, and that it hurt only muscles and skin, and could have encountered no large nerve trunks. Moreover, the region wounded is ill supplied with sensory nerves. All these facts seem to make it unlikely that this was a reflected palsy, and if not,

then it must have been produced by the rough shock of the ball passing over the spine. That a ball in thus passing may radiate effects, so to speak, upon tissues at a distance of an inch at least, is seen commonly enough, where a Minié, gliding over the sciatic nerve, palsies the limb as terribly as though the nerve had been in the very track of the ball. A missile, in its swift way through tissues, diffuses its destructive force for some distance around; and so it happens that a ball going near to a bone, or a chain of bones, may crush the cushioning muscles against them, and without causing fracture may so jar the parts as to disturb effectually the delicate nerve structures they were meant to guard.

If a ball moving across the back of the spinal bones may cause this disturbance, there is every reason to suppose that a ball moving close to the sides of the spine may be competent to produce like results. But the neck is so rich in nerves, and we know so little about how far the lateral destructiveness of missiles may be active, that there will always be cause for doubt, where the ball has gone through the neck from front to back, or reversely, and has seemed to have concussed the spinal column at the side. When a ball passing over the back of the spine has given rise to paralysis of the legs, we can be fairly confident that the spinal centres are the organs injured and at fault; but when a ball has passed through the neck, from back to front, close to the spine, and when paralysis of the arm only results, we cannot be sure that it is due to the shaken spine, or that it may not be owing to concussion of the spinal nerves at their exit, or to more

remotely affected nerves in the lower tissues of the neck.

These questions, and they are of much clinical interest, are to be settled in two ways: by a more careful study of these singular cases in field hospitals, with special reference to the parts implicated in the wound, and by an anatomical examination of recent wounds in men who have been slain. Such inspections should minutely ascertain, by ocular and microscopic examinations, if need be, how far around the ball track there is injury of tissue, whether palpably or not. The observer should thus examine the consequences to bone, nerve, and muscle in the near neighborhood of a ball track. Certain direct experiments would serve to illuminate points which needed such light, and the result would certainly clear up a subject which has never yet been rightly studied, and would probably lead to most valuable results.

The sole remaining case of gunshot injury affecting the spine is of interest, as showing how different the consequences of post-spinal wounds may be in the various cases.

Case 6.—J. L. Calvert, while lying on his belly, and about loading, was shot one inch to the left of the fifth dorsal spine. The ball passed downward, between the bones and superjacent tissues, crossing the spine, and emerging three and a half inches to the right of the tenth dorsal vertebra. No bone escaped at any after time, and there is every reason to suppose that the spines of the vertebræ escaped unharmed. He felt as though he had been severely thumped on the back, but did not lose consciousness, and even tried to continue loading, until he was forced to stop, owing to the pain in his back and shoulder. This pain was of course due to the movement of the wounded parts, and naturally

caused disuse of the right arm, which suffered very much more than the left. But besides the pain, which in time passed away, there was developed early in the case an exquisite hyperæsthesia of the shoulder muscles on both sides, including the deltoids and trapezius. It extended over the dorsal region to the level of the lower wound, and spread out above as described. It was very accurately defined by the patient, on the lower line and on the right side, and the boundaries did not change. It was not confined to the skin, but affected the subcuticular tissues and muscles, so as to limit motion, owing to the pain it caused. The sense of touch is naturally dull upon the back, but it was easy to show that it was not lost anywhere, for loss of touch may occur and sense of pain remain. In this instance a light pressure on the skin gave pain, and was felt as touch. The patient was hurt in July, 1862. When he entered our wards, early in February, 1864, his symptoms were abating, so that after a month of treatment with bromide of potassium, he was able to mount guard. He was shortly afterward returned to duty, at his own request, although not entirely relieved. At this time, as we should previously have mentioned, his right arm was normal in range of movement, but was feeble in power, and measured rather less than the left; all of this may have been due to long disuse.

This case was so interesting that we were at pains to satisfy ourselves of the verity of his symptoms. The means for so doing were found in the absolute correctness with which, unaided by sight, he marked the limits of the hyperæsthetic spaces, when tested by drawing a pencil point across the boundary between the healthy and the over-excitable regions. Had we entertained any further doubt it would have been set at rest by the numerous instances of contusions of the lower spine, which have come under our care, in many of which muscular hyperæsthesia has been a prominent symptom. We shall fully show, in another place, that both cutaneous and

muscular hyperæsthesia are not uncommon in wounds of nerve trunks, as well as in spinal injuries.

From our own experience, as well as from facts gleaned in conversation with field surgeons, we feel justified in arriving at the following conclusions in regard to commotion of the spine:—

A ball passing over the spine posteriorly may cause paralysis of motion and sensation, with or without rapid recovery, and with or without the nutritive changes in the limbs, which may follow wounds of their own nerve trunks. We refer particularly to atrophies and contractions of muscles such as took place in Case 4 of this paper.

It seems also probable that wounds of the upper neck, in which the ball has passed near to the sides of the spine, may, when followed by paralysis, be suspected of having caused it by their perturbing effect upon the spine itself, or upon the nerves at their points of emergence from the intervertebral canals.

CHAPTER IV.

WOUNDS OF SPECIAL NERVES.—WOUND OF THE SYMPATHETIC NERVE.

During our long connection with this hospital, we have encountered a single case of lesion of the sympathetic nerve. That such cases are not more often met with is due to the anatomical situation of the sympathetic, which makes it almost impossible to touch it with a missile, without at the same time destroying other parts whose lesions are usually fatal. So plain did this seem to us, that for a time we hesitated to admit the possibility of the sympathetic nerve being injured in the neck by a ball, and so plain does it still appear, that we are unable to explain precisely how it could have been hurt, unless we regard the case as one of commotion from neighborhood to the track of the missile; or suppose that, by one of the curious accidents of war, a ball passed in this case between the vessels and nerve, or so near as to wound the more delicate nerve and to push aside the vessels.

Case 7.—Edward Mooney, æt. 24, enlisted July, 1861, Co. C, 110th Penn. Vols. He was perfectly healthy before and after enlisting, until wounded at Chancellorsville, May 3, 1863. He was standing erect, and was looking toward the left side, when a ball entered his right neck, one and a half inches behind the ramus of the jaw at the anterior edge of

the sterno-cleido mastoid muscle. The ball passed across the neck, rising a little, and emerged immediately below, and a half inch in front of the angle of the jaw on the left side. He fell senseless, and, judging from the movements of his regiment, may have so remained during half an hour. On awaking, he found his mouth full of clotted blood, which he pulled out. The bleeding did not continue. After a short rest, he was able to walk nearly three miles to the rear, where his wounds were dressed with cold water. On his way he discovered that his speech had become hoarse, difficult, and painful, and that deglutition gave rise to great uneasiness and to burning pains. He says the sensation of pain was felt as though behind the pomum adami. After five days of great suffering and utter inability to swallow, he obtained some relief; but, for a month or more, was forced to swallow a mouthful of water after every mouthful of solid food. The power to swallow gradually improved, and is now as good as it ever was. A week after he was wounded, he became able to articulate without pain, although still hoarsely. This difficulty also lessened by slow degrees. At present, July, 1863, his voice is still a little hoarse.

During his recovery, which was rapid, the wounds healing within six weeks, he had a good deal of pain in the back of the neck. He says that he had headache, whenever after the injury he attempted to walk far, or exert himself; but he describes the headache as chiefly behind the ear and in the back of the head, with some frontal pain. About one month after he was hurt, a comrade noticed the peculiar appearance of his right eye, and called his attention to it. A little later, it began to be troublesome in bright lights, and has remained so ever since, with of late some change for the better.

July 15, 1863.—The pupil of the right eye is very small, that of the left eye unusually large. There is slight but very distinct ptosis of the right eye, and its outer angle appears as though it were dropped a little lower than the inner angle. The ball of the right eye looks smaller than that of the left. These appearances existed whether the eye was open or closed, and gave to that organ the look of being tilted out of the usual position. The conjunctiva of the right eye is somewhat redder than that of the left, and the pupil of the right eye is a little deformed, oval rather

than round. In a dark place, or in half-lights, the difference in the pupils was best seen; but in very bright light, as sunlight, the two pupils became nearly of equal size. The left eye waters a good deal, but has the better vision, the right eye having become myopic. In sunlight he sees well at first, but, after a time, observes red flashes of light in the right eye, and finally, after long exposure, sees the same appearances with the left eye also. He complains a good deal of frontal headache at present, and thinks that since the injury his memory has been failing, although of late it has improved. Has lost flesh and strength since he was wounded.

About the 30th August, the patient rode to the office of Dr. Dyer, who examined his eyes with the ophthalmoscope, but found no abnormal retinal appearances. Mooney walked from Dr. Dyer's office to the hospital, an unusual exertion, as he was weak, and avoided exercise on account of the headache it caused. An orderly who was with him on this occasion, remarked to one of the hospital staff upon the singular appearance which his face presented after walking in the heat. It became distinctly flushed on the right side only, and pale on the left. This fact was afterward observed anew by one of us. The patient had used exercise and had just come in. The right half of the face was very red. The flush extended to the middle line, but was less definite as to its limit on the chin and lips than above these points. He complained of pain over the right eye, and of red flashes in that organ.

A careful thermometric examination, made *during repose*, showed no difference in the heat of the two sides within the mouth or ear. We regret that it did not occur to us to repeat this when the face was flushed by exertion. Under a tonic course of treatment he gained ground rapidly. The eyes became less sensitive, the pupils more nearly alike, the line of the lid straighter. He had several attacks of faintness after exposure to the sun, and these, with occasional diarrhœa, retarded his recovery. He was at last able to return to duty, and left for that purpose in October, 1863, nearly all of his peculiar symptoms having disappeared, and his general health having been altogether recovered.

Was this a case of wound or injury of the cervical sympathetic nerve? Had the peculiar phenomena been observed from the date of the wound, such a conclusion would have been irresistible. It is scarcely less than this even under the present circumstances. When the sympathetic is cut in the neck of an animal, the pupil contracts; the ball seems shrunken a little; the line of the lids is altered; the caruncle appears prominent; the eye is congested and red, and the temperature of that side of the face rises: most of these symptoms decline in prominence after one or two months; but exertion will even then alter the relative temperature of the two sides of the face. This latter symptom is associated with an increased flow of blood to the part affected, and of course is not as visible to the eye in an animal as it would be in man.

If, now, we suppose that this second period had been reached in our patient's case, he would possess all the more decided signs of paralysis of the facial sympathetic nerve, namely, contracted pupil, ptosis, altered line of lids, congestion of the conjunctiva, appearance of altered size of eyeball, and unilateral flush on exertion. Probably this latter symptom was accompanied by rise of temperature; but, as to this point, we cannot be sure. The time for constant difference of temperature might have gone by. If it were a wound of this nerve, it becomes most interesting on account of the brain symptoms attendant upon it, and the other subjective signs which may escape notice in animals. If we add to the evidence already detailed,

the fact that the ball must have passed behind the vessels, and therefore very near at least to the nerve in question, the probability of its lesion becomes considerable.

But if it was not this, to what shall we attribute the symptoms? They might have been due in part to retinal disease, but of this there was no ophthalmoscopic evidence, and the examination was made by a most skillful observer. Nor would such disease, if it existed, account for all the ocular symptoms, and still less for the circulatory phenomena.

Two possible causes remain to be discussed. Mr. Paget, in an able lecture, to which we shall again have occasion to refer, (see *Med. Times and Gazette*, March, 1864,) mentions several cases of injuries of the brachial plexus at the base of the neck, in which the pupil of the eye on the side hurt was altered in size. We have seen as yet no such result in wounds involving the plexus, and merely mention it here to point out that in this present case the wound was too high to injure the nerves of the arms, and that they suffered no loss of function.

The consideration of Mr. Paget's remarks naturally leads us to speak of the only remaining theory which could be employed to account for the facts before us. Dr. Hughlings Jackson suggested to Mr. Paget that the change in the pupil, in injuries of the brachial plexus, might be due to the relations of this plexus to the cilio-spinal portion of the spinal cord. This region, whose discovery was made by Budge and Waller, extends from the first cervical to the sixth dorsal vertebra, or even so low as the tenth, according to Brown-Séquard. Within these

limits irritations of the cord act on the pupil precisely as do similar agencies addressed to the sympathetic nerve itself. With these facts before us, we may believe it possible that, in our own case, the ball, when passing in front of the vertebra, caused commotion of the spine in the cilio-spinal track, and so reacted on the eye and face? It is difficult altogether to dispose of this conjecture, for, as we shall show in another paper, spinal disease sometimes does affect the pupil in a remarkable manner. At present, it is to be borne in mind that there were none of the usual evidences of severe spinal shock.

With these observations, we leave the case to the judgment of others. In the present state of knowledge as to the sympathetic nerve, it would have been wrong to omit facts, which may possibly be looked upon as confirming in regard to man what we know to be true of animals. We ourselves are of opinion that this was a case of injury of the sympathetic nerve, and if so, it is probably the only one on record.*

WOUND INVOLVING THE FIFTH PAIR OF CEREBRAL NERVES.

A single case of injury of the fifth pair has been treated in our wards. It has been briefly referred to in another paper, (on Reflex Paralysis,) but as it

* In the case of Captain Stembel, U. S. N., (Reflex Paralysis, Circular No. 6,) there was loss of sight in the right eye immediately upon injury of the right neck. He has still, June, 1864, slight ptosis, worse on awaking in the morning, contracted pupil and imperfect vision, but no unilateral flush.

has some physiological interest, we think fit to relate it at length.

Gunshot wound of inferior dental branch of the fifth pair.

Case 8.—John Schultze, æt. 23, German, enlisted August, 1862, Co. G, 26th Wiscs. Vols. Previous health good. At Gettysburg, July 3, 1863, while marching at a long distance from the enemy, a single shot, from some remote picket, took effect on his left cheek, over the lower edge of the malar prominence. It was probably fired from an elevation, since it passed across the ramus of the jaw, and entered the anterior margin of the trapezius muscle, whence, two weeks later, it was removed by Dr. Keen. The ball, a Minié, was very much deformed. It somewhat injured the ear in its passage, but although it crossed the ramus of the jaw obliquely, and probably broke off some splinters, it did not fracture the bone so as to affect mastication. The patient fell senseless when hit, and remained thus for at least half an hour. He had no pain. The whole left side of the face was devoid of feeling, and so continued until the second day, when sensation came back rather suddenly, except in a space, which included a large part of the ultimate distribution of the left mental nerve. The first and larger loss of sensory appreciation was probably a result of the local shock. When he recovered his senses, he found that the left arm was almost useless from loss of power. The fingers could be moved well enough, but the arm could not be flexed at the elbow. Sensation was but slightly altered. The arm was merely numbed. The right arm was also weakened, though to a less degree, but in it the sense of touch was defective to a remarkable extent, so that when he sought to undo his belt he could not feel the buckle. This was not merely a general shock or weakness, for his legs were as strong as usual, and he was able to walk to the rear unassisted. Motion and feeling returned within four days to the right arm, but the left recovered more gradually, and was still weak as late as August 10, 1863.

During the first week there was great swelling of the neck, which was relieved when the ball was cut out. During September two or more small spiculæ of bone escaped

from the neck, below the chin. They were probably fragments from the injured jaw.

When Schultze entered our wards, August 10, 1863, his wounds were healed. The jaw could be but slightly opened, owing to the amount of deposit on the cheek and over the articulation. Early in his case, before swelling occurred, he could open and shut the mouth easily. Motion gradually returned.

August 12, 1863.—The skin of the left lower lip and chin is perfectly insensitive to pain and touch, from the middle line to the left angle of the mouth, and within a space between the middle line of the chin and a line drawn obliquely downward and outward, from the left angle of the mouth to the lower edge of the inferior maxillary bone. The curve of the lip within is dead to touch, and so also are the gums in this region. The teeth and gums of the left lower jaw are generally less sensitive to touch and pain than is natural, but they are not altogether deprived of sensation. The external region, defined above, has no appreciation of touch or pain, but the point of exit of the nerve is the seat of neuralgic pain, and pressure on this point is felt by the patient, so that even here the deeper tissues are less affected than the skin. The most intense applications of the electric brush to the dried and powdered chin caused no pain. Wet conductors, which threw the subjacent muscles into contraction, seemed to cause deep-seated pain. Under the use of dry conductors, applied daily, Schultze improved, but not until the thirtieth application of the battery, which was used daily.

November 19.—He was set to work as orderly.

November 27.—The anæsthetic region has gradually narrowed, and is now within a triangle, whose base is the border of the lip, and whose apex lies at the edge of the chin, immediately below the left angle of the mouth. The electricity was steadily used during four months, when, the anæsthetic space being one-third of its original size, the teeth and gums more sensitive, and the jaw motions good, treatment was abandoned. Within twenty days the anæsthetic space again enlarged. It was more speedily lessened in size by twenty electrizations. As he could now chew well and was in other respects healthy, and desirous of being in the field, he was sent to duty at the close of February, 1864. Whether or not the area of insensibility increased afterward, we cannot state.

It seems probable that in this case the ball injured the outer side of the ramus of the jaw, but did not break it across or extensively crush it. The local shock seems to have partially destroyed the vitality of the inferior dental nerve where it enters the dental canal. Had it totally destroyed the nerve, the anæsthesia would have been entire. The reflex paralysis of the arm was of an interesting nature, for the wound was not a grave one, and the inferior dental branch of the fifth was the only large nerve affected. Lastly, the successful use of electric currents, limited to the skin, in treating the anæsthesia, and the relapse when this treatment ceased, all constitute the case one of clinical value and interest.

WOUNDS INVOLVING THE PORTIO DURA NERVE, (SEVENTH PAIR.)

Gunshot wound of left portio dura nerve. Total paralysis of motion. Taste affected. Tongue movements impaired. Deafness on left side.

Case 9.—John C. Dyre, Pennsylvania, æt. 19, machinist, enlisted May, 1861, Co. E, 71st Penn. Vols. Health good up to date of wound, at Gettysburg, July 3, 1863.

While aiming, a ball entered just behind the left ear at the level of the meatus. It broke the mastoid process slightly, and was said to have gone forward and downward. It has not been found. He fell unconscious, and, reviving within about two hours at a hospital where he had been carried, he found that he could not use the jaw, owing to pain in the ear. There was also pain in the left cheek and brow, left neck, shoulder, arm, and hand, together with the left chest. The left arm was weak for several days. He may have fallen upon it. The pain was a neuralgic ache, not the pain of a bruise.

Water-dressings were used after a vain search for the ball. Within two days he had pain in the lower teeth and jaw on the left side. After five weeks all the pains

grew better rapidly, and at the same time the motions of the jaw returned. The ear was deaf from the first; but he does not know whether blood flowed from it or not, or when pus first came from it.

Present state, February 14, 1864, *eight months after reception of wound.*—The features are slightly drawn to the right in repose, and excessively so during laughter and speech. (Specimen No. 26, in the Army Med. Museum, is a cast of his face in repose.) The left side is absolutely paralyzed. The inner canthus of the left eye is a little rounder than that of the right eye. The tears overrun the lid at times. Inability to close the lids on the left side; owing to which he has formed the habit of rolling the eye-ball upward, so as to cover it with the passive lid. He then supposes that he has closed the eye. Chewing on the left side causes pain in the teeth, which endures for some time. Sensation is perfectly normal on the paralyzed side. Motion is of course utterly lost in all the muscles of expression.

Electric Test.—Not the slightest contractility exists in any of the muscles of expression, on the left side, with a curious exception. The muscular layer of the orbicularis oris in the upper and lower lips still responds to the current, but more remarkably below than above. There is, however, no voluntary control over these parts. The buccinator alone of the masticating muscles seemed to have its electric contractility enfeebled, but not wholly lost.

Examination of Special Senses—Tongue—Motions.—The upward and backward motion of the base of the tongue is awkwardly performed. In most of its movements the tongue inclines slightly to the right side, and is capable of being drawn to the left side. The palate hangs a little to the right and acts imperfectly, so that *food is apt to enter the nose.* There is some further loss of power in the other muscles of deglutition, for he is often troubled by food entering the glottis, while at times it is thrust back again into the mouth.

Speech.—He pronounces many letters with difficulty or imperfectly, so that his speech may be said to be a little thick, and he so describes it, referring the trouble to his lips and tongue. The labials are of course affected, but the guttural sounds are also imperfectly executed.

Taste is apparently impaired over the entire left tongue. It was examined by comparing its appreciations with those of the other side.

Electric State of Tongue.—No loss of its electric properties was detected. Hearing on the left side was destroyed. The back part of the bony meatus was carious, and the membrane absent, perhaps from inflammation consequent upon the wound.

Treatment.—The patient was industriously faradized for several months without the least gain in any respect.*

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* As these cases have considerable interest both to physicians and to biologists, we have added, in this note, minute details as to the state of the speech and the senses, which were unnecessary in the text.

1. *Movement* was imperfect as follows :—

The *base* of the tongue could not be well drawn upward and backward as in swallowing and in pronouncing the gutturals. Hence the food, when half swallowed, would regurgitate and be thrown forward into the mouth, or fall into the trachea, the closure of the fauces being incomplete. The muscles employed in this movement are the posterior belly of the digastric and the stylo-hyoid, (both supplied by the facial,) and the stylo and palato-glossus, (both supplied by the ninth pair.)

The *tip* of the tongue could be moved vertically, but was always inclined to the right, and could be moved to the right but not to the left.

The *base* of the tongue could be moved forward (by the genio-hyo-glossus, and the genio-hyoid supplied by the ninth, and the anterior belly of the digastric and mylo-hyoid supplied by the fifth) with accuracy and ease, but the body of the tongue was still deformed, being drawn to the right. All the other movements were normal.

2. *Speech* was of course impaired by the difficulties of movement, as mentioned above, as well as by the paralysis of the muscles of the face. A number of sounds he pronounced inaccurately, but in common conversation it was not so noticeable that it would have been thought anything more than an ordinary peculiarity. He talked "thick" and lisped. On a careful anal-

The nerve may have undergone such changes as might make it impossible to restore to the muscles their lost properties.

The cases above narrated possess interest, because they instructively repeat phenomena usually seen in disease alone. It has been well known that in very superficial disease of the portio dura, the resultant palsy does not affect the sense of taste, or disturb the power to speak or to swallow food. When the injury is deeper, these latter phenomena sometimes accompany the facial palsy. Now, in all of the cases

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ysis, the following are the only sounds, in addition to all the labials, which were affected:—

g hard, as in "hug," was sounded like *k*.

g soft, as in "surge," was sounded like *ch*, as in "search."

l was sounded with some difficulty.

n was sounded with some difficulty.

r he stutters over, if pronounced rapidly. In order to roll it, he has to give his tongue "a start," as it were, by drawing it far back and quickly running it forward against his teeth, when he can produce a quick, short, and rather mechanical trill.

s he lisps decidedly.

t is pronounced with a slight *th* sound, as in "thick," as if he could not control the tip of his tongue.

y, as in "yes," he aspirates; the elevation of the base of the tongue being plainly insufficient to close the fauces.

z is pronounced with a slight *th* sound, as in "this;" a slight lisp.

3. *Taste* is greatly impaired apparently over the entire left side of the mouth. Pepper, salt, mustard, tr. ferri chlor., etc. he could not perceive when put on his tongue, nor even for a considerable time after shutting his mouth. He had to roll his tongue around before he could taste them. The right side is normal.

4. *Galvanic Condition.* We could see no difference between the two sides of the tongue. They contracted equally well.

before us, the ball injured more or less directly the middle ear, and in all there was some loss of taste in the tongue on the side wounded. Only in the first of these cases (No. 9) was there any marked defect of movement in the tongue, and only in this instance was deglutition injured.

Gunshot wound involving portio dura. Paralysis of Motion. Loss of electro-muscular contractility within five weeks. Rapid spontaneous return, followed by return of voluntary power.

Case 10.—J. Gager, æt. 42, blacksmith, Co. M, 14th N. Y. Heavy Artillery, enlisted December, 1863. Health good. Wounded May 12, at the battle of Spottsylvania Court House.

The ball entered the left posterior neck, one and three-quarter inches from the spine of the third cervical vertebra, and was cut out immediately behind and below the left ear, about two and a half inches below meatus and a quarter of an inch behind the jaw. Its track is unknown, except that it injured the ear and paralyzed the portio dura of the seventh nerve, and splintered the edge of the ramus of the jaw. His head, at the time he was shot, was thrown forward and downward. He fell, conscious, bleeding freely from the ear only. After two minutes he arose and walked away, the blood still *spouting* out from the ear until it was checked by a bandage over that organ. He had no pain until the next day, when he had the usual inflammatory pains. His eyesight is said to have become affected on the second day, when there was, according to his account, a distinct difference against the left eye. Things appeared hazy to the left eye. This remains the same. The paralysis of the muscles was immediate, and his speech was made difficult. This seemed to him to come from a defect in the tongue and lips. Hearing was lost at once in the left ear.

Present state, June 8, 1864.—The pains in the face, and the swelling, which was never great, are now better. The wounds are open, but healing.

The nutrition is unaltered. The lines of the face are lost, the tip of the nose and the lower mobile portions of the face are drawn to the right. The left eyebrow has fallen a little. The tears run over the edge of the lid.

The tongue is perfectly movable and under entire control of the will.

Speech perfect, except a slight difficulty in articulating the gutturals, and still more as to the labials.

Special Senses.—The left eye sees only one-third as well as the right.

Hearing is lost in the left ear. On washing out the pus a mass of granulations was seen at the bottom of the ear. Possibly the bony meatus may have been fractured by the ball, but no bone escaped except pieces of the jaw, which came out with the ball.

Taste.—There seems to be no marked loss of gustation. Taste is dulled a little on the left side. Tactility is equally good on the two sides, both in the tongue and face.

June 20.—The sight is becoming worse. Dr. Dyer is of opinion that it was affected before he received his wound. Induced electric currents give rise to slight movement in the left eyelid, and the elevator of the angle of the mouth. A rapid recovery was predicted, and, in fact, within three days later, voluntary power returned in the orbicular muscle of the eye. By July 27, every motion had been reacquired.

Gunshot wound involving portio dura. Loss of electric contractility in the muscles of expression. No relief.

Case 11.—William S. Sylvester, farmer, æt. 22, born in Norway. In this country sixteen years. Enlisted for three years, September, 1861, Co. D, 7th Wise. In good health up to date of wound. At Gettysburg, July 1, 1863, he was shot, while standing, with a Minié ball, which entered the face an inch below the outer angle of the left eye. It passed backward and outward across the external auditory meatus, apparently injuring the left ramus of the jaw, high up, and finally emerged behind the lower half of the mastoid process, which it fractured. He fell instantly senseless, and, reviving after a few minutes, crawled away, and with aid reached

the shelter of a house, where he was taken prisoner. After three days he was recaptured, and sent to Philadelphia to the Satterlee Hospital, and thence to us, August 2, 1863. The wound has never been painful, rarely more than sore; fragments of the jaw escaped anteriorly, during the treatment, and also portions of the mastoid process at the wound of exit. His left face swelled, and is still greatly enlarged. The conjunctiva of the left eye was a good deal inflamed at first, but is now free from inflammation, and the sight unaltered. Early in the case a good deal of blood escaped from his left ear, and the hearing was noticed to be, as it still is, rather dull. The inflammation about the articular portion of the lower jaw is such as to have caused great and painful difficulty in opening the mouth, which is so locked that it is impossible now to ascertain by touch, within the oral cavity, how much injury has been done to the bones. At present, August 4, the anterior wound is healed, but the posterior is open, and an abscess, which formed below the left ear, is discharging very freely. The parts in front of the ear are confused in a mass of firm plastic deposit. There is total palsy of the muscles of expression in the face. The brow and lid hang, the cheek is flabby, the mouth pulled toward the sound side. The tongue moves, but as the jaw is locked by the inflammatory deposit about the ramus, the cheek, and the articulation of the maxilla, it cannot be closely examined. He was long annoyed by the inability to cover his eye with the lid; but has now learned to roll the eye upward, so as to cover the iris. He then supposes that he has closed the lid. This same phenomenon was noted by Sir C. Bell in several of his early cases.

The history of the present case is somewhat obscure, nor can we be absolutely sure as to whether the portio dura, which is paralyzed, was primarily injured by the ball, or secondarily affected by the large and firm deposit in front of the ear, which must of necessity have involved nearly all the facial branches of the nerve. The wound was dressed without other treatment.

October 19, 1863.—The swelling has subsided one-half, but there is still dead bone in the wound, probably a piece of the ramus of the jaw. A mass of granulations fills the outer ear, but the hearing does not seem to be utterly lost. After tearing the granulations away, it was found that the membrane was gone, that there was some inflammation of

the middle ear, and that below the bony meatus, and in front of it, dead bone could be felt.

Faradization of the face showed total loss of electric contractility in all the muscles supplied by the portio dura, and also in the posterior portion of the masseter, which had been injured by the ball and by the subsequent inflammation.

As the face was still inflamed in September, no attempt to treat the case was made till October. From October 1, however, to November 3, he was faradized, although with slight hope of aiding him. At this date he was no better. On returning, December 3, from a furlough, a cast of his face was made. (Specimen No. 25, Army Medical Museum.) The wounds were then healed, and the mouth could be opened.

At this time we were able to observe that taste was duller on the left side of the tongue than on the right; but that the motions and tactile sense of the tongue were healthy.

The electricity was used persistently up to January 10, 1864. It gave a good deal of pain, but in no way relieved the patient's paralysis.

In February he was transferred to the Veteran Reserve Corps. He had gained the power to chew his food, but suffered from all the annoyances of complete facial palsy.

In this as in other like cases, a new course of faradizations should be attempted at the close of a year. Unfortunately for us and for the patient, the ball, which passed in behind the meatus, has never been traced, so that it is in vain to theorize as to what nerves may have been cut by it. In Case 10 the facial must have been merely contused. It could not have been cut, or electric contractility would not have returned to the muscles at so early a date, nor would volition itself have been restored so soon after the muscles began to respond to the battery. In Cases 9 and 11 it is likely that the facial nerve was severed, and in Case 9 the ball probably inflicted deeper mischief than in the other cases.

CHAPTER V.

WOUNDS AND OTHER INJURIES OF NERVE TRUNKS.

Before considering the lasting symptoms of injuries of nerve trunks, it will be well to point out the varied modes in which these injuries arise.

They may be thus classified:—

1st. Direct injury of nerve trunks by a missile, partial or complete division.

2d. Commotion from the near passage of a missile.

3d. Contusions, as from a blow.

4th. Injury resulting from dislocation, or attempts at its reduction.

5th. Cicatrix pressure.

6th. Extension of diseased processes from wounded nerves to those which are healthy.

Class 1st.—*Of direct sections* or partial sections of nerves by a ball, no mention need be made at present, since so many of our after-cases will illustrate their character.

Class 2d.—*Injuries by commotion* have been already discussed with reference to spinal lesions, and will be further exemplified under other headings.

Three classes of nerve injury remain for brief examination.

Class 3d.—*Contusion of a nerve* by a blow, the form of neural injury most common in civil practice, and one of the most apt to be permanent and serious in its effects, has been best studied by M. Duchenne, (*De l'Éleetrieité Localisée*, Paris, 1862;) but many such cases, imperfectly reported, are on record in the great surgical text-books. Rarely grave in its first effects, a severe blow on a nerve is prone to give rise to ultimate consequences as fatal to functions as those which arise directly from a ball wound itself. Again and again there have come before us, too late for any ready relief, cases of this kind, which, had they been earlier understood, might possibly have been saved from many of the evils which followed.

Class 4th.—*Injuries from Dislocations.* Closely related to cases of commotion are those obscure accidents to the brachial nerves, which arise from dislocations of the humerus or attempts at reduction.

Repeated instances of accidents belonging to Classes 3d and 4th have been seen by us. We select as illustrations the following cases:—

Blow on left shoulder causing paralysis of motion and sensation, with subsequent atrophy of the supinator longus, and extensors and flexors of the fingers. Flexors contracted.

Case 12.—James Walton, æt. 47, Ireland, sailor, enlisted June, 1862, Co. A, 115th Penn. Vols. At the second Bull Run battle, August 30, 1862, while lying on his belly in the woods, a shell, exploding in the air, cut off a large branch, which, falling, struck him on the left shoulder, or rather across the base of the neck. He grew dizzy, felt stunned, and lost consciousness. After a certain period, of whose duration he is ignorant, he revived to find that he had

sharp pain down the arm to the hand. It was totally paralyzed as to sense and motion. Up to September 15, 1862, he was a prisoner. At this date, when exchanged, sensation was still absent, but motion was improving slowly. It gained, however, at the same time that atrophy was taking place in the very muscles whose power was returning. Within the year, from September, 1862, to September, 1863, little or nothing was done for the case. The motions grew better, with one exception; sensation returned to a perfect extent, and the muscles ceased to waste.

January, 1864. *Present state.*—The arms measure alike. The right forearm measures $10\frac{1}{4}$ inches, the left $9\frac{3}{8}$ inches. The supinator longus and the extensor mass of muscles in the forearm are wasted, having lost about one-third of their bulk. The flexor group is still more wasted, and is hard and contracted. Tact and localization normal. All the movements of the fingers normal, except extension, which is incomplete, owing to the above-mentioned contraction of their flexors, and also to partial paralysis of their extensors. The wrist has loss of extension and of lateral movements, and the thumb has also defective extension.

It would be needless to relate further details of this case. It shows how contusions may injure nerves so as to cause atrophy; how this may involve only certain fibres of a muscle and respect the rest; and how atrophy is sometimes accompanied with a contracted state of the muscle.

Dislocation of the left humerus. Subsequent loss of motion and sensation. Atrophy.

Case 13.—J. W. S. Grubb, æt. 22, farmer, Pennsylvania, enlisted September, 1862, Co. B, 145th Ohio Volunteers. Previous health good. January, 1862, fell from a tree, striking his left shoulder on the region of the deltoid muscle, and dislocating the humerus, but in what direction is not known. Reduced easily twenty-four hours later. The pain and numbness, which previously existed, disappeared

rapidly, and motion was perfect until the fourth week. At this date, the arm began to fall away, with loss of power and sensation. The motor palsy became complete in the course of a few months. The sensory defect was less marked.

Present state, December 3, 1863, nearly a year from date of accident.—Health good. Sensation normal. General motor paralysis of the arm below the shoulder, except that he has partial flexion of the forearm. Slight power in the extensors of the fingers, and also some in the same flexor group. The atrophy is very marked in the whole arm, below the deltoid, and especially in the flexors of the fingers and in the pronators, which are contracted so as to interfere with supination.

The electric qualities of the muscles were so good, that we prognosed a favorable result, and were not disappointed. The atrophy and paralysis were both very speedily relieved, the arms growing remarkably under the use of electricity, douches, and gymnastics.

This case resembles somewhat those related by Malgaigne and by Duchenne, in which the palsy followed the injury at periods more or less remote, and is to be referred to secondary changes in the nerve: changes whose origin must be attributed to some disturbance of the brachial plexus during the dislocation, or, perhaps, during the act of reduction. Duchenne remarks that, in cases of paralysis following dislocations, sensation is commonly less implicated than motion. Such seems to have been the case here, and the fact carries us back to what has already been said in regard to the general comparative exemption of sensory fibres from injury in accidents which must apparently fall with equal force on both classes of nerves.

Class 5th.—*Injury of Nerve Trunks owing to their being involved in a Cicatrix.* Cases of this nature are

particularly troublesome, if we may believe the accounts which various authors have given of them. We have rarely felt sure that we could lay to this cause the instances in which pain or loss of power came on late in the healing of a ball wound. Where we have thought it likely that the contracting cicatrix caused the symptoms, the case was usually one of superficial shell wound, in which the main symptom was pain referred lower down the limb, and due to the cicatrix compressing cutaneous nerves. The following case will serve as an illustration:—

Case 14.—Wm. McIndoes, Scotland, æt. 27, enlisted August, 1861, Co. C, 77th Pennsylvania Volunteers. Healthy to date of wound, June 25, 1862, at Liberty Gap, Tennessee. The ball entered the right thigh, five inches below Poupart's ligament, just external to the artery. It emerged three inches below the tuber ischii, and one-quarter of an inch external to it. He fell, conscious, but not aware of having been wounded until he saw the bleeding, which was abundant. No loss of motion. Numbness to the knee, with prickling pains. The pain was worst above and inside of the knee. (Internal and middle cutaneous nerves.) It increased for some weeks, and then abated, so that, at the close of two months, it was much better. As the wound, which healed in two months, became fully cicatrized, the pain increased and altered in its character; it was at this time and since, as he describes it, a "jagging, shooting, and darting pain," made worse by motion. He places it below the skin, which is healthy and not tender. There is now a little numbness above the knee, but touch is perfect. Nutrition unaltered, power of movement good.

In this, as in many cases, every cause of excitement increases the pain. All the ordinary means of treatment failed, the pain getting worse rather than better, and visibly wearing out the man's health. Narcotic injections have done most for him, but their continuance of relief has depended upon their incessant repetition. It has been proposed to adopt some more radical means—even the actual

cautery having utterly failed to modify the pain. Two years have passed since he was wounded.

June 25, 1864.—Before deciding to divide the crural nerves, we insisted on the patient's being put on guard duty for a month. After a few days the exercise aided him so much that he lost all desire to return to the ward, and has continued to improve in the most satisfactory manner up to the present date, August 30, 1864.

Among the cases of wounds of the upper thigh, have been two at least, in which neuralgia existed associated with malposition. The thigh was drawn up toward the trunk, and in this position the wounds had healed. In both there was crural neuralgia, which was relieved by restoring to the parts their normal motions, and by the use of stimulating liniments and frictions over the cicatrix. Ready cures were obtained in both instances.

The position of the cicatrix sometimes becomes important, when it happens to cross the track of a large nerve at a right angle, and is so related to it that certain positions of the limb press the nerve against the cicatricial tissues and cause pain and even loss of motion: a set of conditions illustrated in the following case:—

Case 15.—Admitted June 30, 1863, Joseph Springer, æt. 21, cigar maker, German, enlisted June, 1861, Co. E, 45th New York Volunteers. Some evidence of scrofula in early youth. Otherwise he was healthy up to date of injury, at Chancellorsville, May 3, 1863, when he was shot in the right thigh. The ball entered at the upper line of the lower third of the thigh, on the inside, between the sartorius and quadriceps extensor. It passed backward straight through the limb, which was extended at the time, and emerged at the back of the limb in the middle line. He thought himself shot in the foot, did not lose consciousness, and in a little while arose and walked to the rear. On the

way he had violent pain in the foot, and was forced to rest on account of it. There was not then, nor has there been since, any loss of motion from nerve lesion.

The wound healed in three weeks, but he had so much pain in certain postures that he kept the leg bent on the thigh, and the thigh thrown back, while he lay on his side. In this position the wound cicatrized; but he soon found that, when he straightened the member, the pain returned, the limb grew weak, and he must have fallen if he had not seized on some support. The difficulty was relieved by passive movement and the douche. Even after the passive extension became endurable, he could not stand on the limb without pain and loss of power. By September, 1863, he was, however, relieved entirely, and was transferred to the Veteran Reserve Corps.

The effect of suddenly making the leg straight in the early period of this case was very striking, and could be imitated by pressure over the cicatrix.

The influence of the cicatrix is oftentimes visible enough; but not so easy of diagnosis or study are some of the various consequences of nerve wounds, such as inflammations, œdema, the presence of pus, and the like. Most of our own opportunities have been limited to the study of the later stages of disease, in wounds long since healed, and hence we have little to say in regard to the symptoms which arise during active inflammatory conditions. Our future experience may fill this void.

Class 6th.—*Extension of Diseased Processes from Wounded Nerves to Healthy Nerves.* Among the inflammatory diseases which we have been enabled to study, is one which we have enumerated as Class 6th, leaving out of consideration other nerve maladies, such as are pointed out above, but whose clinical study is yet incomplete.

Of Class 6th, therefore, we shall speak as fully as its importance demands. It consists essentially in the extension of disease from the site of injury along the nerve trunks to others which become likewise involved, so that atrophy, and all the other ordinary results of injured nerves, appear in distributions remote from those on which fell the original injury.

Cases illustrating these results are introduced here the more willingly, because the view which we take of them is in some degree novel, and because just such cases have, as we suppose, been misunderstood by at least one very distinguished observer. We shall quote two cases, and discuss them afterward. One was caused by gunshot wound and one by a bruise or contusion. Numerous other examples have been noticed in our wards, but these may suffice for our purpose.

Contusion of right ulnar nerve, at bend of elbow. Paralysis in ulnar distribution. General extension of paralysis to all of the forearm and hand. Atrophy.

Case 16.—Chas. A. P., æt. 44, enlisted December, 1861, Co. G, 88th Penn. Vols. A man of good education, and of refined habits, but uncontrollably intemperate as to stimulants. He was, with this constant exception, in good health until injured at Cedar Mountain, July 12, 1862. He fell and struck the right ulnar nerve, at the bend of the elbow, on an angle of rock, causing the usual numbness and tingling in the ultimate distribution of the nerve. The sense of formication along the inside of the arm continued for some months, but the limb was in full use again the day after the accident. About December, 1862, the third and fourth fingers became weak, and gradually the loss of power affected all the fingers, the thumb, and the wrist.

June 24, 1863.—At this time, the date of his admission,

he still possesses all the motions natural to the limb, but all below the elbow are singularly feeble, so that he is now unable to write. The motor paralysis is gaining ground. The loss of sensation is well marked in the ulnar distribution, and is gradually increasing in the median distribution. The localizing sense is also much confused. The point of injury shows no scar, but the ulnar nerve is tender to the gentlest pressure, and the median nerve is hardly less so. The hand is as warm as usual. There is no swelling nor burning, and the nutritive changes are not very notable as yet. The right forearm measures nine and a half inches, the left measures ten inches.

The electro-muscular contractility is diminished in most of the muscles. The electro-muscular sensibility is slightly lessened. The treatment by faradization and douches was used actively, but caused electric neuralgia, which is usually a favorable sign.

July 10.—No better. The neuralgia less, but the extensors are contracting, so as to limit flexion, and the tenderness of the nerves continues unabated.

July 11.—Ordered passive motion. Electricity to the flexors and leeches to ulnar nerve track, with subsequently a long blister, one inch wide and eight long. The electricity again increased the neuralgia, and accordingly it was laid aside, and the arm kept at rest, with repeated efforts to extend the fingers, and the use of a splint for this purpose at night. The leeching gave immediate ease as to pain, but as he drank incessantly on every opportunity, the chance of useful treatment was small.

August 10.—He descrted.

November 19, 1863.—He returned to the hospital drunk, and materially worse. The right forearm now measured eight and three-eighths, the left nine and one-eighth. The flexors are greatly shrunken. The extensor group is atrophied and contracted, limiting what flexor motion is left. Everywhere below the elbow, and especially in the forearm, the power is lessened, but the electric properties are still quite good, and are nowhere lost. A sober man so situated would without doubt recover under the use of faradizations for a length of time. P.'s case is hopeless. Confinement injures his health, and every time he receives a pass it is used for the worst purposes.

December 12, he was finally discharged. See Specimens Nos. 5 and 6, Army Medical Museum, which are casts of his two arms, taken just before his discharge.

Wound of left chest, causing paralysis of the great pectoral muscle, probably by injury to the external anterior thoracic nerve. Extension of disease from the wounded nerve to the brachial plexus, with consequent loss of sensation and motion. Lesions of nutrition. Intense burning pains. Musculo-spiral and median principally affected.

Case 17.—Stephen Warner, æt. 33, farmer, New York, enlisted August, 1862, Co. B., 18th P. V. Healthy to date of wounding. At Locust Grove, November 27, 1863, a ball entered the left chest, below the first rib, half an inch below the clavicle and two and a half inches from its sternal end. Passing probably under the arch of the subclavian artery, it went backward and downward, and made exit two inches below the inferior angle of the left scapula, three and a quarter inches from the spine. The ball was fired by a skirmisher not twenty yards distant, and was received while the patient was in the act of bending forward to aim. He fell, giddy, but conscious; tried to move, but failed, and fainted from loss of blood. After several hours he revived, and discovered that the left arm and hand were sensitive throughout. On the radial side of the forearm there was slight numbness, a condition compatible with perfect tactile sensibility. Motion appears to have been lost, or greatly lessened during some hours, and within a day to have become restored entirely. No doubt exists as to this point.

No dressing was used until the third day, when water was applied. At this date the arm motions were complete below the shoulder, and there had been no pain. Soon after the cold dressing, to which he attributed the sequent symptoms, he was seized with neuralgic pain, which was principally in the median nerve distribution, but also on the outside of the arm and shoulder, with a spot of intense pain at the deltoid insertion. The pain

was darting and prickling in its nature. Coincidently with the pain, the joints of the fingers swelled and became sore, and this was especially the case with the thumb and the fore and second finger. At the same time the shoulder muscles grew weak, flexion of the fingers grew feeble, and the flexion of the forearm was affected. All of these defects increased for several months, and the flexor group in the forearm wasted so much as to attract attention. The biceps, brachialis anticus, and coraco-brachialis were in like manner atrophied. The pectoralis major was also thus altered at a still earlier period. Up to the eighth day the patient spat blood freely. Then it ceased, and he has had no pulmonary difficulties of any kind since.

February 19, 1864.—Admitted.

Nutrition.—Atrophy of pectoralis major great, of shoulder muscles slight, wasting of biceps and other anterior and internal arm muscles considerable. Arm at biceps measures—left, 10 inches; right, $11\frac{3}{4}$ inches. Forearm, left, 10 inches; right, 11 inches. Left hand congested, dark, and cold. It grows cold easily.

Sensation perfect. The neuralgia has nearly disappeared, except in bad weather, and about the insertion of the deltoid, where there is great tenderness, and a good deal of hardening and deposit in the subcuticular tissues and over the bone. The only muscle which is hyperæsthetic to any marked degree is the biceps. The course of the musculo-cutaneous and the median nerves is acutely tender upon pressure.

Motion.—None in the pectoralis major, scarcely perceptible in the biceps, the supinator longus alone flexing the forearm. Extension of forearm perfect. The fingers act in flexion feebly, but are improving. The thumb motions are also weak, but not lost. Motion is now most limited by the state of the finger-joints, which, although no longer tender, are stiff and enlarged. So much improvement has taken place very recently that we cannot be sure as to what motions were lost. Probably the principal nerves of the external cord of the plexus, namely, the musculo-cutaneous and the median, were those chiefly affected; certain filaments of the posterior strand, as the circumflex, also sharing in the diseased conditions. The remainder of the case would be irrelevant here. It was improving when ad-

mitted, and it gained ground with increased speed under a course of baths, gymnastics, and faradization.

We have here stated two striking instances out of several, to show that a nerve being injured, it is possible for other trunks of the parent plexus to become secondarily affected. Two explanations are open to us: a reflex effect, or the theory that an inflammation originating at the wound has traveled backward along the hurt nerve and fallen upon one or more stems of the main trunks. Let us examine this view in the light cast upon it by the cases before us.

M. Duchenne (*De l'Électricité Localisée*, second edition, page 194) quotes a case almost precisely like No. 16, in which a blow on the ulnar nerve caused ultimate paralysis in other and remote nerves. Here is his explanation: "These facts seem to me to demonstrate that there exists a sort of mutual dependence (solidarité) between all the nerves of a limb, so that no one can be suddenly destroyed (supprimé) with impunity, or without compromising the general innervation of the limb." The fact was therefore a striking one to M. Duchenne. His explanation is assuredly not very happy, for although he has stated a theory which has a basis of truth, it is inapplicable here, since the simpler view which we have enunciated is amply defended by certain circumstances, which may or may not have been present in his case, but which were evident in our own. It will suffice to analyze Case 17; a wound of the external anterior thoracic, made probable by position of wound and subsequent state of the pec-

toralis major, which it supplies. On the third day, neuralgia, subacute inflammatory state of joints of fingers, motor paralysis. The phenomena affect chiefly the musculo-cutaneous and median nerves; in other words, the remaining nerve trunks of the external cord of the brachial plexus, from which the anterior external thoracic nerve arises. Add to this the long-continued and still existing tenderness in these nerve trunks in the limb itself, and we have evidence enough to make more probable that which at the start seemed a likely means of explaining all the facts.

A third case of somewhat similar character is No. 28 of this essay, and other instances of like nature have repeatedly presented themselves.

CHAPTER VI.

WOUNDS OF NERVE TRUNKS—CONTINUED.

The cases which we have related in the earlier portions of this essay are of more or less rare occurrence. Those which will now claim attention must be comparatively frequent in hospital practice, if we may judge from the number which has sought our wards during the past year. As their practical interest is in proportion to their frequency, we have spared no pains to make the closest clinical study of their peculiarities, and of the best methods of giving them relief.

We have already considered the character of the symptoms which in the graver cases of nerve wounds develop themselves at the moment of injury. Some of these early symptoms may be also permanent, as the paralyses of motion and feeling. Others display themselves as the case proceeds, and of this class are the nutritive alterations, the changes in the calorification, and the neuralgic and other sensory phenomena. When a sensori-motor nerve has been completely divided, motion and sensation are lost, and certain profound alterations occur in the size and form of the parts supplied by it; but when, as occasionally happens, a nerve has been partially injured without entire loss of motor function, changes in

nutrition may take place of such a nature as to destroy the use of the limb as fully as though its nerves had been cut across. Peculiar conditions of the tissues grow out of these cases, and are frequently associated with, if they do not cause, certain annoying or painful symptoms, which are most difficult to control.

The very remarkable effects of wounds of nerves upon the nutrition of the part, have found no full record anywhere. More is said of them in Duchenne than by any other author, although the physiologists have done something to fill the want by their experiments on animals.

In works on the surgery of war, here and there we meet with stray cases, whose singularities in the way of symptoms insured their preservation; but no one has attempted to describe all the lesions of nutrition which follow nerve wounds, and even in individual instances, however curious, the record is often incomplete. For these reasons, then, because the nutritive alterations are important in themselves and in their relation to other symptoms, and because they have as yet had no historian, we wish to consider them first, and with the utmost care.

Altered Nutrition of Parts whose Nerves have been injured.—One of the most remarkable of the nutritive changes induced by nerve injuries, is wasting or atrophy of the muscles supplied by such nerves. It may exist alone, or be associated with like conditions of the skin and its appendages.

Atrophy of the muscles of an entire member is sure to follow complete division of its nerves when

there is no subsequent repair. In this case the muscles waste alike, the areolar tissue shrinks, the vessels fade from view, and the pulse becomes feeble and small. The rate at which this process goes on varies greatly, but it begins very early in extreme cases, and continues until nothing is left but bone and degenerated areolar structures, covered with skin, whose altered surface tells of the singular blight which has fallen upon the member.

So complete a destruction is commonly the work of years; but where, as we have seen in certain nerve wounds, the main artery has been also destroyed or interrupted, the atrophy which followed was, as may be supposed, unusually rapid. Partial atrophy is a much more usual symptom, and gives rise to strange and almost grotesque deformities in the limbs it attacks, as is well shown in the collection of casts which we have deposited in the Army Medical Museum. Sometimes a single muscle, as the deltoid, will be almost lost to view, and the arm will drop and the shoulder flatten; or a group of muscles, such as the flexors in the forearm, disappears, and leaves a deep furrow in the limb. In others the biceps has faded, or the muscles of the thenar eminence; while, most curious of all, are the cases of waste in the hypothenar and interosseal groups in the hand. Detailed accounts of the deformities thus produced are to be found in the cases illustrating motor paralysis.

In the variety of partial wasting, the course and duration do not differ from the more general form, unless repair of the special nerves implicated should follow. This may occur, however, without the dis-

eased muscle regaining its size. But if, under such circumstances, electricity be locally used, repair is often speedy, and is preceded by certain changes in the electric manifestations to be hereafter described. Of this we are distinctly sure, that there is no test of the restoration of nerve supply except the electric current, and that without its employ a cure is often hopeless when the atrophy is well marked, no matter how perfectly the nervous communication may have been restored.

Partial atrophy is due of course to partial nerve lesions. The filaments which supply a group of muscles may have suffered, or only those of one or more muscles, or, finally, a part only of the nerve fibres of one muscle.

In some cases the loss is equal throughout a muscle; in others it affects a lateral or longitudinal part of a muscle.

Among the injuries which fail to palsy a limb at once and completely, those which bruise a nerve have seemed to us to be the most likely in the end to cause atrophies.

The relation of muscular atrophy to voluntary movement and to electro-muscular manifestations, is of importance for obvious reasons.

Complete division of the nerves of a limb, of course involves paralysis of motion and sensation, with subsequent wasting. In partial atrophy, as of a portion of a muscle, voluntary power is usually lost in proportion to the extent and amount of the wasting; but, on the other hand, there may be, and often is, motor paralysis of a muscle or group, without any more wasting than disuse would account

for. In still rarer cases, the muscle palsied as to motion has scarcely seemed to lose bulk at all. In these cases of paralysis of motion without notable waste of substance, the electro-muscular properties were sometimes intact, and sometimes lessened.*

Change of Tension.—When, after injury of its nerve supply, a muscle begins to suffer in its nutrition, the first effect is usually an increased softness or flabbiness of the muscular mass. The paralyzed muscle loses its tone and relaxes. Soon or late, in many cases, the muscle begins to waste, and this continues indefinitely, or until the nerve is repaired. The wasting is again followed by a new change in the state of tension of the muscles, and in a certain number of cases the muscle gradually shortens or contracts, thus giving rise to deformities and loss of movements. Some of these results are very singular, and present difficulties which seriously embarrass treatment.

This shortening does not bear a strict relation to the amount of atrophy, for, although the former is apt to follow the latter, it has often chanced to us to meet with instances where the wasting was slight and the contraction extreme.

Shortening from Paralysis of Opponent Muscles.—The contraction which follows atrophic alteration must in practice be carefully discriminated from the shortening of a muscle which takes place in conse-

* See chapter on Alteration of these Properties in Nerve Wounds.

quence of the paralysis of its opponent muscle. In such cases, passive motion, used often and diligently, will prevent the mischief from taking place; but where atrophic shortening occurs, and the opposing group of muscles is also paralyzed, the evil arising from contraction is presented in its worst possible form.

We have spoken of two forms of shortening in muscles, or rather of shortening due to two different causes: a lesion of the nerves of the muscle, a paralysis of the opponent organ.

Shortening from Spasm.—A third form of contraction is met with, and it also is caused by a lesion of the nerve. In this, a single muscle is thrown into a state of tonic contraction without atrophy. The part is well nourished; the spasm capable of being overcome, but instantly returning. There is some volitional control, and the electric properties are entire. Sometimes a certain tremor exists in the muscles thus affected, and the spasm is less marked on some days than on others. Unlike the other forms, it relaxes under etherization, and is capable of temporary relief, and in some cases of permanent cure by injections of atropia into the body of the muscle; whereas no effect is thus produced when muscles contracted by other causes are so treated. The most interesting cases of this kind which we have encountered, were two of them due to wounds, and a third to rheumatic paralysis. Case 27, annexed to the chapter on lesions of mobility, is a good example of this form of spasm.

The close connection of contractions of muscles with atrophy, has led us to digress so far as to enumerate and discuss all the forms of contraction which we have seen. Whatever else of practical value is to be said of them and of atrophic change, will be found in the chapter which illustrates the lesions of motion following wounds of nerves.

We shall now return for a time to the question of atrophy, in order to announce certain conclusions which grow out of its study, and which appear to bear equally upon all the nutritive alterations to which wounded parts are liable.

It is to be inferred, from various hints in M. Duchenne's work, that he considers muscular atrophy to be due to any cause which cuts off certain spinal influences from the muscle; but that in cerebral palsy it is not apt to occur. He nowhere formularizes this proposition, if we are not mistaken, for his book is a model of confusion in the arrangement of subjects, and is without an index, so that it is not easy to be sure as to what is and what is not in it. Rather than do him injustice, we have stated what we glean as his view.

We ourselves are inclined to believe that great wasting very rarely follows upon simple cerebral disease; while it is far more common after true spinal lesions. Vast numbers of cases of complete cerebral palsy occur in which there is no more wasting than might occur from disuse. In a few instances of apparently simple cerebral disease, atrophy of a decided nature has followed; but it has usually been at a long interval. Can we be sure that spinal disease may not have been the connecting and effective

link? That such disease may rapidly or in time follow upon extensive cerebral disorganization, is well enough known. We have lately seen a remarkable case of atrophy of the right arm and leg, which seemed to be due alone to cerebral alterations. On dissection we found inflammatory softening of the left cerebral hemisphere, with like but less complete changes in the spinal cord. It should be needless to add that the microscope was used to confirm the judgment of the naked eye.

On the whole, it appears to us that atrophy from purely cerebral disease is doubtful. That it is far more apt to follow great spinal alteration, and that, in any case of very rapid wasting, especially if partial in its character, we should suspect the spine as its source, whenever quite sure that it is due to disease of a nerve centre.

A wound of a nerve insulating its muscles causes atrophy. Destruction of spinal centres gives rise to it in the parts they supply. Thus, a lesion of the spine at the upper dorsal region, leaving the centres below it intact, will not give occasion to wasting other than that from disuse; while if these centres become disorganized, atrophy may ensue in the muscles which they supply. Again, in cerebral palsy the limbs are usually thinned to a slight extent, or else remain fairly nourished; and so completely is this the rule, that we may suspect error in the cases which appear to be exceptions.

Let us now add to these facts, that a nerve may be hurt and partial paralysis occur without atrophy, and that the atrophies bear no strict relation to the

extent of the paralysis, and we shall have acquired sufficient evidence to show that there are in muscles motor nerve fibres and nutrient nerve fibres, and that the animating centre of these latter lies in the spinal column. On this theory, and on this alone, can we explain all the facts before us.

Analogy also lends us some support, since, as we shall hereafter point out, it is necessary to admit that in the skin as in the muscles there are nerves of special function and nerves presiding over its nutrition. In fact, the proposition which we have thus stated is well sustained by the views of many modern physiologists, and will but be strengthened by these added proofs.

When, therefore, a nerve is injured, the muscles may be paralyzed, sensation destroyed, or nutrition attacked. But for obvious reasons these triple results will usually occur in one and the same case, but in differing degrees—as motor, sensory, or nutrient nerve fibres happen to suffer more or less.

The temptation to enlarge upon these physiological bearings of our cases is naturally great; but the necessity for condensation has obliged us to confine them within the most moderate limits. For this reason we have failed to go beyond the present facts and to seek for the mechanism by which the nutrient nerves act. Whether they are sympathetic fibres, as we believe them to be, and whether they produce effects directly on the tissues, or only through their control over the vessels, are points which our cases do not aid us to clear up, and for these reasons we decline to discuss them.

Effect of Wounds on the Nutrition of the Skin and its Appendages.—So far as we are aware, only one author has spoken of the singular influence of nerve wounds upon the skin. Many have described the bed-sores which arise in paralysis, especially in spinal cases, from pressure on the sacrum, elbows, and other prominent parts.

The changes in the skin which follow wounds of nerve trunks differ from these in an essential respect. They are of spontaneous origin, and are not brought about by pressure. Two distinct varieties are observable.

The first is the result of entire division of the nerves of a part, and is best exhibited in cases of total palsy of a whole limb. Early in the case it is found associated in most instances with œdema of the part, and is one of the remotest effects of the loss of nervous influence. The skin becomes thickened and dry, the epithelium hangs in patches here and there, and is yellow or even pale brown in tint. These peculiarities are in part owing to mere disuse, but this in noway applies to the changed form of the nails, which become curved as in tubercular disease, although to a less degree than in the other form of cutaneous affection, which is caused by partial injuries of the nerves. In fact, it may be stated as a rule, that the skin and subcuticular tissues are less strikingly altered in entire paralysis than in cases of a lighter nature.

The second form of pathological change in the skin and its appendages is that which has heretofore escaped attention, if we except the slight notice of that most able pathologist, Mr. Paget.

In a recent paper, (*Medical Times and Gazette*, London, March 26, 1864,) Mr. Paget speaks as follows: "Glossy fingers appear to be a sign of peculiarly impaired nutrition and circulation due to injury of the nerves. They are not observed in all cases of injured nerves, and I cannot tell what are the peculiar conditions of the cases in which they are found; but they are a very notable sign, and are always associated, I think, with distressing and hardly manageable pain and disability. In well-marked cases, the fingers which are affected (for this appearance may be confined to one or two of them) are usually tapering, smooth, hairless, almost void of wrinkles, glossy, pink or ruddy, or blotched as if with permanent chilblains. They are commonly also very painful, especially on motion, and pain often extends from them up the arm. In most of the cases this condition of the fingers is attended with very distinct neuralgia both in them and in the whole arm, and its relation to disturbance of the nervous condition of the part is, moreover, indicated by its occasional occurrence in cases where neuralgia continues after an attack of shingles affecting the arm. In two such cases I have seen this same condition of the fingers well marked, and only very slowly subsiding, and seeming unaffected by the ordinary treatment of neuralgia."

That the author quoted regards these conditions as rare and of interest, is the best reason why we should minutely describe them. How very common they are as results of gunshot wounds, may be gathered from the fact, that in fifty partial nerve lesions they existed in different degrees in nineteen cases.

No particular time can be named as the period at which these changes in nutrition first show themselves. This alone can be said, they do not belong to cases of complete destruction of the nerves. They occur in such as have received slight or severe nerve wounds, provided always that these latter do not separate the part entirely from its nerve centres. They may begin within a few days, or at any later date; but usually they arise while the wound is healing, and are in many instances distinctly related to the occurrence of inflammatory accidents in or about the wound.

The duration of this condition is various. It may be slight and disappear in a few weeks, or more rarely it may last for many months, and be very rebellious.

In a large part of the cases now under study, the palm of the hand was the part most affected, but in others quite as severe the fingers suffered. The feet were also liable, but never so remarkably as the hands.

Glossy Skin.—The skin affected in these cases was deep red or mottled, or red and pale in patches. The epithelium appeared to have been partially lost, so that the cutis was exposed in places. The subcuticular tissues were nearly always shrunken, and where the palm alone was attacked, the part so diseased seemed to be a little depressed and firmer, and less elastic than common. In the fingers there were often cracks in the altered skin, and the integuments presented the appearance of being tightly drawn over the subjacent tissues. The surface of all the

affected part was glossy, and shining as though it had been skillfully varnished. Nothing more curious than these red and shining tissues can be conceived of. In most of them the part was devoid of wrinkles and perfectly free from hair. Mr. Paget's comparison of chilblains, is one which we often used to describe these appearances; but in some instances we have been more strikingly reminded of the characters of certain large, thin, and highly polished scars.

Where a single nerve, as the ulnar, had been attacked, the described state of skin was seen only in its ultimate distribution; but in other instances of more extensive nerve injury, the central palm suffered, or a single finger, or the pulps of all of them. In others the palm or fingers were dotted with islets of thin and red and glossy skin. The dorsum of the hand, as a rule, was in that member the part least subject to the alteration, while the dorsum of the foot was in that region the part most liable to suffer. Do the greater functional endowments of the palm of the hand, as compared to the sole of the foot, account for this preference?

Eczema.—A very constant feature of this state of skin was the occurrence of eczematous eruptions, which appeared as minute vesicles thickly scattered over the thin and tender cutis, or else showed themselves in successive crops of larger vesicles on the skin about the altered parts, with usually a preference for the portions which lay nearer the trunk.

In some patients this symptom was absent, in others it was never wholly lost, but varied in amount;

while in a small number it came and went, being absent for weeks at a time, and then returning. It was also remarkable in these latter, that recurrence of the eruption gave ease to certain painful symptoms to be presently described, or, to speak more cautiously, when the eczema came back the pain declined.

We have spoken of this eruption as eczematous; but it is difficult to describe accurately, in ordinary terms, an appearance which presents itself on surfaces so diseased. The reader will certainly have recalled to mind by our statements, the herpetic and other forms of skin disease which are sometimes seen to accompany neuralgic affections.

At the close of this section of our subject will be found a number of cases illustrating the various phenomena which we have described. Among these is the case of Schively, No. 18. It is an admirable example of the presence of eruptions associated with depraved nutrition. We mention it here only to call attention to the fact that the right hand was the injured member, and that eczema appeared secondarily in the left palm, and was relieved by the treatment which was addressed to the right limb. Was this a case of reflex influence?

The Nails and Hair.—When the depraved nutritive state has lasted for some months, the hair commonly disappears from the fingers affected, and the nails undergo remarkable alterations. They suffer only in the fingers the neural supply of which has been interfered with, so that the nails in the median distribution may be contorted, and those in

the little finger be unaffected. The alteration in the nail consists of a curve in its long axis, an extreme lateral arching, and sometimes a thickening of the cutis beneath its extremity. In other instances a change takes place which is quite peculiar, and which to us at least was new. The skin at that end of the nail next to the third finger-joint becomes retracted, leaving the sensitive matrix partly exposed. At the same time the upper line of union of skin and nail retreats into or under the latter part, and, in place of a smooth edge, is seen through the nail as a ragged and notched border. The patient who presented these changes in the most striking form had also lateral arching of the nail, but no longitudinal curving. It was a case of the most terrible suffering, from a combination of burning pain in the hand and neuralgic pain in the forearm.

No deformity of the nails in tubercle at all approaches that which nerve wounds occasion. Indeed, we think it would be possible for one familiar with these cases to diagnose the existence of a nerve lesion from the form of these protuberant and oddly curved nails.

When the nails of the toes have been attacked, and they are very rarely so, the curving is less marked, but a distressing ulceration is apt to occur at their angles, and to break out again and again, despite of every care and attention.

The best remedy then is excision of the outer edges of the nail, matrix and all. This has given permanent relief in a number of our patients.

Before passing to the discussion of other parts of

the same subject, we must confess that it is almost impossible, without a colored plate, to convey any clear idea of the worst cases of these cutaneous lesions. To see them is sufficient to impress one with the idea that their very peculiar appearances have no exact likenesses anywhere else in the pathological states to which the skin is subject. In the cases of glossy skin where there was no marked hyperæsthesia as to pain, the patient seemed to have healthy power of tact throughout the altered tissues. In others, though rarely, there was partial tactile paralysis. We may therefore infer that the change in the skin arises from agencies which may or may not be associated with conditions which disturb the nerves of touch.

Pain with Glossy Skin.—In some form, pain has been an invariable attendant upon the diseased state of skin which we have tried to describe. In the great mass of cases it has been of that peculiar burning character which we have spoken of at length in the chapter on lesions of sensation. In other instances, there was associated with this acute or aching pains, which extended beyond the diseased tissues. So remarkable was the connection of burning pain with glossy skin, that we can hardly fail to believe that the burning itself depends for existence upon some nutritive alteration of the ultimate extremities of sensitive nerves.

Alterations in the Nutrition of Joints.—Again we call attention to a peculiarity of nerve injuries which we believe to have been overlooked.

Like the altered nutrition of the skin, the symptom which we are at present considering occurs at any time after the first few days. It consists essentially in a painful swelling of the joints, which may attack any or all of the articulations of a member. It is distinct from the early swelling due to the inflammation about the wound itself, although it may be masked by it for a time; nor is it merely a part of the general œdema which is a common consequence of wounds. It is more than these,—more important, more persistent. Once fully established, it keeps the joints stiff and sore for weeks or months. When the acute stage has departed, the tissues about the articulations become hard, and partial anchylosis results, so that in many cases the only final cause of loss of motion is due to this state of the joints. Of all the agencies which impede movement, it is the most difficult to relieve.

Were we asked to state in what essential respect these lesions differ from subacute rheumatic disease of the same parts, we should certainly be at some loss to discern a difference.

The subject suggests certain interesting reflections. We have ourselves seen cases of spinal injury, in which rheumatic symptoms seemed to have been among the consequences; and four such instances of striking character are to be found recorded in a paper by the late Prof. J. K. Mitchell, *Am. Jour. of the Med. Sci.*, vol. viii. p. 55. Upon the hints which were thus furnished, Dr. Mitchell was induced to consider rheumatism as of spinal origin. His treatment, founded on this view, was most successful, and is still used and recognized in

this country. Modern pathologists have traced the causation of rheumatism to a strictly chemical source; but no one can avoid seeing that there may be a cause beyond this, even though the chemical conditions be still considered as essential links in the chain. Thus, after all, the true origin may be spinal, or, at all events, the indisputable fact that there are rheumatisms depending for existence on neural changes, may aid us hereafter to discriminate varieties of type among the forms of rheumatic diseases. It were easy to dwell upon this subject, but enough has been said to show that subacute inflammations of joints may be brought about by nerve lesions, and to direct medical thought anew in a direction which seems favorable to its true and rational progress.

The Secretions of Wounded Limbs.—The recognition of the manifold influence of the nerves over the secretions is one of the triumphs of modern physiology. The effect of the wounds of nerves upon the secretions of the part itself has been studied by us with some care, but without the definite results which we have attained as regards other symptoms.

After complete section of the nerves of a limb, the skin is commonly dry; but incomplete injuries of the nerve supply give rise to the most variable consequences.

In some cases the paralyzed part was perfectly dry, and the line of perspiration accurately defining the edges of the sensitive skin constituted an additional means of diagnosis of the nerve injured. In wounds of the median nerve, this was very well marked.

In the case of Captain Stembel, so often alluded to in these pages, there is a marked defect in the secretion of sweat on the right neck, arm, and chest. On the left side, which was not wounded, the sweat is perhaps excessive in amount. Two years have elapsed, without change in these symptoms.

In other examples of partial paralysis, associated with nutritive changes, the sweat was excessive. Three or four curious instances of altered perspiration were met with in connection with the same group of symptoms. In one of these, Case 22, the sweat was copious and intensely acid, so that an odor of vinegar could be smelt at all times in the neighborhood of the man. It left the patient as he improved. The same unpleasant symptom existed to a less degree in others; while in a single instance the odor of the sweat was disgustingly heavy, and resembled the smells from a bad drain.

We have thrown together at the close of this section a number of cases which illustrate the following symptoms of injuries of nerves, namely:—

Atrophy and contractions of muscles.

Perverted nutrition in the skin and its appendages.

Perverted nutrition in the joints.

Altered secretions.

Burning pain. Included here because of its frequent association with the above-named perversions of nutrition, the two being usually exemplified by the same case.

Gunshot wound of axillary nerves. Paralysis of motion; slight of sensation. Burning on tenth day. Great atrophy and contracted muscles. Subluxation of fingers. Nutritive changes. Eczema in both palms. Great improvement. Discharged.

Case 18.—David Schively, æt. 17, no trade, Pennsylvania, enlisted August, 1862, Co. E, 114th Pennsylvania Volunteers. Healthy before and after enlisting, except a slight attack of typhoid fever.

At Gettysburg, July 2, 1863, while aiming, a ball entered one inch to the left of the middle line, and one inch above the sternal end of the clavicle. Exit on the posterior part of the right arm, at the middle line, two inches below the axilla. The ball passed in front of the trachea, broke the inner half of the right clavicle, went in front of the vessels of the neck and the subclavian artery, in front of the axillary artery, and below the humerus speaking of that bone as raised and abducted at the time. When hit, he thought his arm was shot off. It dropped, the gun fell, and, screaming that he was murdered, he staggered, bleeding freely, and soon fell unconscious. When a little later he revived and raised his head, a second ball struck him in the right temporal fossa and emerged through the right eye. He jumped up, ran a little way, and fell once more. When hit, he lost all motion in the limb, which became numbed, but felt no pain. Two weeks later, feeble power to move returned gradually in the elbow, shoulder, and arm; and, after two months, in the wrist and hand.

Treatment, cold water-dressings and means to relieve burning, but all ineffectual.

The joints became swollen early, and the arm bent at a right angle. The hand, dependent, lay across his chest during a long period. He made some attempts at passive motion as he found the hand becoming stiff, but no great good was thus gained, and, as the contractions took place, and the joints grew worse, the wrist became moulded to the curve of the chest on which it lay.

About the tenth day, burning pain began in the palm and fingers, especially in the cushions of the fingers and the knuckles. It was at its worst a month later, and re-

mained thus another month, after which it grew less. When at its height, he suffered from loud sounds, vibrations, and dry contact The rubbing of his boots on the floor was the greatest annoyance, and this he relieved by wetting his stockings. Since October, four months after he was wounded, it has been unaltered. Sensation, little affected at the outset, has undergone no change of moment. Voluntary motion, which grew better for awhile, suffered anew and increasingly, as the nutritive changes developed themselves. When they first arose, we have been unable to determine.

Present state, December 17, 1863.—*Nutrition.*—The wounded arm is shrunken generally, with well-marked atrophy of the supra and infra spinatus, deltoid, and biceps, the loss in the last two being fully one-half. Triceps, no wasting of moment. Supinator longus and radial extensors, two-thirds loss. Flexors and extensors in forearm, one-half loss. Thumb muscles almost absent. Little finger and interosseal group, no loss.

Contractions.—The flexor carpi ulnaris, palmaris longus, and flexor carpi radialis, being strongly contracted, the wrist is bent at a right angle to the arm and drawn to the ulnar side; the extensor group is in like manner contracted, and the first phalanges, having thus been violently extended while the wrist was flexed, have undergone subluxation.

The color of the back of the arm and hand is natural to the knuckles. Thence to the finger tips the skin is tense, shining, hairless, mottled red and blue, abraded in spots; the nails curved, and the joints swollen, and very tender. Palmar surface normal to wrist. The whole palmar face of the hand and fingers is polished, deep scarlet, abraded in points, and eczematous all over to a remarkable degree. The eruption followed the burning in about six weeks. The palm of the left hand is nearly equally eczematous. It began to be so nearly a month before any eczema appeared in the wounded member.

There is slight soreness on pressure in the infra spinatus, biceps, and flexors of the fingers.

Voluntary Motion.—Entire in the shoulder, though weak. The elbow possesses the middle third of its normal range of motion, but cannot be fully flexed or extended. The wrist, lying at a right angle to the arm, has about forty-five

degrees of extension only. The thumb, nearly fixed in adduction, has slight and very feeble motion in all its joints. The fingers, bent back in extension, can be flexed to make a straight line with the dorsum of the hand. The flexors move the second and third phalanges through one-fourth of their usual range. They perform abduction and adduction well.

Sensibility.—Tactility nearly normal. Localization of touch not quite perfect on the radial distribution in the hand.

Pain.—The burning in the right hand is intense and constant. It is made worse by heat, exposure, drying of the skin, and dependent positions. He has kept it wet and wrapped up since October, 1863, which we believed might have made the skin troubles worse, until we saw this and other cases improve under treatment without any cessation in the application of the water.

The left hand, which, it will be remembered, was also eczematous, is painful on pressure or touch, especially in the palm. He is positive that there is pain in that hand, and that it is a burning pain. Both hands are kept covered with loose cotton gloves, which he wets at brief intervals. He is especially fearful of having the right hand touched; is nervous and hysterical to such a degree that his relatives suppose him to be partially insane. It is difficult even to examine him properly on account of his timidity, and his whole appearance exhibits the effects of pain, want of rest, and defective hæmatosis. His treatment was constitutional and local. It answered admirably so far as gain in health and loss of pain were concerned. The after means employed to cure the deformities and restore motion were partially successful, and will occupy us elsewhere.

Remarks.—The electric tests satisfied us that in time the muscles could be restored, and assured us that the nerve communications were entire. The sensibility was practically perfect. Motion, though feeble from atrophy in some parts, was present in every group of muscles. *It was limited by the contracted muscles and by the nutritive lesions in the joints.*

These two combined have damaged the power of movement, and left worse effects than usually result from partial paralysis affecting directly the motor nerves. Had proper passive motion been early used, there can be little doubt that the hand would now be far better than it is. Specimen No. 15, in the Army Medical Museum, is a cast of the limb.

Gunshot wound of left brachial plexus. Slight loss of sensation. Paralysis of motion. Atrophy and contraction of numerous muscles. Joint lesions due to disuse.

Case 19.—Jacob Bieswänger, æt. 39, boxmaker, enlisted August, 1861, Co. B, 75th Pennsylvania Vols. Healthy to date of wound. July 1, 1863, at Gettysburg, while capping his gun, he was shot from the rear, through the left shoulder. The ball entered on a level with the fifth dorsal vertebra, an inch to the left of its spine, and emerged one-quarter of an inch above the left clavicle, piercing the outer edge of the sterno-cleido mastoid muscle, two inches from the sterno-clavicular articulation. The arm fell, bleeding a good deal, and thus only he knew he was hit. Then he examined the arm, and found it devoid of motion and sensation. After walking a little way, he fell, fainting and unconscious. Reviving shortly after, he began to spit blood, and continued so to do for a few days, without further evil as regarded the lungs. He lay on the field and in field hospitals four days—dressings being applied on the fourth day only. No splints used then or later.

He could not say when the wound healed, but is sure the pain began at or about that time. It was a prickly feeling in the pectoral region, shoulder, arm, forearm, and hand, where it was worse. It is now scarcely perceptible. There was no burning.

Sensation improved from above downward, as the wound healed. About the end of the fourth month, the shoulder movements returned in part, but the fingers moved feebly more than a month previous to this date.

Present state on admission, December 6, 1863, five

months after reception of wound.—In this as in all of these cases measurements were made, but those of the forearm especially fail to represent the amount of atrophy in individual muscles. They were in this case as follows: Chest, over nipple, left, (wounded side,) 18¼ inches; right, 19½ inches. Over deltoid and under axilla, left, 15 inches; right, 16 inches. Around biceps, left, 9¼ inches; right, 12 inches. Forearm, three inches below olecranon process, left, 9¼ inches; right, 11 inches. Wrist, left, 6⅞ inches; right, 7⅜ inches. Hand, around palm, left, 8⅛ inches; right, 8⅜ inches. The pectoralis major and deltoid were wasted one-half. The supra and infra spinatus slightly wasted. The triceps not at all. The brachialis anticus was slightly wasted. The biceps and coraco-brachialis were almost absent. In the forearm the extensor and supinator group was well preserved. The flexors and interosseal group were in extreme atrophy, their position being marked by a deep furrow. The thumb muscles and the pronator radii teres were also extremely wasted. Specimens Nos. 13 and 14, in the Army Medical Museum, are casts of his entire arms and shoulders, showing excellently all these deformities.

Of the muscles, the following were contracted: the biceps, the flexors of the hand and the fingers, pronator teres, flexor ossis metacarpi pollicis, and the extensor communis digitorum, which had escaped atrophy. Hand a little swelled, congested, and dark. No acid sweats. Second and third joints of third and fourth fingers swollen, sore, and stiff.

Voluntary Motion.—Shoulder motions feeble, but normal in extent, except abduction of arm, which has one-half the usual range. Elbow, one-half. Pronation and supination feeble and incomplete. Hand, extension to line of forearm. Flexion perfect in range, feeble in power. Fingers, the first joints have partial motion, and the flexor com. digit. moves them pretty well; the second and third joints are restrained as to movement by the stiffened joints and the contracted state of the interosseal muscles, and by stiffness from disuse, chiefly. No extension of the fingers beyond the first joints; over these last there is some control. The second and third joints are not moved by the will. No lateral finger movement; abduction and adduction of thumb feeble; no extension of thumb. Flexion fair. Sensation entire for touch, pain, and temperature.

The electric examination need not be added. It showed that in some of the most wasted muscles there was good hope of restoration, and that in many the prospect of recovery was slight or very remote. The future of the case verified our prognosis. Under treatment, the gain was great, and, as usual, the chief trouble arose with reference to the contracted muscles and the state of the joints, which owed their stiffness to disuse and want of passive movement more than to nutritive alterations directly due to nerve lesions. The patient was discharged greatly improved, but with the contractions persistent. As in many of these cases, a very protracted faradization would be likely to aid him.

Let the reader contrast with this any instance of paralysis from injury of motor nerves alone, however long it may have existed, and he will be struck with the difference. We shall, however, return to this subject, in connection with motor paralysis.

Three cases are added to illustrate further the burning and the perverted nutrition. A fourth will be found in the chapter upon treatment.

Gunshot wound causing partial injury of left sciatic nerve. Paralysis of flexors of foot. Slight loss of sensibility. Intense burning. Ulcers about the nails. Frost-bitten appearance of foot. Great improvement. Discharged.

Case 20.—Kilian Grim, æt. about 20, German, enlisted August, 1861, Co. B, 121st Penn. Vols. Healthy until wounded; but exhausted and ill-fed for three days before being hurt. At Fredericksburg, December 13, 1862, a

ball passed through the lower third of the thigh, entering externally, four inches above the upper border of the patella, and emerging two inches lower on the inside. It went behind the bone, entered the right leg below and behind the knee, and, traversing the calf obliquely downward, made its exit on the other side. In the right leg no large nerves were injured. In the left the sciatic must have been slightly affected. He was able to walk several miles with his limbs thus wounded.

The chief difficulties in his case, when we examined him in July, 1863, were severe burning on top of the left foot, congestion and eczema, without marked redness or thinning of the skin, but accompanied with ulceration on the edges of the nails. This existed also in the great toe of the right foot, which had defective sensibility. He had complete paralysis of all the flexors of the foot, partial of the flex. com. dig. pedis, and of the calf muscles. He could walk, but dragged the foot, or else carried it in a long sling.

All of these muscles improved under treatment; the burning grew better, and the eczema left his foot, but the ulcers proved very unmanageable.

After five months' treatment, he was discharged, with more or less volitional control over all the muscles affected. At no time had he any marked atrophy.

This case was a fair type, if we except the ulcers, of a partial wound or commotion of a nerve. Severe not excessive burning; increasing paralysis; gradual gain in motion, and relief of the burning.

Gunshot wound causing injury of the sciatic nerve. Partial paralysis of motion and sensation. Burning pain. Eczema.

Case 21.—Admitted about the same time as the last, was another instance of ball wound close to the sciatic nerve. Here also was burning on top of foot. Defective sensation of touch on the outside of the foot and the leg, in the sole and the toes, and part of the instep. Loss of power in the flexors of the foot complete. Eczema coming

in crops about every two weeks as high up as to the knee, and with relief to the burning. Foot swelled when dependent, and this increased the pain to an unbearable degree. Nearly total relief of all the symptoms in five months, when he was transferred to the West. Cessation of the electricity at this time. Partial relapse as to movement. No further history.

Gunshot wound of brachial nerves. Slight loss of motion and sensation. Early burning pain. Diseased joints. Acid sweats.

Case 22.—Austin Lawton, machinist, æt. 20, enlisted April, 1861, Co. A, 4th Ohio Volunteers. Wounded at Chancellorsville, May 3, 1863, by a piece of shell, which fell on the inside of the arm, just below the axilla. The skin was torn slightly and the parts severely bruised. His fingers clutched the ramrod, which he was using, and required force to unlock the grip. Pain in the hand, of a burning character, came on, he says, within a few minutes, and has remained ever since. So severe was it, that he was in bed on account of the pain alone for nine weeks. The hand is now kept in a sling, and constantly covered with wet cloths. Sensation impaired in the back of the forefinger and thumb, and in the radial half of the palm. The flexor profundus digitorum, and the flexor subl. dig. were both very feeble, but they soon regained power when faradized, during a few weeks. It was then perceived that the real difficulty lay in the stiffened and painful state of the joints, at the second and third digital articulations. Passive motion and the usual treatment of the burning were ordered, with almost total return of normal movement, but without any ease to the burning. After two months, he preferred to return to his regiment for light duty, as orderly to the colonel.

We should add that this was the most remarkable case of the vinegar sweats which we have encountered. The odor disappeared during the electrization of the arm, but probably not through its agency.

CHAPTER VII.

LESIONS OF SENSATION.

Scarcely any case of nerve injury presents itself in which there is not present, or has not existed, some sensory loss. A good deal has already been said upon the subject incidentally, in our former pages, and cases have there been quoted for other cause which equally belong to the study now before us. We may consider lesions of sensation under the following heads:—

Hyperæsthetic conditions.
Anæsthetic conditions.
Neuralgia. Burning.
Physiological remarks.

Hyperæsthesia.—The subject of hyperæsthesia need not detain us long. The sensibility of a part to pain, when its nerves have been partially injured, is exhibited on the skin and in the muscles. Such a thing as true tactile hyperæsthesia, we have never encountered; but it was common in many of the cases of burning already described to witness a condition in which a touch was interpreted or felt as pain. In such instances localization is often perfect, and the sense of tact not lost but practically defective, by reason of the overwhelming influence of the pain. Besides these, we have met with one instance only

where, without the altered cuticle or burning pain or inflammation, the skin of the thigh appeared to be so sensitive that a mere touch was recognized as pain alone.

Muscular Hyperæsthesia.—Besides these rare forms of cutaneous sensibility, there exists in many cases of nerve wounds a hyperæsthesia of the muscular tissues. When, for instance, the skin was lightly pressed or pinched, there was no pain, neither was there any when a broader pinch or deeper pressure acted also upon the subcuticular structures; but when the belly of the subjacent muscle was pressed upon or pinched, there was felt a soreness. Sometimes it was severe; more often slight. At times it affected a group of muscles; at others, insulated muscles, in different neural distributions, suffered. Nearly always motion, passive or active, made it felt, and, like rheumatic soreness, it was worse in wet weather.

We are not sure as to whether this muscular condition is an early symptom or not. It is so much more trifling a matter than the first pain and inflammatory distresses of the wound itself, that it perhaps does not arrest attention until a later date.

It may be supposed that it owes existence to the original engorgement and general inflammation which the early days of a wounded limb present; but we think it plain that in some cases it was probably more recent, and rather neural in origin than due to conditions of altered circulation. Elsewhere the reader will find this symptom more fully studied in its relation to other forms of disease. Except in

hysteria, it has been far too much neglected. In wounds of nerves its presence is of no practical moment, as it rarely interferes with movement, and usually disappears as the limb improves. (See Case 6.)

Anæsthesia.—We have already noticed the fact that loss of sensation is a less permanent sign of partial nerve lesions than loss of motion. It is also, if we be not mistaken, a less frequent sign; that is to say, it is not uncommon to find among the first symptoms complete loss of motion, with incomplete loss of sensation, or even with hardly any absence of this function. How shall we account for this? Are the sensory fibres less impressible by shock or commotion? That they seem to have a readier recuperative power than motor filaments, is clear enough; but this may be due to other causes than the peculiar endowments of the sensory fibre. It may be owing to the fact that slight defects of sensibility over large surfaces are not so easy of appreciation as losses of motility; or, perhaps, to yet another cause.

When a function is partially paralyzed, its continued exercise is one of the conditions of its ultimate return to full activity so soon as the neural injury has become repaired. Now, the sense of touch is in constant automatic use, so to speak; every contact is a continuous stimulus to its activity, and the very fact of deficient feeling, subjects the part to rough and unusual irritations. It does not seem incredible that this may explain, in part at least, the early disappearance of sensory paralysis in cases where the function of sensation appears to

be quite as much affected at the outset as that of motility.

In regard to voluntary movement, the case is quite different. When muscles are paralyzed partially, an effort of will, and a greater one than common, is demanded to call them into action. The early inflammatory conditions make motion painful. The effort is unusually wearisome, and there is no inevitable and constant stimulus, such as exists in regard to touch. Hence, perhaps, it is that motility is regained less easily than sensibility, although, beyond all this, there are also certain mechanical obstacles in the way of a return of voluntary movement, which vary greatly, and constitute every single case a special object of study.

We may sum up the matter in this briefer shape. The skin is all the time stimulated, whether we will or not. The muscles which volition has ceased to move with ease have no such incidental stimulus. Accident and position do for the skin what artificial medical agencies must do for the muscles, if we desire to sustain their nutrition and restore their power.

We add a case to this section in order to show how singular may be the exemption from loss of sensation where the motility of muscles supplied by the same nerve is totally paralyzed.

Shell wound affecting the musculo-spiral nerve. Trivial loss of tactility. Entire motor paralysis in the ultimate distribution of this nerve.

Case 23.—B. Graham, æt. 22, enlisted September, 1861, Mass. Artillery, 5th Battery. Previously healthy. On May

12, 1864, he was struck on the back, and outside of the right arm, by a piece of shell, which denuded but did not break the humerus. The wound lay immediately below the deltoid insertion, and was five inches wide as it stretched across the arm, and three inches in diameter from above downward. The arm dropped, and he had sharp pain in the wound, so that he cried aloud. The after-pain was trifling. As he went to the rear, he examined the limb, and found that he could move his fingers a little, but that there was no notable loss of feeling. The wound healed rapidly, and is now, June 10, 1864, level with the skin. Nutrition is unimpaired. The right forearm measures $9\frac{3}{8}$ inches; the left, $9\frac{1}{2}$ inches.

Sensation.—Outside of the elbow, for a short space, tactility is enfeebled. In the radial distribution touch is slightly less perfect than usual; elsewhere there is no lesion of sensation. The supinator longus muscle, supplied by the musculo-spiral, acts pretty well. The extensors of the wrist and thumb and the extensor communis are completely paralyzed. The interossei act well. The triceps extensor is healthy.

Electric Tests.—The muscles above named as paralyzed have no electric contractility, the currents applied to them always causing contraction of the flexor group. Under treatment.

This case well enough illustrates how sensation may escape, and the nerves of motion be largely destroyed. The triceps and long supinator escaped nearly unharmed, while the remainder of the extensor group was totally palsied.

Such was the nature of the wound that it was easy to see how the triceps and other brachial muscles escaped injury to their nerves. On the other hand, it was very difficult to perceive how the muscular branches to the forearm could be so completely palsied with such trivial injury to the cutaneous and radial branches of tactile endowments.

The amount and extent of anæsthesia vary endlessly, from the faintest traces of enfeebled feeling to the most absolute annihilation of the function. As a rule, when a nerve trunk is injured, both sensory and motor filaments suffer, but with the exceptions already stated as to relative completeness and duration of the effects in the two classes of nerve fibres.

In some cases, however, the sensory nerves of one trunk suffer, the motor filaments of another; but this is rare.

It is never safe to conclude that there is perfect paralysis of the skin nerves until we have used the electric brush; for it sometimes happens that in parts which do not feel heat or a needle well, we recognize the existence of some obscure feeling under the intense stimulus of this agent. The bearing of this information upon the prognosis is of course evident enough, and is most valuable in paralytic cases of central origin.

When touch is slightly defective, there is often no appreciable change in the sense of pain; but usually, in graver cases, the senses of pain, touch, and temperature suffer together.

Pain, in the shape of neuralgia like the darting, typical pain of tic douloureux, is a common sequence of nerve wounds. It assumes all kinds of forms, from the burning, which we have yet fully to describe, through the whole catalogue of terms vainly used to convey some idea of variety in torture. Except the darting pain, that which most men call aching pain is the most common.

Long after every other trace of the effects of a wound has gone, these neuralgic symptoms are apt

to linger, and too many carry with them throughout long years this final reminder of the battle-field. Neuralgic pain from wounds has received more attention than most of the minor results of gunshot injuries. Moreover, its treatment and symptoms differ so little in most respects from those of the neuralgias met with in civil practice, that it would be treading on old ground were we to venture upon its lengthened study here. We shall, therefore, adhere to the rule which has governed us throughout, and only treat fully of points which are novel, or upon which our own clinical experience enables us to cast a clearer light.

For these very reasons we have here set apart for distinct consideration that kind of pain which we have before spoken of as burning pain. It is a form of suffering as yet undescribed, and so frequent and terrible as to demand from us the fullest description. In our early experience of nerve wounds, we met with a small number of men who were suffering from a pain which they described as a "burning," or as "mustard red hot," or as "a red-hot file rasping the skin." In all of these patients, and in many later cases, this pain was an associate of the glossy skin previously described. In fact, this state of skin never existed without burning pain.

Recently we have seen numbers of men who had burning pain without glossy skin, and in some we have seen this latter condition commencing. The burning comes first, the skin change afterward; but in no case of great depravity in the nutrient condition of the skin have we failed to meet with it, and that in its forms of almost unendurable anguish. The terms here used may seem strong to those who

have not encountered these cases; but no one who has seen them will think that, as regards some of them, it would be possible to overstate their most wretched condition.

We have some doubt as to whether this form of pain ever originates at the moment of the wounding; but we have been so informed as regards two or three cases. (See Case 22.) Certain it is that, as a rule, the burning arises later, but almost always during the healing of the wound. Of the special cause which provokes it, we know nothing, except that it has sometimes followed the transfer of pathological changes from a wounded nerve to unwounded nerves, and has then been felt in their distribution, so that we do not need a direct wound to bring it about.

The seat of burning pain is very various; but it never attacks the trunk, rarely the arm or thigh, and not often the forearm or leg. Its favorite site is the foot or hand. In these parts it is to be found most often where the nutritive skin changes are met with; that is to say, on the palm of the hand, or palmar face of the fingers, and on the dorsum of the foot: scarcely ever on the sole of the foot or the back of the hand. Where it first existed in the whole foot or hand, it always remained last in the parts above referred to, as its favorite seats.

The great mass of sufferers described this pain as superficial, but others said it was also in the joints, and deep in the palm. If it lasted long, it was referred finally to the skin alone.

Its intensity varies from the most trivial burning to a state of torture, which can hardly be credited,

but which reacts on the whole economy, until the general health is seriously affected.

The part itself is not alone subject to an intense burning sensation, but becomes exquisitely hyperæsthetic, so that a touch or a tap of the finger increases the pain. Exposure to the air is avoided by the patient with a care which seems absurd, and most of the bad cases keep the hand constantly wet, finding relief in the moisture rather than in the coolness of the application. Two of these sufferers carried a bottle of water and a sponge, and never permitted the part to become dry for a moment.

As the pain increases, the general sympathy becomes more marked. The temper changes and grows irritable, the face becomes anxious, and has a look of weariness and suffering. The sleep is restless, and the constitutional condition, reacting on the wounded limb, exasperates the hyperæsthetic state, so that the rattling of a newspaper, a breath of air, another's step across the ward, the vibrations caused by a military band, or the shock of the feet in walking, give rise to increase of pain. At last the patient grows hysterical, if we may use the only term which covers the facts. He walks carefully, carries the limb tenderly with the sound hand, is tremulous, nervous, and has all kinds of expedients for lessening his pain. In two cases, at least, the skin of the entire body became hyperæsthetic when dry, and the men found some ease from pouring water into their boots. They said, when questioned, that it made walking hurt less; but how or why, unless by diminishing vibration, we cannot explain. One of these men went so far as to wet the sound

hand when he was obliged to toueh the other, and insisted that the observer should also wet his hand before touehing him, eomplaining that dry toueh always exasperated his pain.*

Cold weather usually eased these pains; heat and the hanging down of the limb made them worse. Motion of the part was unendurable in some of the very worst cases; but, for the most part, it did no harm, unless so exeessive as to flush the injured region.

The relations of burning pain to altered nutrition have already received attention from us. It appears quite eertain that in cases of glossy skin, burning always exists. It is also eertain that it may exist without association with diseased skin; but that in these instances the evidences of depraved nutrient states will be very likely to follow upon the pain, should that symptom last very long.

The temperature of the burning part we have always found to be higher than that of surrounding parts, or than that of corresponding points on the other half of the body.

The rationale of the production of this form of pain was at first sought for among reflex pheno-

* Since the above was written, the advance of General Grant has filled our wards with recent nerve wounds, among whom are several cases of burning. One of them is a mere lad, whose repetition of all the peculiar and singular statements of older sufferers is a strong confirmation of the truth of their complaints. As the present case had never been in a hospital before, and as when he entered our wards there were no marked cases of burning, he could have had no previous chance of acquiring knowledge sufficient to enable him to repeat in detail every singularity of our former cases.

mena. It then seemed to us probable that a traumatic irritation existing in some part of a nerve trunk was simply referred by the mind to the extreme distribution of this nerve, agreeably to the well-known law of the reference of sensations. Further study led us to suspect that the irritation of a nerve, at the point of wound, might give rise to changes in the circulation and nutrition of parts in its distribution, and that these alterations might be themselves of a pain-producing nature. The following considerations tend to strengthen the view, that the immediate cause of burning pain lies in the part where the burning is felt.

If the burning were a referred sensation, it would sometimes be met with in cases of complete division of nerves, and, therefore, in parts devoid of tactile sensation. But we have encountered no such cases; and, on the other hand, the burning pain is often accompanied with hyperæsthesia, while motion and touch may remain unaltered. Is it not probable that the depraved nutrition, often so marked in the congested, denuded, and altered skin, may give rise to a disease of the ultimate fibres of the sensitive nerves? Just such a pain comes when we attack the cutis with irritants; and, let us add, that the agents which help these cases of burning are those addressed to the spot where the pain is felt, and not to the cicatrix.

We have again and again been urged by patients to amputate the suffering limb. Were such a step needed,—and we know of one case, not treated by us, in which the sufferings observed might justify it,—the above considerations would demand atten-

tion, since if the real cause of the burning be in the cicatrix, it would be in vain to amputate a member while the scar lies beyond it in a part like the neck, which could not be attacked by the knife of the surgeon.

We feel that we may be supposed to have exaggerated somewhat in delineating these hitherto undescribed neural disorders. Surgeons who have happened to encounter a single one of the worst of them, have been so surprised at the character of the suffering as to suspect that such extreme hyperæsthesia must be due, at least in some measure, to a desire on the part of the patient to magnify his pains. In answer to this we have only to ask attention to the details of the cases which we have added to the chapter on altered nutrition and to this present section of our essay.

We infer from all that we have here tried to prove, that the skin, like the muscles, has its nerves of specific function and its nutrient nerves, and that disorders of the latter may occasion extensive changes in the cuticle; that these changes are often associated with what seems to be a disease of the ultimate extremities of the nerves of pain which gives occasion to the hyperæsthesia and to the violent burning which we have described.

Duration.—Many cases of burning pain last but a few weeks; when associated with diseased skin, they are very enduring. We have seen one instance in which the pain had existed for twenty-one months.

If we be not mistaken, this form of neuralgia is

hitherto undescribed. Perhaps no pen can do it justice without the more life-like details of cases. We beg to refer the reader to Cases Nos. 18, 20, 21, and 22, to the following case, and, finally, to that of Marks, No. 31, which we have appended to the chapter on treatment.

Injury of brachial nerves, resulting in nutritive changes and in burning and neuralgic pains.

Case 24.—Hiram Weston, æt. 42, Co. E, 18th Mass., enlisted May, 1861. Healthy until wounded, in the Wilderness, May 5, 1864. He was moving at a double quick, and was shot in the left arm. The ball entered three and a half inches immediately above the internal condyle of the humerus. It emerged directly below the anterior angle of the axilla, two and a half inches lower. The ball passed over the nerves, and injured the ulnar nerve especially.

He felt violent pain throughout the limb, which was instantly flexed at every joint, and so continued for fifteen minutes, when it was extended by the aid of the other hand. The pain which then began has never left him. The arm soon lost motion entirely; but within a few days regained so much as it has now. As to sensation, he can tell us nothing, except that probably it was only damaged in the ulnar range of nerve supply.

Present state.—It is now fifty days (June) since this man was shot. Of the intervening period, he gives a very clear account. Immediately after the wounding, the whole limb swelled; but this rapidly subsided, and the hand was no larger than its fellow, until about the fortieth day, when it became rapidly œdematous. The pain has consisted all along of darting pangs from below or under the elbow, down into the hand, but not in the anterior surface of the forearm. In the hand, the pain is burning and tingling, or, as he phrases it, "prinkling." It is intense, and is increasing. It is worse in daytime and in hot weather, and when the hand hangs down. Noise and excitement increase it; but it has not reached the state of hyperæsthesia to which it is certainly hastening. The burning lies in the whole of the fingers, back and front, except the little finger, which is

devoid of sensation; but it is worst in the palm. The entire hand is sore to touch everywhere; but tact is unimpaired, save in the little finger and ulnar side of the third finger. The burning pain certainly dates back to the moment of the wounding. The nutritive changes did not become well marked until about the forty-fifth day; they are now obvious, and in time will no doubt give rise to the glossy skin, to which we have so often referred. The hand is swollen. The palm is red and dotted with patches of thickened epithelium. The redness is limited sharply at the borders of the palm in some places, and especially between the fingers. It occupies their palmar face alone, extending half way round each finger, excepting the fourth only. The junctions of the fingers and the crease at the base of the thumb are ulcerated, and in two places there is pus under the palmar cuticle. The nails are laterally much arched, the skin at their bases is retracted, and at their extremities the line of union with the skin is deeply notched. The back of the hand is eczematous, and mottled in tint. The joints are exquisitely tender, and very stiff and swollen. The patient has kept the hand wet ever since he was hurt. Are any of the phenomena caused by the prolonged humidity? Perhaps the eruptions may be due to it; and even as to this there may be doubts. All the other symptoms have been seen repeatedly in cases which had never used water at all.

Tactile sensation is perfect throughout the hand, except in the fourth finger and the ulnar side of the third.

This patient is now undergoing a course of blisters. His case has been given thus unfinished, because it shows the relation of the nutritive changes and the burning pain, and because of the exemption from burning of parts in which sensibility was lost. Were the burning a reflex sensation, having its sole cause in the wound itself, and merely referred, in obedience to a well-known law, to the distal distribution of the nerves implicated, we should have been as likely to find it in this case in the ulnar dis-

tribution as elsewhere. We have said nothing, in stating the case, of the amount of motion possessed by the patient. In fact, all movement was so painful that it was impossible to prevail on the man to use such voluntary power as he really enjoyed.

Case 25.—Jos. H. Corliss, late private Co. B, 14th N. Y. S. M., æt. 27, shingle dresser, enlisted April, 1861, in good health. At the second Bull Run battle, August 29, 1862, he was shot in the left arm, three inches directly above the internal condyle. The ball emerged one and a quarter inches higher, through the belly of the biceps, without touching the artery, but with injury to the median and ulnar nerves. He was ramming a cartridge when hit, and "thought he was struck on the crazy-bone by some of the boys, for a joke." The fingers of both hands flexed and grasped the ramrod and gun tightly. Bringing the right hand, still clutching the ramrod, to the left elbow, he felt the blood, and knew he was wounded. He then shook the ramrod from his grasp, with a strong effort, and unloosened with the freed hand the tight grip of the left hand on the gun. After walking some twenty paces, he fell from loss of blood, but still conscious; attempted to walk several times, and as often failed. He was finally helped to the rear, taken prisoner, lay three days on the field without food, but with enough of water to drink, and had his wounds dressed for the first time on the fourth day, at Fairfax Court House.

On the second day the pain began. It was burning and darting. He states that at this time sensation was lost or lessened in the limb, and that paralysis of motion came on in the hand and forearm. His statement is unsatisfactory and indistinct.

Admitted to the Douglas Hospital, Washington, D. C., September 7, 1862. The pain was so severe that a touch anywhere, or shaking the bed, or a heavy step, caused it to increase. The suffering was in the median and ulnar distribution, especially at the palmar face of the knuckles and the ball of the thumb. Motion has varied little since the wound, and as to sensation he is not clear.

Peter Pineo, Surgeon U. S. V., now Medical Inspector

U. S. A., exsected two or three inches of the median nerve at the wound. (See Army Medical Museum, Specimen No. 959.) The man states, very positively, that the pain in the median distribution did not cease, nor immediately lessen, but that he became more sensitive, so that even the rattling of a paper caused extreme suffering. He "thinks he was not himself" for a day or two after the operation. It seems quite certain that the pain afterward gradually grew better, both in the ulnar and the median tracts. Meanwhile the hand lay over his chest, and the fingers, flexing, became stiff in this position.

About a week after he was shot, the *right* arm grew weak, and finally so feeble that he could not feed himself. He can now, April, 1864, use it pretty well, but it is manifestly less strong than the other. The left leg also was weakened, but when this began he cannot tell. He gives the usual account of the pain, and of the use of water on the hands and in his boots, as a means of easing it.

Present condition, April 21, 1864.—Wound healed. Cicatrix of the operation two and a half inches long over median nerve. The forearm muscles do not seem to be greatly wasted. The interosseal muscles and hypothenar group are much atrophied, and the hand is thin and bony. The thenar muscles are partially wasted.

The skin of the palm is eczematous, thin, red, and shining. The second and third phalanges of the fingers are flexed and stiff; the first is extended. Nails extraordinarily curved, laterally and longitudinally, except that of the thumb.

Pain is stated to exist still in the median distribution, but much less than in the ulnar tract, where it is excessively great.

He keeps his hand wrapped in rags, wetted with cold water, and covered with oiled silk, and even tucks the rag carefully under the flexed finger tips. Moisture is more essential than cold. Friction outside of the clothes, at any point of the entire surface, "shoots" into the hand, increasing the burning in the median, sometimes, and more commonly, in the ulnar distribution. Deep pressure on the muscles has a like effect, and he will allow no one to touch his skin with a dry hand, and even then is careful to exact a tender manipulation. He keeps a bottle of water about him, and carries a wet sponge in the right hand. This hand he wets always before he handles anything; used

dry, it hurts the other limb. At one time, when the suffering was severe, he poured water into his boots, he says, to lessen the pain which dry touch or friction causes in the injured hand. So cautious was he about exposing the sore hand, that it was impossible thoroughly to examine it; but it was clear to us that there was sensibility to touch in the ultimate median distribution, although he describes sensation as somewhat lessened in this region, and states that he has numbness on the inner side of the palm, and in the third and fourth fingers, (ulnar tract.)

When the balls of the first and second fingers were touched, he said he felt it; but, on touching those of the third and fourth fingers, he refused to permit us to experiment further, and insisted on wrapping up and wetting the hand.

He thus describes the pain at its height: "It is as if a rough bar of iron were thrust to and fro through the knuckles, a red-hot iron placed at the junction of the palm and thenar eminence, with a heavy weight on it, and the skin was being rasped off his finger ends."

Subjoined are, first, the extract of Corliss' case from the books of the Army Museum, in which his exsected nerve is preserved; and, second, a letter from Inspector Pineo, who removed it.

Gunshot Injury of Median Nerve.

J. H. Corliss, Co. B, 14th N. Y. Bull Run 2, August 29, 1862, ball passed through fleshy parts of left arm, involving probably median nerve at juncture of middle and lower third.

Pain and irritation everywhere along the branches of distribution of median nerve, in palm of hand, and at ends of fingers.

His appetite is good. Iced-water applications alone render any service. The pain is gradually becoming less severe. Wound still open. Heavy doses of morphia and other anodynes required.

October 18, 1862.—Getting slowly better.

Operation, December 9, 1862.—Removal of two inches of median nerve. Suffered severely up to time of operation. December 10, said he felt better; had slept well. December 11, not much material change in this man. December 22, I do not think he is at all benefited; complains of much pain, and is very excitable. Refers the pain to that part of the hand supplied by ulnar nerve.

HILTON HEAD, S. C., May 12, 1864.

DEAR SIR:—Your communication of April 22, 1864, I have but just received, and hasten to answer your inquiries concerning the history of those cases of resection of the median nerve, which occurred in the United States Army Douglas General Hospital, in December, 1862. The notes I have not with me, but it will give me pleasure to communicate all I can under the circumstances.

Joseph H. Corliss, private, Co. B, 14th Regiment N. Y. S. M., was admitted into the Douglas General Hospital about the 1st of September, 1862. I took charge of the hospital in December of the same year, and first saw Corliss four months after entering. The injury was from a rifle ball passing through the inner side of the left arm, about three inches above the elbow, injuring the median and ulnar nerves.

The previous history of the case was one of great suffering. The pain at first was confined to the extremities of the nerves, but at the date of operation there was intense hyperæsthesia of the entire system. The slightest jar, or touch, or sound, the presence of light, or the advance of the surgeon toward the bed, seemed to cause excruciating pain. The tears would flow profusely; and ice-water applied freely to the hand seemed the only thing that gave a sense of relief.

Shortly after taking charge of the hospital, I resected a portion of the median nerve, having received the impression that the median alone was injured. The resected portion was two inches long, the neurilemma intensely red and injected.

After the operation, the patient was narcotized, isolated, and carefully attended and nourished.

The hyperæsthesia, which had become reflex in its character, very gradually but perceptibly lessened; the patient

grew fleshy, and when he supposed no one was present or watching him, seemed to be free from pain much of the time, and read while in bed. But the presence of the surgeon or attendant would recall partially and strangely the hyperæsthesia.

About the 1st of March he was discharged by his own request; since which I have heard nothing of him, until the reception of your note.

Very respectfully,
Your obedient servant,

PETER PINEO,
Medical Inspector U. S. Army.

The subject of the above narrated disease was suspected, as Dr. Pineo states, of exaggerating his sufferings. We prefer to believe that, like many such cases which we have seen, he was rendered nervous by the presence of others from the fear of being hurt; and hence arose the fact, that when alone he was so much more free from the exhibition of nervousness. When examined by us, he gave the same evidences of terror at the approach of a hand; and at this time he was a discharged man, visiting a wounded comrade in our wards. Nevertheless, he continued to nurse the hand tenderly, and to wet it every few moments with watchful care. The motive for deceit, if it ever existed, was then absent, and it is simply absurd to suppose that desire for sympathy would induce him to continue his troublesome practice of keeping the parts wet.

Another point of great interest is, the existence of sensibility in the median distribution, when examined by us thirty months after a portion of the nerve had been removed. Was it reproduced, or could there have been any mistake as to the nerve

trunk exseeted? Exeept the internal cutaneous trunk, no other eould have been taken away as the median; and we hesitate, on a doubt as to the possible reproduction of a nerve, to speculate upon the operation of a brother surgeon. An examination of the eutaneous sense throughout the arm might have east light on the subjeet; but, unfortunately, the patient was too irritable and too fearful to allow of a perfeet inspeetion of the limb.

Besides pain, in its numberless forms, we eneounter, in eonnection with nerve wounds, a great many strange perversions of feeling whieh are merely annoying. Among these is *numbness*, which eommonly results from some very slight injury to a nerve. It is well to bear in mind that the feeling of numbness is not, as physicians suppose, either defeetive sensation, or inevitably aecompanied by that eondition. In many instances where the patient has complained of this feeling, we have vainly sought to diseover, with the compass points, any differenee as to touch between the part which felt numb and the eorresponding healthy region. Yet the sense of numbness may exist in regions which are partially anæsthetic.

Physiological Remarks.—Biologists have long discussed the question, as to whether there are distinct nerves for touch and pain. It was admitted that in eertain eonditions of the body, as when partially under the influence of ether, or in hysteria, or in the magnetic sleep so called, it became elear beyond doubt that the functions were distinet; but it was thought by some that this did not necessitate a be-

lief in the existence of nerves of touch and nerves of pain. It was only needed to suppose the existence of distinct centres for the reception of the two sets of impressions.

Apart from other considerations, if we can make it apparent that in any wound of a nerve trunk the one function has been lost and the other left intact, we shall do much to convince physiologists that there must be two sets of nerve fibres involved, as well as two distinct centres. If, moreover, the sense of pain be lessened or lost, while the more delicate sense, that of touch, still exists, our argument in favor of two sets of nerves—the one for touch and the other for pain—will be further strengthened. Besides several minor and less decisive observations, Cases 27 and 28, quoted under lesions of motility, must be convincing. The subject of the latter observation was a very reliable and intelligent soldier, whose discharge was certain, and who could have had no motive to deceive.

In Case No. 2, (of Circular No. 6, Reflex Paralysis,) we have related a remarkable instance of analgesia without loss of tact; but this was the result of reflex paralysis, and of consequent central affections.

Power of stating the locality of sensation.—The reader may have noticed that we frequently make use of the term sense of locality, or localization. We mean simply to refer to the power which the patient possesses of telling where exactly he has been touched. We know how confused this may be in spinal diseases, where the left leg is mistaken for the right, or the right for the left. The sense of touch may

be acute enough to enable the patient to say that he has been touched, but not to tell where.

The same deficiency, in a less marked degree, is met with in some cases of nerve wounds. The touch is felt, but the patient misplaces its situation, from one finger to another, or from a finger to the palm.

We have observed a curious fact, which seems to apply to many such cases, whether of wounds or of spinal injuries.

The patient refers the touch to the nearest region of more distinct sensation—toward the trunk as a rule.

CASE 26.—A very distinguished medical officer received a blow on the spine, and suffered from paralysis of sensation and motion in the legs. When we touched his knee, where feeling was very dull, he would say: "I cannot tell you in words where I was touched, but it was here;" and would then put his finger upon a spot six inches higher up the limb, and where touch was more distinct.

We do not mean to assert that this reference of sensations finds illustration in every nerve wound where sense of touch is affected; but it is certainly not an uncommon occurrence in that class of paralyses.

In this connection, it is well to state a very singular instance of defective power to localize a touch —an instance so frequent, that its repetition on many occasions induced us to observe it with care; and finally to conclude that it was a normal defect, or at least that it exists in a considerable proportion of sound persons.

Let the observer, to test the matter, touch in suc-

cession the toes of a man whose eyes are covered. When he comes to the third and fourth toes, counting the great toe as the first, he will find in many cases that the man will mistake the third for the fourth, or the fourth for the third; or perhaps even the fourth for the fifth or little toe. It is very rare for the little toe to be taken for the fourth.

It is necessary in this case, or when examining the sensibility of the fingers, to order the patient not to move the parts, and for this most curious reason: the moment he is puzzled by the contact, and cannot localize it, he will instinctively move the toe or finger touched, and will then, in many cases, answer correctly, while otherwise he could not. He moves the part in order to learn through the muscular sense where he has been touched. At first, we supposed the movement to arise from an instinctive or habitual tendency to push the toe against the foreign body; but no matter how light may be the touch, the motion seems to aid him in placing it, and of course when the touch is cautious and trifling, and instantly removed, the only use of the movement which follows must be of the kind we have stated.*

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* The examination of the subject of power to localize a sensation has yet to be made. In some cases where tact has been dulled, a sensation which is felt at all is correctly referred. In others, where the sense of touch is not more dull, there seems to be a tendency to mistake the place of a sensation. Certainly no sense is more easily deceived than this one, and even during health, very slightly altered conditions suffice to confuse its appreciations.

A well-known example is to be found in the double sensation

which the crossed fingers receive from a ball rolled over their pulps so as to touch both. Parts unaccustomed to act together are here forced to do so, and the result is what it would be no misnomer to call a tactile squint. Just as in sudden strabismus we see double, so here we feel double. While studying the subject of dull sensations and the reference of them, we made certain simple experiments, in which we endeavored so to interfere with the normal position of the fingers as to affect the accuracy of their tactile sense. The result was curious. Let the reader place his hands behind him, and adjust them so that they lie back to back. Then let him interlock the fingers, and twist them one about another. Let him make the position, in short, as unusual as he can. Now, let a second person tap the fingers lightly, while he himself states what finger has been touched. He will be surprised when told that now and then he has mistaken one finger for another. He will also find how instinctive is the impulse to move the finger when puzzled by the contact, and how readily motion sets right the baffled perceptive powers. These facts serve but to show that confusion as to the site of a sensation may arise under other circumstances than from disease of nerve centres.

CHAPTER VIII.

OF THE INFLUENCE OF WOUNDS OF NERVES UPON MUSCULAR MOVEMENT.

The reader who has followed us thus far will have learned that pure paralysis from nerve section is but one of the several causes of loss of motion when nerves have been wounded. These causes are indeed so numerous and so perplexingly related in individual cases, that it is not always easy to assign to each its share in the production of defects of motility.

We shall separate them here for purposes of study, and try to learn how far each is directly concerned in causing loss of motion, and what it does incidentally.

Nerve lesions affect motility:—

1st. By causing muscular paralysis.

2d. By occasioning contractions, organic or functional.

3d. By causing alterations in the joints.

All of these results of nerve lesion in turn give rise to secondary difficulties, which we shall notice in detail.

Paralysis of Muscles.—Very little need be said on this subject in this place. Its relations to sensory paralysis have already been discussed, and in the

chapters upon treatment and electro-muscular properties, we shall have further occasion to return to its study. That the motor palsy may be slight or severe, complete or not; that it may affect groups of muscles, or a part only of one muscle; and that it may be caused by blows, wounds, commotions, or transferred irritations, has already been shown in the cases previously quoted. Very little remains to be added as to the mere traumatic paralysis; much has yet to be said in respect to the consequences which indirectly grow out of it.

The diagnosis of this paralysis is of course easy. A ball cuts a nerve, or, as is more common, stuns or contuses it, and we have certain muscles made powerless. In a few days, if the nerve injury has been partial, some of these muscles improve or recover entirely. In other cases, weeks or months go by without change for the better, and the muscles fall victims to atrophy and contractions.

Prognosis.—Of course every case of partial loss of function is more likely to recover than one of total loss, and if the will has any control over the muscle after the injury, we may reasonably look for an increasing gain. But there are varieties of muscular injury outside of the mere palsy of volitional control. Early loss of tone in the muscle is a bad sign; rapid shrinking in size is another; and contraction, when this is a nutrient change and not pure spasm, is worse still. They are all due to lesions of nutritive fibres, and are ominous of ultimate deformities and of permanent loss of power. But these signs, already fully discussed, arrive late in the case. It is possible, at a very early date, usually within two

weeks of the injury, to make a very complete prognosis, by means of electricity, as to the extent of the motor palsy, and the probability of its remaining intractable to treatment or not. For the necessary details of this subject, we refer to the chapters on the therapeutics of wounds of nerves.

Consequences of Paralysis.—The evils which arise out of loss of action in a muscle do not end in it. The opponent muscle or group, meeting with no resistance, is liable to shorten, if efforts at passive motion be not carefully and continuously made. Under these circumstances, the motions which are proper to the opponent group become abrupt from want of a balancing power to hold them in that constant check which is a condition of steady natural motion. When, owing to paralysis of a group of muscles, their opponents shorten somewhat, the evil is increased should there happen to be at the same time nutritive changes in the joints of the parts acted on by the contracting muscles; for in this case the deformity will be made permanent by the resultant anchylosis.

Loss of motion from alterations in the joints has been fully described at page 83. We have nothing further to add that will not be found in the cases appended to the present chapter.

Contracted muscles, as affecting motion, although likewise the subject of former remarks, require some further notice.

Muscular contractions, after nerve lesion, come on at various periods, and are of several kinds:

1. Shortening from paralysis of opponent group of muscles.

2. Organic alteration of tissue, causing shortening, a frequent accompaniment or sequence of atrophy.

3. Tonic contraction, without atrophy, a condition of spasm.

From whatever cause they arise, contractions of muscles affect motion by fixing parts in positions, or, when the contractions are not extreme, by interfering with the normal range of movement. But contractions which fix an articulation rigidly, also occasion loss of motion in a way which is very interesting. An example will best illustrate the subject.

In Case 27, quoted at the end of this chapter, the flexors of the wrist, contracting, flexed the hand permanently. The fingers were found to possess the power of entire extension, but the first joints alone could be flexed; the second and third scarcely stirred when flexion was willed. When we forcibly overcame the wrist flexion in part, the fingers could be flexed. There was, therefore, no paralysis of the common flexors, and the difficulty of moving the last joints, with the wrist bent, was seen to arise from the inability of the flexors to shorten enough to overcome the relaxation of their tendons, caused by this position of the wrist. When, too, the wrist is bent, the common extensor tendons are stretched, and must yield still further as the flexors of the fingers act. This would apply, however, only to the first phalanges, which are flexed by the interossei chiefly, and which alone of all the phalanges are extended by the extensor communis. The influence of this false position may be made clear by

placing one's own wrist in extreme flexion, and then trying to flex the fingers. The difficulty is great, and were we able to imitate on ourselves the extreme flexion existing in the above case, it would be even better shown.

Spasmodic Affections of Muscles.—The earliest example of these affections is offered in many cases at the moment of the wound. When the ball passes through a muscle, it is usually contracted violently for an instant, and then becomes paralyzed. A missile passing near a nerve, or slightly wounding it, sometimes causes more extensive and more prolonged spasm, as in Case 25, where also the less frequent occurrence of reflex spasm of the opposite limb was observed.

Spasm of Muscles.—Tonic contractions of one or more muscles take place rarely; but when seen at all, they occur gradually, and at periods more or less remote from the date of the original injury. The muscle then presents certain signs which enable us to separate this form of contraction from that which is so often associated with atrophy, and in which there is some peculiar alteration of the structure of the muscle. The latter form of shortening is very rare as an early symptom, and is accompanied with loss of electric properties; that is to say, the muscle no longer responds to electric stimulus.*

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* This remark requires brief explanation. Where the atrophied and contracted muscle is completely insulated from nerve centres, the waste may be extreme, and then there is apt to be con-

In the spasmodic shortening of muscles, the tissue is hard but not wasted, and the electro-muscular contractility is normal, or else more marked than in the corresponding muscle on the healthy side. The muscle is over-excitable, and this is well shown when we attempt to extend it, for the effort is resisted by the most violent spasmodic contractions, which may be readily felt when the hand is placed over the part.

A slighter form of the same condition is sometimes present, but does not show itself until the muscle is stretched, by moving the parts on which it acts to an extreme limit of movement, in a direction opposite to that in which the muscle itself draws them. Thus, if the flexor or carpi radialis be in this state of irritability, and the hand be violently extended, the flexor begins to quiver with a series of irregular fibrillar spasms. The effort of the will to extend the wrist may sometimes produce the same results.

Tremors.—In some instances of nerve wound certain muscles were affected with tremulous or even with choreic movements, which increased when an

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traction with loss of electric irritability. This form of shortening is caused by some nutritive change in the muscle. Where the nerve lesion is partial, there probably may be in a muscle this same kind of contraction; but if, scattered through the tissue, there are portions which are still irritable, it will be impossible to make an electrical diagnosis.

It sometimes happens that true spasm affects muscles which are partly atrophied. In this case we should be struck with the unusual irritability of the muscle attacked.

attempt at voluntary motion was made. We never encountered this phenomenon in totally paralyzed muscles, but the lighter forms of it were met with in limbs the actions of which had been partially lost through stiffening of the joints and long disuse. In others it may be supposed to have depended upon a reflex impression originating in the wound. In one very striking case, a wound of the forearm, the supinators and pronators were in constant agitation. All of the patients affected with tremor, in any degree of severity, were readily cured by the use of passive motion and frictions.

Physiological Remarks.—It is now well settled that when a movement is willed to occur, the muscle which effects the motion is not the only one which is concerned. The opponent group not merely relaxes, but its fibres yield to the movement with a certain amount of resistance, which is sufficient to prevent the act from being abruptly executed. Without this there would be no grace in motion, and every action would be awkward, and clumsily performed in jerks. What it would be is seen when a muscle is paralyzed completely, and its opponent contracts without restraint. It is possible that the elasticity of a muscle alone may answer to effect this checking, but we are disposed to believe that there is more than this passive quality of the muscles involved, and for these reasons:—

Electricity applied to one set of muscles, which is paralyzed as to motion, will often call the healthy opponent group into play, showing how close must be the central relations of their nerves. When a

muscle is paralyzed, and the patient wills to move it, the opponent muscle or group of muscles very often contracts. Now, these are not cogent reasons for the belief that every motion entails, first, strong contraction of one set of muscles, and, second, consentaneous weaker action of the opposing muscular parts; but they lend additional force to a view which science has already made probable. (*Duchenne*, 2d edition, p. 836.)

We regret that we have not space to pursue the subject further.

Shell bruise of right brachial nerves. Slight loss of motion. Tonic spasm of the flexor carpi radialis, flexor carpi ulnaris, and palmaris longus, causing violent flexion of wrist. Analgesia well marked. No loss of tactility. Section of tendons. Relief.

Case 27.—Lawrence Monaghan, æt. 26, machinist, Kentucky, enlisted January, 1863, and had been previously in the nine months' service. At Chancellorsville, May 3, 1863, he was struck by a fragment of shell on the outside of the right arm, seven inches above the external condyle. It scratched the skin only, but bruised the subjacent parts severely and extensively. When hit he was lying down, leaning on the left elbow. He felt nauseated, the arm dropped, with general weakness only, and numbness, and with slightly impaired sensation. The wound swelled and grew black and red, being bruised from the shoulder to the middle forearm. The hand also swelled, as usual, but this disappeared, except in the mornings, within six weeks. The swelling of the bruise lasted several months. At first the pain limited motion, but in two months the motions of the arm were much better throughout. Sensation also improved, but has never been quite perfect.

About the second week, and while the arm was in a sling, on a pad, the wrist began to flex. The surgeon's attention being called to it, he put it on a splint, and bandaged

it down; but after four weeks of this treatment it was abandoned on account of the pain, and also because it proved useless. After this liniments to the arm were used, but the flexion went on. Then, as the arm grew stronger, the contraction relaxed; and, finally, he was mustered out of service. Re-enlisted August 15, 10th N. J., Co. A.

The handling of a musket brought back the pain in the arm, which was a numb aching, extending into the hand. At the same time the wrist began to flex anew, and forcibly, with pain also in the wrist and in the track of the musculo-spiral nerve. It is unchanged since April last, but is constantly cold, and is kept covered with a glove.

Present state, March 9, 1864.—Nutrition good. Skin natural, but soft and moist, from being covered and unused. Acid odor distinctly marked.

Sensation.—Tactile sensation, examined by compass, no perceptible difference from the other hand, but the sense of pain is lessened one-half. He feels the cold in his right hand severely; it becomes cold easily.

Motion.—He has every movement; but the finger extension and flexion is limited by the extreme flexion of the wrist, for, when in this condition, the two flexors of the fingers cannot shorten enough to flex the second and third joints. Of course extension of the wrist is impossible, but he has perfect extension of all the digital joints. The flexor carpi radialis, the palmaris longus, and flexor carpi ulnaris are very rigid, and, when extended, contract violently.

Electric Test.—The rigid muscles appear to possess fully as much electric contractility as those in the other arm.

June 12, 1864.—Dr. Keen cut the tendons of the flexors carpi radialis and palmaris longus completely, and that of the flexor carpi ulnaris partially. The wrist was then brought to a right line with the forearm, and placed on a Bond's splint. Motion soon began to return to the fingers as the soreness arising from change of position subsided. The patient is now, July 1, recovering rapidly.

Remarks.—This is a typical case of pure tonic spasm without atrophy or palsy. The loss of sense of pain was notable, while tactility was perfect. He discriminated the compass points as well on the hurt

side as on the well one; but when his eyes were covered, a large needle could be run nearly through the palm without his seeming to feel more than a little pricking.

Gunshot wound of calf of right leg. Slight loss of tactile sensation. Great analgesia. Entire loss of motion below knee. Tendency to malposition from want of antagonism to calf muscles. Relief by use of club-foot apparatus. Improvement in electric properties in the muscles. Regains power to walk. Discharge.

Case 28.—J. S. L. Scott, æt. 31, farmer, New York, enlisted August, 1862, Co. F, 121st N. Y. Vols. Wounded May 3, 1863, at Chancellorsville. The ball entered the right leg a little below its middle, in front of the fibula, three-fourths of an inch, and emerged one inch and a fourth behind the tibia, on the same level, without injury to the bones. Total loss of motion below knee; slight of sensation. Pain only on the second day, from inflammation. The after history doubtful, except that sensation improved.

Present condition, September 12, 1863.—The patient walks with a crutch, the foot being suspended in a long sling, in extension, and quite useless. Attempts at flexion resisted by the pinning of the cicatrix and by shortening of the soleus chiefly. (See Specimen No. 17, in the Army Medical Museum, a cast of the foot and ankle.) Sensation impaired slightly in the foot, but nowhere lost. The leg and thigh muscles slightly tender on pressure. The foot feels warm, the toes are cold and purple. No burning.

Treatment.—Alternate cold and hot douches. Splint to correct malposition. Faradization daily.

October 26, 1863.—Re-examined.

Sensation.—Tactility and localization nearly perfect. Cold and heat are appreciated correctly, although slowly. Sensibility to pain much impaired below the knee, but lost at the outer head of the gastrocnemius and on the outside of the foot. Volitional control lost from the knee downward.

Electric contractility feeble in the tibialis anticus, extensor longus digitorum com. and extensor proprius pollicis. It is best, though weak, in the peroneus longus. In none of these nor elsewhere are the contractions sufficient to stir the parts. None of the calf muscles respond at all, and electro-muscular sensibility is absent in all except at the upper end of the external origin of the gastrocnemius. Withal there is no atrophy. The electric brush gives little or no pain on the dried skin. The muscles, or at all events the subcuticular tissues, are sore when firmly pressed, especially the great toe and the inside of the plantar arch. It is difficult to reconcile this with the analgesia so evident when a needle is used.

It is remakable, but in accordance with M. Duchenne's experience, that above the wound the muscles in general have lost electric contractility as well as below it.

December 20, 1863.—The anterior muscles have regained sensibility to electricity. A club-foot apparatus was used to flex the foot.

January 1, 1864.—Contractility under electricity returning in anterior muscles and calf. No voluntary power.

January 20, 1864.—Calf muscles begin to respond to will. Electro-muscular contractility well marked in tibialis anticus, peroneus longus, common extensor, and interossei. Volition good as to calf muscles. None as to anterior group; but the foot is now flexed to over a right angle, and when it is cased in a stout gaiter, he can walk well with a cane; for although he has no volitional flexion, the weight of the body on the toes and ball of the foot serves to antagonize the calf muscles. The man is anxious to be discharged; although from the return of electric properties in the tibial group, we feel sure of ultimate cure with the aid of electricity. Under the circumstances, we do not feel that it is proper to retain him. Discharged, February 12, 1864.

Remarks.—In this case, also, there was great loss of sense of pain, and but little of that of tact. It is a good example of paralysis of muscles. The malposition of the foot, caused by contraction of the calf muscles, is also a point of interest.

Gunshot wound of forearm. Injury of filaments of musculo-spiral nerve. Partial loss of sensation, and recovery of it. Contraction of flexors. Wound of extensor muscles.

Case 29.—Richard McCabe, æt. 29, farmer, enlisted August, 1862, Co. I, 141st Penn. Vols., corporal. Wounded May 3, 1863, at Chancellorsville, while loading, with left arm semipronated and semiflexed. Entry, externally over ulna, three inches above its styloid process. Ball cut out two inches below external condyle, an hour later. Bone injured; ball traversed extensor muscles diagonally. No pain, until a few minutes later, and then it increased with the rising inflammation. It was a numb pain. No spasm. The wounds healed easily, and the upper reopened to let out pieces of the coat. The hand lost feeling in part; but, he says, recovered in a month. As to motion, the evidence is unreliable. The arm seems to have been long on a splint without use of passive motion.

Present state, December 6, 1863.—Nutrition of hand good. Sensation perfect. No atrophy; but the flexor group is contracted from want of opposition. The extensors have been damaged by the ball, and probably their muscular nerves injured, for in them alone the electric properties are lost; elsewhere, *i.e.* in the supinator longus, they are feeble but not lost—electric sensibility being nowhere absent, except in the common extensor, which is most affected by the ball. All of the other muscles became rapidly well under the use of electricity, so that he was ordered to be discharged with a prothetic apparatus, to imitate the extensor action, January 20, 1864.

Remarks.—There was probably nerve injury of the extensor communis, and of the thumb and wrist extensors. The slight loss of electric properties and of voluntary power in other muscles was due to disuse and to the splint.

Gunshot wound of left arm, ulnar, and median nerves. Paralysis of motion; slight of sensation. Contraction of flexors; relaxation under treatment. Atrophy. Claw hand from paralysis of interossei. Stinging pain in hand. Great gain. Interosseal paralysis alone remains. Discharge with prothetic apparatus.

Case 30.—Henry Gervaise, æt. 20, Canadian, blacksmith, enlisted February, 1862, Co. F, 1st Vermont Cavalry. Healthy, until shot, July 7, 1863, in the left arm. Probably the wound of entry was the one over the artery, at the edge of the biceps, six inches above the internal condyle of the humerus. Exit on postero-internal face of arm, half an inch above, and three and a quarter inches behind the other wound. He felt pain in the arm, but dismounted, the artery jetting blood. After walking a little way, he fainted, and, awakening after some hours, found that the bleeding had ceased, but that he had no motion from the shoulder to the finger tips, and that sensation was lessened below the elbow. The pain in the hand grew worse gradually, and was neuralgic in character. On the second day, he could move the elbow, and during the first week could stir the thumb. About December, 1863, he began to move the fingers voluntarily, and this control has continued to improve.

In January, 1864, electricity was used in the hospital where he then was, but he says it was applied only on the fingers.

Present state, February 18, 1864.—Hand congested; palm purplish; nails curved. Measurements: Biceps, right, $11\frac{3}{8}$ inches; left, $10\frac{1}{8}$. Forearm, right, $11\frac{1}{2}$; left, 10.

Flexors in forearm wasted considerably. Thumb muscles wasted, and all the interossei much atrophied. No stiffness in the joints. The short flexor of the thumb, and the flexor group in the forearm, are moderately contracted. The former defect has allowed the extensors of the thumb to act on it so as to bring its metacarpus level with those of the fingers, and to turn the nail upward.

Sensation.—Anæsthesia and analgesia in palm and pal-

mar face of all the fingers; but only in the dorsum of the hand, and not on the dorsal aspect of the fingers.

Motion.—Good above elbow. Supination and pronation normal. The wrist flexion is incomplete from want of power. Extension limited by flexor contraction.

Thumb.—Flexion partly lost from want of power, and extension limited by contraction of short flexor. He has no abduction nor adduction of the fingers, and cannot flex the first phalanges, or extend the last two. Hence there is paralysis of the interosseal group.

It is not necessary to speak in detail as to the electric properties, which were wholly absent in the interosseal muscles, and defective in some others.

Treatment.—Electricity, douches; splint to correct flexions. Under this treatment, with energetic use of passive motion, the flexions were corrected, and every motion regained, except that of the interosseal muscles. To have a prothetic apparatus, and be discharged.

April 9, 1864.—The hand is now healthy in color, the neuralgia nearly entirely well.

Remarks.—This is a fair illustration of what care and perseverance may do for a severe case of nerve lesion. The "claw hand" here spoken of is well figured by Duchenne. We hold, with this author, that the interosseal group and lumbrici abduct and adduct the fingers, and are the extensors of the second and third digital phalanges; that the extensor com. digitorum acts only primarily on the first phalanx. The flexion of the first phalanges is done by the interossei; that of the second and third, by the two flexors sublimis and profundus alone. Thus, in Gervaise's case, the interosseal group only is paralyzed, and as a consequence the flexion of the first phalanges is lost as an independent act. When the flexors of the other phalanges contract, they first flex the second and third phalanges, and finally roll

all three into the palm. But when, in consequence of the want of opposition by their normal flexor, the first joints are more or less given over to the extensor communis, it pulls them back, and may even subluxate them, as in Schively's case, No. 18. Meanwhile, the second and third phalanges have no extensor at all, owing to the interosseal palsy, so that they are flexed by the constant action of the great flexors sublimis and profundus. Hence the form of the claw hand.

CHAPTER IX.

OF THE CONDITION OF CALORIFICATION IN INJURIES OF NERVES.

CALORIFICATION.—A great deal of time was expended in futile attempts to measure the temperature of the wounded limbs with thermometers. We failed, because it was impossible to overcome certain practical difficulties which we encountered in applying the bulb on flat surfaces; and because, in other cases, as in the hands, there was usually some loss of grasping power, so that there could be no just comparison with the sound hand, which readily embraced the bulb.

We resorted at length to the thermo-electric disks of M. Becquerel, in connection with a very delicate galvanometer, kindly lent to us by Prof. Rand, of the Central High School, Philadelphia. The disks were applied on corresponding parts of the body, and the deflection of the needle of the galvanometer informed us which was the warmer of the two localities.

The differences were so great, that the needle flew to the limit of its arc of motion in nearly every case; and thus it was that no numerical comparison could be made of the wounded and unwounded parts.

The examinations were repeated, until we were satisfied of their accuracy, and beforehand each one

of the two limbs to be compared was placed for half an hour in the same conditions as to covering or exposure.

The following statement records the results in a number of very grave cases of nerve wounds.

Where the lesion was of one nerve trunk, the parts examined lay always in its distribution.

It was observed that the member the nerves of which were affected was nearly always colder than the other, whether the nerve lesion was extensive or trifling. In two cases, there was no difference. One of these was an instance of total motor palsy, below the knee, with good tactile feeling preserved, and without atrophies. (See Case 28, Scott.) The other was a wound of the portio dura of the seventh nerve. The motor palsy complete, sensation perfect.

Five cases had a higher temperature in the wounded limb than in the sound member. Of these, one was an ordinary nerve wound, with slight loss of sensation and with a good deal of motor paralysis. All of the others were cases of the burning pain so often alluded to. The examination in these was limited to the spot affected. At the time of these observations we had no wounds in which complete division of all the nerves of a part had occurred; and in fact this is a rare accident. The sole exceptions were wounds of the seventh pair. One of these we examined as to temperature, but with no notable result. There was no difference between the two sides. At some future period and under more favorable conditions, we hope to resume this inquiry.

CHAPTER X.

TREATMENT — OF THE USE OF ELECTRICITY IN THE DIAGNOSIS, PROGNOSIS, AND TREATMENT OF INJURIES OF NERVES.

In the next chapter we shall give the chief symptoms of nerve wounds, with the various therapeutic means which they require for their treatment. Most of these agents need little comment, and are familiar to the profession. One of them, and the most efficient, is perhaps the most overrated and underrated of all the medical armamenta. Need we add that we refer to electricity?

As regards its use in medical cases proper, we have nothing here to say. As respects its value in traumatic lesions of nerves, we feel constrained to state that it has been understood and rightly appreciated by M. Duchenne alone.

After a year of great experience in the use of electricity, we are still satisfied of the essential correctness of almost every proposition on the subject which this distinguished physician has laid down. In a few instances we have had occasion to differ from him, but it has always been with a doubt, rendered more grave by the frequency with which our conclusions have agreed.

We have no intention to write a detailed account

of electric therapeutics, and in the following brief summary of M. Duchenne's views, as accurately tested by us, we shall presuppose the existence among our readers of such an amount of knowledge of electricity as is common among medical men.

When a healthy muscle is electrized or "faradized" (Duchenne) with an interrupted current from an electro-magnetic battery, it contracts, and there is a deep pain referred to the belly of the muscle.

The first phenomenon is said to be due to the electro-muscular contractility of the muscle. This property has curious relations to the ordinary contractility controlled by the will. Thus, a diseased muscle may be capable of volitional movement, and yet not exhibit the least tremor under the most violent and frequent shocks of a battery. This singular discovery, M. Duchenne has failed to theorize upon, and no other physiologist has ventured to do so. Our own experience has verified the truth of M. Duchenne's statement in numerous cases.

Electro-muscular sensibility is that property of muscle which gives rise to pain when the muscle is faradized. The pain is not caused by the contraction of the muscle. It is not a mere cramp pain, for it still exists when we faradize a muscle which has lost the power to contract galvanically. It is important to remember this property in the electrical prognosis of wounds of nerves; but, in examining soldiers, we have not always been able to induce them to make nice distinctions between the prick-

ling pain which the current causes in the skin, and that deeper *muscular* pain just described.

M. Duchenne employs wet conductors when he desires to pass a current with least pain through the skin into the muscles. We have used the same means, employing metal conductors, of various sizes, covered with wet sponges, and furnished with insulating handles. With these it is easy to call almost any single muscle into play, and in every case it is the muscle itself, and not the nerve, which we desire to faradize. The certainty with which each muscle may thus be excited is so wonderful, that by this, and by this means alone, is it possible to reach accurate conclusions as to the function of the various muscles.

When a nerve has been cut across, the muscles to which it is distributed undergo one or more of the following changes:—

Paralysis as to will; loss of tone; loss of electro-muscular contractility; loss of electro-muscular sensibility; atrophy, and possibly contraction.

The loss of volitional control is instantaneous. The loss of plumpness and firmness, or tone, comes next; and within a few days the electro-muscular contractility begins to fade. Of course, in this total paralysis, the muscular sensibility is extinguished with all other forms of feeling. Now, let us suppose months to have passed, and that the nerve has undergone partial restoration. We faradize the limb daily, or thrice a week. Some of the muscles make no response in any shape; their neural connections are not remade. Others, after a time, begin to fill up, tone returns, the vessels enlarge, the skin flushes,

and at last electric contractility and sensibility come back by small degrees to some and rapidly and fully to others. These muscles we shall cure in time. If the limb now begins to suffer from neuralgia, it is also a favorable sign, but may call for a temporary suspension of treatment.

In many muscles voluntary motion is recovered without the slightest exhibition of electro-muscular contractility. Nevertheless, the electricity seems to be equally as efficient in these as in other cases.

In every instance the use of the battery must be prolonged for months after the return of partial voluntary control, although, of course, this is itself a great aid to further treatment.

Let us again suppose that we have to deal with a case where there has been a partial lesion of a nerve of recent date; a week old, for example. The effect of the local commotion still remains, and some of the nerve fibres have been torn. We faradize the muscles in turn.

And let us suppose the case to be a wound of the brachial plexus. We find loss of electro-muscular contractility in the biceps, coraco-brachialis, brachialis anticus, and deltoid muscles, with a like affection of the extensor and supinator mass of the forearm coupled in them, with distinct loss of electro-muscular sensibility. The other muscles are paralyzed to the will, but have perfect electro-muscular sensibility, and little or no disturbance of electric contractility. We should conclude that the exterior and posterior cords of the plexus had been severely injured, and the other parts slightly affected. We should also state, as a prognosis, speedy recovery of all the

muscles but those in the range of the circumflex, musculo-cutaneous, and musculo-spiral nerves. One of the branches of the median, which springs from the outer cord, would have escaped injury of any grave nature, although the other nerve of like origin, the musculo-cutaneous, would have been damaged. The muscles which exhibit no lesion of electric properties within two or three weeks of the wound, we may look to see revive, as the effects of the commotion pass away. Those which have lost all electric properties will be least likely to get well; and those in which only the electric contractility is weakened or lost, will have a chance of cure, good in proportion to the amount of this property which remains.

At the close of two or three months, it is usually still more easy to make a diagnosis or prognosis. By that time the immediate and temporary influence of shock is at an end. All the muscles the nerve supply of which was not seriously compromised will be well, and an examination of the others, with the battery, should enable us to say what chance there is of early relief, and what muscles may never recover, or at least be difficult to revive. But the whole question will not have been answered until, *at long intervals*, continued and persevering faradizations have been resorted to, for in these intervals new nerve repairs may have been made, which would enable us to recall to functional life muscles which a year before were, to appearance, hopelessly isolated from their centres.

When, then, at the close of some months, a muscle has lost all its electric properties, it is certain to

be difficult of restoration. If its sensibility be intact, and its electric contractility alone be lost, the case is better than where there is lesion of the sensibility.

The amount of contractility present in a muscle under faradization, as compared to that of the healthy corresponding organ, is a good test of its condition. The nearer the healthy amount, the better the chance of future volitional control. The muscle may improve in size and tone, and the will reassert its dominion, without the return at any period of electro-muscular contractility.

M. Duchenne does not mention, what is common, a hyperæsthetic state of muscles after wounds, so that in some which have volitional power, but no electric contractility, the electric sensibility is such as to make the use of the battery exquisitely painful.

Lastly, under the use of induced currents, the atrophies of muscles disappear, and the local nutrition receives a singular stimulation.

To faradize the skin, M. Duchenne uses a bundle of thin wires, which makes a brush. The skin is dried, and powdered with flour, and the brush swept over the anæsthetic surfaces. We concur with M. Duchenne in his statement, that this is the most intense and painful local excitant known to medicine, while yet it has no power to injure the part it thus violently irritates. As a test of any doubtful remnant of feeling which may be left in a part, it is more perfect than heat, and quite harmless.

The value of this agent was well shown in Case No. 8; but we have had less occasion to resort to it

than to wet faradization. In hysterical anæsthesia it has given the most excellent results. The batteries employed by us have been those of M. Duchenne, and the cheaper though less efficient machines made by Neff, of Philadelphia, and by Hall, of Boston.*

It is, of course, quite impossible, in so limited a space, to detail at length the numerous and elaborate researches by means of which we have tested M. Duchenne's views, and verified them to a large extent. We hope, at some future date, to enter more fully into the subject, and to point out how much the art of electric therapeutics owes to him, and also to state more at length the points as to which we differ from him, and why we differ. Enough has been said here, we trust, to enable physicians to carry out the plans of treatment which we have laid down.

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* For hospitals we prefer electro-magnetic instruments to electro-galvanic machines, which, on the other hand, are best in private practice, and wherever they can be carefully looked after and cleaned as soon as used. None of the American batteries for medical purposes have power enough, and Duchenne's are too costly. We still need a good electro-magnetic instrument in which the armature should be steadily rotated by clock-work.

CHAPTER XI.

DIAGNOSIS, PROGNOSIS, AND TREATMENT OF NERVE WOUNDS AND THEIR CONSEQUENCES.

As we earnestly desire that this essay may become a means of aiding a neglected class of sufferers, we shall endeavor, by making it as concise as possible in this, its most practical chapter, to put the scheme of treatment within those brief limits of statement which are best suited to the slight leisure of our too busy field and hospital surgeons.

Diagnosis.—Let us suppose a case in which a ball has passed near to nerves or through them. The surgeon will be told that there is numbness, or loss of sensation. By touch and the needle point and electricity, he will be able to tell how great is the loss of sensibility, and by its limits, what nerves have been primarily affected. As regards motion, there may arise some embarrassment, because the early inflammations and swelling from the wound lessen mobility by making it painful and mechanically difficult. If the patient be seen immediately after the wound, this scarcely applies, and, at the close of a week, unless the injury has been extensive, it equally ceases to apply. Whatever loss of motion

ensues at once, is owing to neural affections, for the nutritive changes are of later date. After two or three weeks, and more remarkably after a month or two, the points for diagnosis become numerous. Loss of sensation remains or not; but its cause is simple, uncomplicated—a nerve lesion always.

Loss of motion, at first due only to primary nerve injury, may now come from cicatrix pressure, or may be modified in extent by it, and by inflammatory and obscure secondary affections of the nerves. It may be limited by atrophies, muscular contractions organic or spasmodic, by joint affections, and by malpositions arising out of one or more of the above-mentioned conditions. Indeed, the neural lesion may have been long well, and the ill it did live after it in some of these shapes.

Or finally, there may be no one of these complications. Simple paralysis may be present, the nerve lesion may have healed, and the muscles, long disused, be merely awaiting some stimulus to recall their volitional activity. If the physician cannot tell that they are in this condition, they may lie dead as to motion, for years or for life; and it is here that electrical diagnosis becomes invaluable. (See Chapter X., Electric Diagnosis.)

Thus it is not always easy to see at a glance, why or how a limb has lost movement: the more remote the wound, the less easy is it; but, on the other hand, a little care will usually enable us to discriminate as to the various causes of loss of motion of which we have spoken. Two or three cases, carefully studied, will make all the rest seem sufficiently simple.

Prognosis.—As regards pain, we regret to say that when it has been severe for months, and is neuralgic in character, and where it has resisted hypodermic injections of morphia, it is only too likely that it will continue for periods to which our experience sets no limits. The burning pain is rarely so permanent a symptom; but, if it be not alleviated by frequent blisters, it also is apt, in some instances, to resist all other means. Sensation is on the whole more likely to get better than motion; and there is no sign, except gradual improvement in it, which will warrant us in entertaining a hope as to the ultimate recovery of this function.

As regards motion, the case is otherwise. The action of electricity enables us to decide, with an approach to accuracy, as to the probabilities of recovery in each muscle affected with paralysis. No experience, however, will assure us that atrophy and contractions, or joint lesions, may not come on at any time, though usually, if they have not appeared within three months, and the patient be then rightly cared for, we have reason to suppose that he will not be annoyed by them in future.

Of course, a total destruction of a nerve by a ball should point to a grave prognosis; but it is to be remembered that a blow or bruise is sometimes as fatal in its remote effect, and as permanent for evil.

The surgeon who sees a case immediately after a wound may feel sure that, unless the nerve has been cut across, some at least of the lost motions will return within a week. At that date, the electric battery will determine to what extent the remain-

ing inactive muscles are affected, and which are likely to recover motility readily, and which are not.

Treatment. Pain.—Although not the most important symptom, pain in some shape is so frequent and so prominent, that we shall enter upon our sketch of treatment with its consideration.

Pain is usually neuralgic, aching, or burning; or else these three types mingle. In every case it is necessary to examine the scar and the nerve tracks. When the scar is so situated as to press upon the nerve, in certain postures, we have found that active frictions over the cicatrix, with moderate exercise of the part, whether there was great pain or not, succeeded always in relieving it. In some cases the first movement must be passive in character; but the patient soon learns to aid himself.

If the track of the nerves implicated be painful or tender on pressure, the neuralgia may get prompt relief from the free use of leeches, which should be placed over the nerve. In other cases we have applied blisters, or the actual cautery, but have found on the whole most good to result from repeated leechings.

Combined with this, we should also employ hypodermic injections of morphia, which, although but palliative in some instances, are in very many curative. It has seemed to us usually of little moment where the injection was made, the result being the same. Many such cases of neuralgia have been thus treated in our wards, and we are glad to add our evidence in favor of this method.

Burning Pain.—For this the patient has one treatment, which he adopts early and uses with perseveranee. It is the eonstant wetting of the part. He never allows it to dry, and it is often hard to persuade him to use any other means of relief.

When we first eneountered this formidable symptom, we exhausted our ingenuity in devices for its relief. Most of these were addressed to the nerve or the eicatrix—no one of them did any good. Finally, we were led to suspeet that the starting-point of the pain lay in some altered state of the ultimate nerve fibres, and that it was eonneeted with the defeetive nutrition of the part. When, in accordance with this view we sought to ehange the surface eondition by repeated blisters, our suceess was more than we eould have dared to hope for in so obstinate a malady. The treatment is a simple one. The palm, if that be the seat of pain, is first blistered with Granville's lotion, and afterward with the ordinary eantharidal ointment, or with cantharidal collodion. The blistering is repeated, not onee, but many times, until the pain is absent, and even afterward at intervals. This is all we need do; but it must be done thoroughly and repeatedly. In some eases. the blister, or rather the absenee of water, is so painful, that it is necessary to injeet morphia under the skin of the arm onee a day at least while using the blisters. In rare examples, two out of twenty, this treatment has given no relief. Where it failed, we used, as we had used in many others, the morphia injections. They eased the pain, but we have seen no permanent benefit from their employment in these or in any instances of

the burning pain alone. That it is commonly distinct in origin from ordinary traumatic neuralgia, and that it should be distinct as to treatment, we have little doubt. Light cases of the burning were cured by two or three blisters; severe instances, by ten, twelve, or more, applied in succession—one to be used as soon as the preceding one healed.

The following case may serve at once to illustrate further the clinical history of the burning pain, and also the progress and treatment of a traumatic paralysis, in which nearly all the accidents or incidents of such cases were exhibited. In this patient, as in others, the burning returned several times after having been relieved by blisters. The tendency to recurrence was most marked in hot weather. It is to be met by a new series of blisters.*

Gunshot wound of the left brachial plexus. Paralysis of motion and sensation. Muscular hyperæsthesia. Intense burning in hand and arm. Nutritive changes. Atrophy. Contracted extensors. Relief. Discharged.

CASE 31.—A. D. Marks, sergeant, Co. C, 3d Maryland Vols., æt. 43, enlisted August, 1861. Previously healthy.

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* Since this essay was written, we have had occasion to treat several cases of burning pain from the battle-fields of General Grant's recent campaign beyond the Rapidan. Some of these came under our care very soon after the wounding took place; others began to exhibit the burning while in our wards. In all the prompt use of a blister was decisive for good. In a few repeated blistering was called for; but no recent example of this form of pain has proved rebellious to frequently renewed vesication.

As the general result of this later experience, we have been taught that the earliest treatment of this symptom is the easiest, and that on the first complaint of scalding pain, the ammonia vesicant should be promptly and thoroughly applied.

May 3d, 1863, at Chancellorsville, he received two wounds; one in the neck and one in the chest. The first ball passed in below the anterior boundary of the left armpit, through the margin of the great pectoral muscle, the arm being raised at the moment. The missile glanced on the neck of the humerus, and made its escape anterior to the coracoid process, apparently wounding the plexus. As he turned to leave the field, a second ball entered the right side of the back, to the right of the eighth dorsal vertebra, and, crossing behind the spine, entered the left chest. The first wound caused palsy of motion and feeling in the left arm. The second gave rise to cough, spitting of blood, dysphagia, etc. It finally caused pleurisy, and large escape of pus during breathing. The wound is now closed, July 4, 1863, but the lower half of the lung is consolidated. The second wound brought him to the ground. He was taken prisoner, exposed a good deal to weather, and finally exchanged, and sent to West Philadelphia, Satterlee General Hospital, June 10, 1863.

During the first week, the arm, though palsied, was painless. Then he began to feel a knife-like pain from the wound down the inside of the limb, and also on its front, and on the ulnar side, half-way to the wrist. With these pains came a tingling and burning sensation, as when the blood returns into a limb said to have been asleep, but more severe. Soon afterward this extended to the hand also, and he began to be able to feel the touch of foreign bodies.

Present state, July 5, 1863.—He lies on his back, anxious-looking and pain-worn. The left arm rests on a pillow. It is cold, mottled, and swollen. The skin of the hand is thin, and dark-red, but presents no eruption.

Tactility, nowhere absent, is dull on the dorsum of the hand and fingers. Except in these parts, localizing sensation is good. The whole arm and hand, except its back part, is, as he says, alive with burning pain, which warmth and dependence of the limb increase, and which cold and wetting ease considerably. It is subject to daily exacerbations about mid-day.

Motion.—The shoulder muscles act well. The deltoid is feeble. There is no motion below the elbow. The fingers are half flexed, and their joints swollen, sore, and congested. The deltoid is atrophied one-half. The extensors in the

forearm are flabby, but the general œdema prevents us from telling whether the forearm muscles are wasted or not. Pressure on the cicatrix gives no pain.

While at Satterlee Hospital, Dr. Walter F. Atlee used ice to the arm, and on the shoulder a blister, dressed with morphia. These measures relieved the arm for the time without aiding the hand.

July 5.—Ordered hypodermic injections of the fourth of a grain of sulphate of morphia, near the scar, twice a day. This relieved the arm; the hand growing daily worse, so that even ice ceased to afford ease, and he constantly prayed us to amputate the arm.

July 7.—Erysipelas set in about the seat of the injections, and they were discontinued for a time, morphia being used internally, and lead-water locally.

On the 9th the disease had left him, and two drops of conia were injected into the shoulder. This was thrice repeated, but gave no relief. Atropia, one-twenty-fifth of a grain, was next essayed, three times successively, at intervals of two hours. It caused dilatation of the pupils, flushed face, giddiness, and dry tongue. The only valuable result was a relaxation of the flexors of the fingers, which had become contracted, but which never afterward became so rigid as they had been. The patient himself called attention to this singular effect. Again morphia, one-third of a grain, was injected into the arm without aiding the hand.

July 15 to July 20.—Injections of morphia were made into the hand twice a day. They gave so much ease that the ice was temporarily abandoned.

July 21.—For the first time we were able to examine the limb with electricity.

Tactile sensation was good in the arm and absent in the ulnar distribution. In all other parts of the hand tactile sensation existed. In the portions insensitive to touch, deep pressure and pinching caused pain, which was very severe, but was indistinctly localized by the patient.

Electro-muscular contractility was absent in the whole hand and forearm. The currents caused everywhere great pain, so that we could not tell if it were muscular or not. Probably the muscles still had sensation, since pressure on them was agonizing. Every electric examination necessitated the immediate subsequent use of morphia injections.

August 14.—The recent warm weather has increased the pain, so that he moans and weeps incessantly.

Up to September 9, various means were employed. The injections have been so numerous that the part is dotted with punctures, and their irritation has aggravated his sufferings to such a degree that they have been permanently laid aside for the internal use of narcotics. As local agents, we have had recourse to laudanum, lead-water, ice, oil, poultices with and without soda, and poultices of carbonate of soda, with vinegar to release carbonic acid. Of these the soda poultice did best; but in this, as in every instance, the ease lasted but for a day or two. In despair, leeches were placed about the cicatrix, and blisters were applied over it and kept open, and also over the nerves which were tender on pressure; neither aided him.

Meanwhile the pain increased, but became limited to the palm and fingers, and lower forearm, with darting pains up the arm. The tactility improved and the muscular tenderness lessened. The general œdema disappeared, and the atrophy was seen to be extreme, while the finger joints remained sore and swollen. Every motion or vibration caused pain.

October 18.—A blister on the palm failed to draw, but a blister on the dorsum of the hand acted well, and gave very marked relief. It was followed up with ammonia blisters on the palm and arm. These were repeated, with, finally, cantharidal blisters. And now for the first time the ease was complete. Incessant blisters gradually ameliorated the pain. They were continued every few days for two months, until every trace of burning left him. He was so sure of the relief from this application, that he was unwilling to allow the hand to heal before using a new one.

December 1.—Slight pneumonia of right lung.

December 10.—Electricity ordered. Immediate return of pain. Ceased its use.

Up to January 6th, his arm and hand were shampooed daily, passive motion was employed, and he began to sit up and move about.

January 6, 1864.—Careful re-examination. Arm gaining flesh. Cicatrix shrinking. Atrophy general. Worst in the extensor group, in the forearm. (See Specimens, Casts Nos.

18 and 19, Army Medical Museum.) Sensation good throughout, but not quite perfect.

Voluntary Movements.—Shoulder abduction, one-third; other actions perfect. Elbow extension complete. Flexion by biceps alone, two-thirds. Supination effected only by biceps. Pronation, one-third. Wrist extension and flexion about one-sixth of usual range. Passive extension to line of forearm, where the flexors, which are contracted, limit the motion. Thumb everted, and flattened like that of a monkey. Slight flexion and adduction. Muscles utterly wasted. The finger joints are no longer swelled, but are excessively rigid, and have no movement.

Electric Test.—Below the shoulder no muscle has any electric contractility, and the sensibility to induced currents is also diminished. Again the electricity brought on the burning, and was abandoned.

Ordered daily etherization, and the fingers to be then freely moved. Shampooing to be continued, and the douche twice a day, with occasional blisters.

January 29, 1864.—Electricity no longer renews the burning, and is to be daily employed. The gain was now rapid. Flexor power over the fingers came back, but no extension, and no thumb motion.

February 23.—Supination and pronation improving. Atrophy lessening. Ordered bandage-roller to be placed on the palm, the fingers to be bound down over it, to overcome the extensors, which, within a month, have been contracting.

On April 10, 1864, he was discharged, free of pain, and having only three-fourths flexion of the fingers, without power to extend them. All the other motions were improving, and the thumb muscles began to respond to the will. Sensation perfect.

Treatment of Nutritive Changes.—We have already pointed out the use to be made of electricity in the atrophy of muscles. It is not contraindicated where there are also organic contractions in the wasted muscles. Of its mode of use we have already spoken, and we repeat that it should be employed daily; the

sitting to be about ten or fifteen minutes, and each muscle to be faradized in turn, remembering that the treatment of atrophied muscles is an affair of months, or even of years.

With the electricity, we have had recourse to other agents, for the purpose of flushing and re-exciting the muscles. These were the douche, passive motion, and shampooing.

The most effective douche was found to consist in the alternate use of hot and cold water.

Passive motion was performed by the assistant surgeon in charge of the wards. Where it was very painful, we gave ether, and the men were themselves taught to make frequent passive use of the injured limbs.

Shampooing, which is an effective ally, is best made by kneading the muscles, at first gently, and then more and more roughly, until the part re-acquires its tone and fullness.

Active movements of limbs not completely paralyzed were enjoined upon the men; but as it was not possible to trust this to them, with the certainty of its being efficiently done, two classes, one for legs and one for arms, were organized, and put in charge of intelligent orderlies, whom we trained for the purpose. By this means an efficient system of calisthenics was carried on every day.

Malpositions and anchylosed joints were of course treated variously, as their nature demanded. The splints used to correct extreme states of flexion or extension were worn during the night, or a part of each day, the intervals being occupied with more active treatment.

A splint on the back of the arm, with a bandage, or caoutchouc bands, answered to effect extension of the fingers. Flexion was brought about by placing a small roll of bandage in the palm, and bandaging down the forcibly flexed fingers over its curved surface. For other, and like purposes in the feet, the usual forms of club-foot apparatus were made use of, with such modfications as the cases suggested. The stiff joints proved very troublesome. Passive motion, under ether and the use of liniments, relieved many. A very few were inexorable under every means employed.

Spasmodic Affections.—The tremor, so often alluded to, appeared in some cases to depend upon the rigidity of the limb in which it occurred, for it was always cured by the douche and passive movement with frictions.

Spasmodic contractions of short muscles, such as the abductor minimi digiti and the flexor brevis pollicis, yielded easily to a few injections of atropia thrown into the centre of the muscle itself—a novel means, upon which we are still experimenting. This agent failed us when we came to use it in long muscles, such as the flexor carpi radialis. We made continued and persistent efforts to overcome the more obstinate spasms, by faradizing the opponent muscles. Contrary to M. Duchenne's experience, we failed in every case, the currents either exciting the contracted muscles reflectively, or, passing through their opponents, acted directly on the contracted muscles. M. Duchenne's cases were spasms not due to wounds; but in our own cases these

shortened muscles were as excitable, or more so, than is usual in the healthy organs.

Paralysis.—The one great means in the treatment of paralysis, from defect of innervation, is electricity.

M. Duchenne is of opinion that this agent has no real utility in traumatic nerve lesions until some months or longer have passed away, and there has thus been a chance for nerve repair. Until this time he believes that its use does no good, and that atrophy and other changes go on, whether it be employed or not. Upon this point we cannot speak with confidence, owing to the fact that most of our cases had been long wounded when they came to us. Our present experience in recent nerve wounds will enable us to give more decided evidence for or against his views.

It certainly would seem reasonable to endeavor, in recent wounds, to keep up the circulation and to stimulate the muscles by motion, frictions, the douche, and perhaps also by faradization. And, at all events, some of these agents would be effective to prevent the deformities which result from long disuse in connection with imperfect nutrition.

The mode of faradizing a part has already been described. It should be conscientiously employed for long periods, ceasing it for a time when it causes neuralgia. We feel sure that in our hands it has been of the utmost value. In many instances, a single sitting has recalled motion to parts long at rest; in others, several sittings have restored more or less power to a whole limb, and we

have seen few cases which have not become better nourished, more sensitive, and stronger, when it could be long enough continued. Finally, we most earnestly repeat that without its use no limb, however palsied, should be abandoned by the physician as hopelessly injured.

We have thus rapidly and concisely treated of the means which we have used to relieve the various conditions arising out of nerve lesions.

It will have been seen that these measures are few in number and simple in character. Two things are necessary to their success—first, a clear comprehension of what it is in each case that limits motion; and second, the most unflinching perseverance in the employment of the therapeutic means.

We have said nothing of general remedies. There are frequently cases of traumatic injury occurring in the subjects of malarious or scorbutic disease, which never improve until the constitutional condition has been attended to. There are others, in which the health has been broken by intense suffering of purely local origin, such as the burning pain, so often spoken of in former pages. In all these patients, the administration of tonics is obviously suggested. Iron and cod-liver oil, with moderate use of malt and spirituous liquors, have answered best; but no such case can be successfully treated without the frequent aid of narcotics. These, as we have seen, are most effective, and perhaps least injurious, when used subcutaneously.

No class of cases with which we have been called to deal seemed to us, at one time, so sadly hopeless

as injuries of nerves; none has better rewarded enduring and steady efforts to afford relief. We look back with unfeigned pleasure upon the great number who came to us, despairing cripples, and have left us eased of pain, and either entirely well or so far aided as to enable them to employ their limbs in useful occupations.*

* The subject of enabling persons who have lost some essential motion, to imitate it by artificial means, has attracted our attention but lately; at present, several men are having made for them, by Mr. Kolbe of this city, at government expense, prothetic apparatus, to give extension or flexion to the wrist or fingers, from which we anticipate the most favorable results.

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