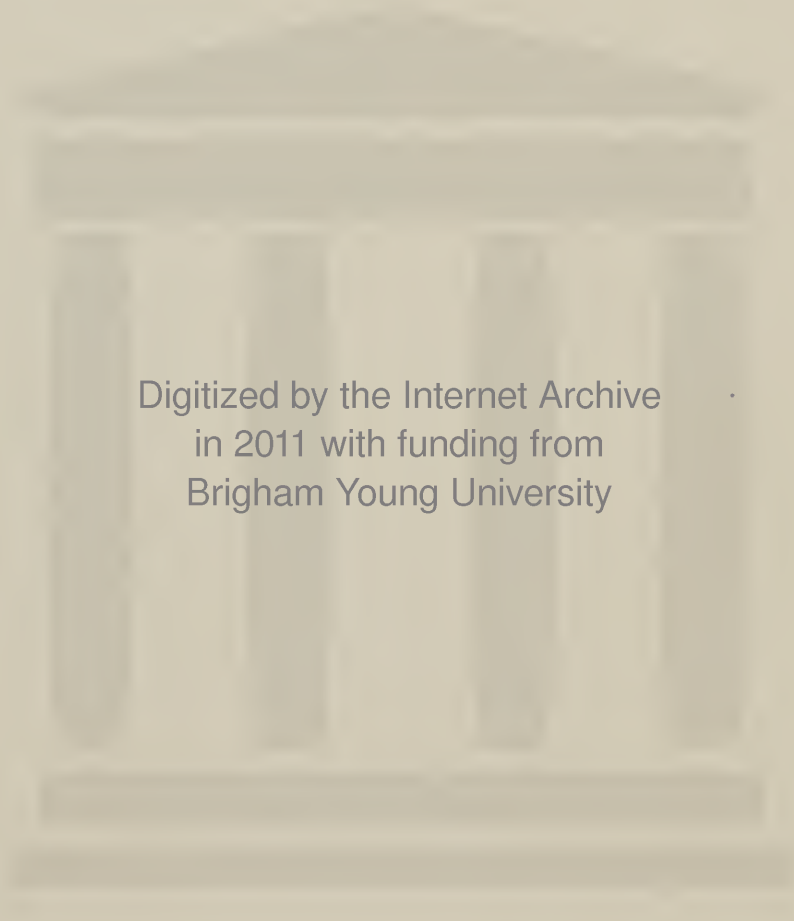

Mrs. Horace C. Maldonado

A MANUAL OF

THERAPEUTIC EXERCISE AND MASSAGE

DESIGNED FOR THE USE OF PHYSICIANS STUDENTS AND MASSEURS

BY

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PREFACE.

This book has been written to fill the need for a work on the therapeutic use of exercise and massage. While the value of these methods is generally conceded, it is equally certain that they are not yet used in practice to the extent they deserve. Because of the general neglect of these important therapeutic resources many patients who appreciate their value find their way into the hands of quacks or incompetent persons.

The correct indications for and applications of exercise and massage require not only a thorough knowledge of the anatomy and physiology, but also a good understanding of the underlying pathological conditions. It is this knowledge, together with sound judgment, that makes the competent masseur—the technic is of secondary importance; similarly the best surgeon is not necessarily the one who develops the best operative facility, but the one who combines skill with sound judgment. Throughout the book it has been the foremost intention of the writer to bring out this point as clearly as possible.

In most of the conditions treated in this book the clinical pathology has been omitted for obvious reasons; only those affections have been discussed at length which the author's daily experience has shown are not commonly understood, such as certain lesions of the shoulder, the lumbosacral and sacro-iliac regions, and a few others.

The subjects of massage of the eye, the ear, and the female pelvic viscera have purposely been omitted, while those of the nose and throat and those connected with mental disorders have been but briefly mentioned. The accurate diagnosis of these diseases requires such a degree of specialized skill that they should not be treated by the general practitioner or the masseur. Great harm may be done by the unintelligent application of massage in these regions.

The use of complicated mechano-therapeutic apparatus has been dealt with only very briefly, as this book is intended for the general practitioner, the student, and the masseur, and not for restricted use in special institutions.

My grateful acknowledgments are due to my secretary and to the friends who have assisted me with advice in the preparation of the work.

C. H. B.

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EXERCISE AND MASSAGE.

CHAPTER I.

HISTORICAL INTRODUCTION.

Exercise and massage were used by the old Hindus, Chinese and other ancient peoples, but mainly for general hygienic purposes. Their therapeutic value was first recognized by the Greeks. An interesting analogy with our times exists in that Herodikos, a so-called Jatrolipt or officer in a gymnasium, was the first man who developed systematically exercises for the cure of a weak body. He was not a physician, and was considered by physicians to be a quack. However, the sane and sensible ideas of his methods could not fail to attract the attention of physicians and thus we find not long after Herodikos exercises and certain massage manipulations mentioned by Hippocrates and others, although their hygienic value was still especially emphasized. Asclepiades, who is often called the father of physical therapeutics, was the first to develop exercise and massage into a scientific system which was fully recognized by the physicians of his time. Afterward physical therapeutics held a prominent place in medicine until the dark period of the middle ages. The reports of cases in Galen's books such as the cure of a boy with deformity of the chest by movements of the arms, singing and respiratory exercises, call forth our interest and attention even now. Physical therapeutics have never entirely disappeared since then, but they were used rather as popular medicine than on the doctor's prescription, as is still frequently the case in our time.

The recent development of exercise and massage is forever connected with the names of two men: Ling and Metzger.

Peter Henric Ling (1776–1839) a Swedish gymnast, not a physician, is generally considered as the founder of the Swedish system of exercise which by its rational application of anatomical and physiological principles is still the standard system of therapeutic exercise. The methods and principles have been worked out so thoroughly by Ling and his followers that recent development has as its main subject not so much the technic as the indications in practice. With better knowledge of disease and its causes therapeutic factors such as exercise and massage are now on a more rational and scientific basis, and this will be the case still more in the future.

Therapeutic exercise was already highly developed in Sweden when Zander, induced by the desire to make the treatment independent of the more or less unreliable gymnast, began to construct his apparatus. Thus he became the founder of the medico-mechanical treatment, the method which, as the name indicates, is applied by mechanical apparatus under the direction of the physician. Zander's apparatus and its modifications by Herz and others have stood the test of time, and their almost universal and ever-growing application clearly demonstrates their great usefulness.

In the older Swedish method massage was largely considered a part of exercise. Its modern scientific development and general application, however, begin with Metzger, a physician of Amsterdam, who by his highly developed technic and successful treatment of many medical and surgical affections in the middle of the last century, attracted the attention of leading physicians and surgeons. Billroth, Langenbeck, Esmarch, Volkmann, and others sent their assistants to Metzger in order to learn his technic for a proper application in their clinics. Both massage and exercise are now placed on a strictly scientific base by the experimental and clinical work of v. Mosengeil, Zabludowski, Colombo, Rosenthal, Zuntz, Weir Mitchell and many others. In the chapters on the physiology of exercise and massage their most important scientific results will be described. At this place we shall briefly mention the historical development of these

physiological studies. At the fourth congress of the German Surgical Association in 1876, v. Mosengeil reported his epochal experiments on the absorptive effect of massage. Chinese ink injected into the knee-joints of rabbits was found to be much more speedily and thoroughly removed from the joint and absorbed by massage than under ordinary conditions. Furthermore, the accelerating effect of massage on the venous blood stream was proved by this author. In the following year Lassar demonstrated the same effect on the lymph vessels. In 1883 Zabludowski began his studies on the metabolism, the action of the muscle, the reflex irritability, blood-pressure, and many other matters, experiments which, although not always conclusive, have nevertheless helped a great deal in the understanding of the physiological effect of massage. Furthermore, the experiments of Reibmayr and Hoffinger (1883) on the effect of massage on the absorption of fluids in the abdominal cavity; of Eccles (1885–87) on the influence of general massage upon the body temperature; Bum's (1888) interesting studies of the secretion of urine; Maggiora's (1891–92) experiments on the fatigued muscle; John W. Mitchell's studies on the augmentation of the blood corpuscles may be mentioned in passing. Of later work the experiments of Bendix (1894) on the metabolism; Colombo's interesting results with the secretary function of many glandular organs; Eckgren's observations on the effect of abdominal massage upon the pulse and blood-pressure as well as the peristalsis and the excretion of albumin in nephritis, deserve attention. Rosenthal's various experiments since 1908 on the absorption of fat, the increase of the surface temperature, his plethysmographic studies on the volume of the arm, the production and discharge of warmth and others, will be described in detail in the chapter on Physiology of Massage.

Likewise the effect of exercise on the physiology of various organs and the general metabolism has been made the subject of frequent experiments. We shall mention here merely the following: In 1878 Treves published his experiments on the increase of strength and endurance of the muscle by systematic training. Chauveau and Kauffmann stated the increased

speed of the venous blood in the chewing muscles of the horse. Zuntz and Hagemann (1898) reported their results on the blood-pressure. Johansson showed that the products of metabolism of the active muscle act in a stimulating manner upon the heart and lungs. Zuntz and Schumburg experimented on marching soldiers; Spirig and Adolf Schmidt (1892) on the peristalsis and the digestion; Atwater and Bryant (1900) on the metabolism of college students training for boat racing.

E. du Bois-Reymond in 1881 called attention to the intimate relation of muscle and nerve training. Atwater and Benedict (1899) experimenting with special technic showed the relation of the gas metabolism to rest and work. There should also be mentioned in this connection the inspiring work of Oertel and the brothers Schott on the treatment of circulatory disease by exercise.

A considerable number of text-books have been published on the subject of exercise and massage of which the following may be mentioned: Eckgren's *System of Swedish Exercise;* Bum's *Massage and Heilgymnastik;* Graham's *Treatise of Massage;* Hoffa's and Böhm-Painter's *Manual on Massage;* Nissen's *Practical Massage;* Mitchell's *Mechanotherapy and Physical Education, including Massage and Exercise,* a part of Cohen's *System of Physiologic Therapeutics,* and the *Handbuch der Physikalischen Therapie,* edited by Goldscheider and Jacob.

CHAPTER II.

TECHNIC OF ACTIVE AND PASSIVE EXERCISE.

Therapeutic exercise, or medical gymnastics, is the term for a variety of movements which are done for therapeutic purposes by the patient alone under the personal direction or after the prescription of the physician, or by the patient with the coöperation of the physician, a gymnast, a masseur, or apparatus specially devised for such purposes. Also certain sports and games may be used for therapeutic purposes.

We shall begin with those movements which are done with the coöperation of another person or, as we shall briefly say, an "operator." These movements are divided into:

I. Active movements, or those which are done by the muscle power of the patient.

II. Passive movements, or those which are done without the coöperation of the patient, but by another person or a special apparatus.

III. Active-passive or promotive movements, or those in which the patient executes an active movement of some muscles whereby a passive movement of the part to be treated is brought about. Under this heading also fall those exercises which may be called promotive, whereby the patient begins and to a certain extent maintains, the exercise which is promoted or aided by the power of a pendulum or a revolving wheel.

ACTIVE MOVEMENTS.

The active movement is by far the most important one in therapeutic exercise, a fact which is by no means generally recognized. In local as well as in general gymnastics the correct coöperation of the patient's muscles is the chief if not the indispensable factor. The Swedish gymnasts who deserve the great merit of having developed therapeutic

exercise into a rational system have recognized the importance of the active coöperation of the muscles for most purposes. On a scientific, anatomical and physiological basis they have built up the system of resistive and assistive exercise which will play a very prominent role in this book and with which we shall deal first.

By the term active exercise all those movements are included which require the intentional or voluntary and active use of the person's muscles. In a strict sense, therefore, all the motions we make should be called active exercise. To render it of therapeutic value, however, certain requirements are made as to the localization, regulation and measurement. For the understanding of the value of these factors attention must be called to certain important principles of general kinesiology.

Any active voluntary motion depends upon the action of muscles. This action is of three types—positive, static and negative action, as an example will make clear. In the act of raising the arm the deltoid muscle contracts; its ends are brought closer together. It performs, as we say, a positive action. When the arm is held up steadily the deltoid is still in a state of contraction, but its ends remain in a constant relation to each other. This is called static action. Again, in the act of lowering the arm the deltoid is still at work in such a way that its ends gradually become separated. We speak then of a negative action.

It is at once clear that the extent to which a certain muscle or muscle group acts during a given movement must depend on the position of the individual. The example chosen above shows a person lifting the arm while in an upright position. These conditions will change when the person is lying down. Then the deltoid will perform a positive contraction until the arm is lifted above to a right angle. Shortly before the arm reaches the vertical position the axillary muscles, particularly the pectorales, begin to work. To be sure these muscles have been at work from the first, when the arm is being raised. They have performed a negative action which at first has more of a passive character but gradually shows more and more of an active tendency, as the difficulty

of balance increases. From the moment the arm is moved beyond the vertical line over the head the axillary muscles begin to perform further negative action while the deltoid is now relaxed. On reversing the movement the axillary muscles act positively until near the vertical line. Then the deltoid again becomes active, letting the arm go downward, whereby a negative action is performed.

These examples will suffice to demonstrate the principles. They also show that for many purposes it is not enough to prescribe simply active exercises, but that we must regulate them in a certain manner. This is done by applying resistance or by making an active exercise a resistive exercise. In a general sense any movement is a resistive movement, in that the weight of the body or its parts furnishes resistance, but in a special sense we speak of resistive exercise when the resistance is furnished by the hand of the operator or by an apparatus constructed for such purposes.

Before we discuss the principles of the technic of resistive exercise we shall consider the important principles mentioned above, localization and measurement or dosage.

The importance of an exact localization is at once apparent when we want to exercise the hip or shoulder. With many affections of the hip-joint the patient shows a tendency to move the spine rather than the hip unless we apply proper fixation or support to the pelvis. Another example: If an affection of the humeroscapular joint is the object of treatment we execute or prescribe exercise for this particular joint, whereas the patient rather has the instinctive tendency to keep this joint fixed, and compensate the effect intended by motions of the scapula or even the whole spine. By correct application of support and resistance or assistance the exercise may be localized where it is most necessary. Of particularly great importance is the exact localization of the exercise in cases of paresis or paralysis where the muscular control of a certain part is greatly or totally defective, or in a cardiac case where by an indefinite localization of the exercise the effect on the circulatory system must at once become uncertain, rendering the exercise dangerous perhaps instead of beneficial.

All that has been said about the localization is also true for the second requirement of methodical therapeutic exercise, that is, the measurement (dosage).

According to the various indications it is important to vary the amount of work which is required of the working muscle or muscle group; *i. e.*, with any inflammatory signs present, it is not wise to require much work of the muscle, but rather to start with very gentle contractions, assisting the patient in a rational way. Paralytic or paretic or even very atrophic muscles should never be required to work to their possible limits, as this is liable to overexert their fibers and produce a stretching effect which must be avoided under all circumstances. We shall see later how these dangers are best averted. Again, for the general or dynamic effect the exact dosage is of the utmost value, as we know that exercise may produce according to its intensity, exactly opposite effects, such as raising or lowering the blood-pressure and the rate of the pulse.

The dosage of the exercise of a given muscle group is not only of importance for the movement in total, but also for the various phases of the movement. This depends on anatomical and physiological conditions. For the former the flexors of the forearm may serve as an example. When the elbow is fully extended or, as in many cases, slightly hyperextended the flexor muscles act under unfavorable leverage conditions. This is easily demonstrated by the fact that it requires but relatively little strength to prevent the arm from being flexed when the operator holds it in extended position. The effectiveness of the muscle then depends largely on the angle between the bones and on the direction in which it pulls with respect to the part moved.

In regard to the physiological conditions Schwann's law must be considered, namely, that the strength of the muscle is reduced in direct proportion to the state of contraction or to its relative length. Consideration of that law will make it evident that the resistance applied must be different for the different phases of the movement. In general it should be greatest during the so-called optimum of the muscle contraction which is practically identical with the middle

third of the total amount, and should be accordingly smaller during the beginning and ending third. Most probably the conditions are really much more complicated. We shall only mention the theory of Krukenberg, who believes that the stimulations proceeding from "the brain are regulated by the centres of coördination in such a way that their power slowly increases during the first half of the movement, and decreases during the second half."[1]

Moreover, correct resistance is often the only way to make one muscle group work alone and exclude its antagonists. The following example taken from practice will illustrate this idea. We had to treat a patient with a fracture of the patella, which had been sutured some seven or eight weeks before. The leg was put up in a plaster cast, and the patient was then sent to the medico-mechanical department for after-treatment. The methods employed in such a case will be described in detail in the chapter on Fractures. Here only one point is to be mentioned. The patient is lying on the table with his leg hanging over its edge and the foot supported by the hand of the operator. Now when we ask the patient to bend his knee actively without giving him a resistance he will do so by carrying out a negative action of his quadriceps muscle. This muscle, however, which had been injured with the patella and had been sutured will show a tendency to spastic protective contraction allowing only a very limited amount of flexion, perhaps 20° to 30°. On the other hand, when we ask the patient to bend his knee while the operator's hand supporting his foot gives a definite resistance, the patient must now act with his hamstring muscles which are not injured, and must at the same time relax his quadriceps. Proceeding in that way the angle of flexion obtained was always much larger, up to 40° or 50°. Thus we see that it is a tendency of the resistive exercise temporarily to exclude the action of that muscle or muscle group which on account of its own injury or through its close relation to the affected part, is unable to perform a normal action.

[1] Handbuch der Physikalischen Therapie; ed. by A. Goldscheider and P. Jacob. Part I, ii, p. 203.

In connection with those conditions, Bum, citing O. Thilo, emphasizes another advantage of the resistive exercise: that it decreases the interarticular pressure.[1]

"Every movement of the limbs takes place through the coöperation of two groups of muscles opposed to each other. Thus the dorsal or plantar flexion of the foot takes place through the coöperation of the dorsal and plantar flexor muscles, which pull the articulating ends of the bones against each other, thereby causing a pressure equal to the sum of the force of tension of the dorsal flexors plus that of the plantar flexors. Now by excluding one of those muscle groups through application of resistance a part of that pressure will also be excluded which otherwise would be exerted by its.

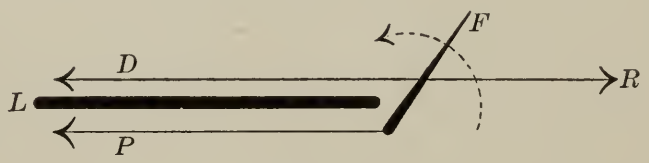


FIG. 1

"In the schematic illustration L (Fig. 1) designates the lower leg, F the foot, D the dorsal flexors, and P the plantar flexors, R the external force acting in the direction of the arrow. By free active movements through the pulling of the muscle D and P, a pressure, $P\,R$, is exerted upon the articulating ends of the bones which is expressed by the following equation:

$$\mathrm{pr} = \mathrm{d} + \mathrm{p}.$$

If P is excluded by the resistive power R, that is, if we apply a resistance to the pull of the dorsal flexors which is equal to the muscular effect of P, the equation will then be changed;

$$\mathrm{pr} = \mathrm{d} - \mathrm{r} = \mathrm{o}.$$

or expressed in words, in resistive movements the pressure of the articulating ends of the bones is = 0. Although in practice the conditions will never be exactly those expressed by this equation it may help to explain the frequent ex-

[1] Bum, Handbuch der Massage und Heilgymnastik, 4th edition, p. 95.

perience that the pain of inflamed joints so common when they are actively moved, is greatly reduced by inserting an appropriate resistance."

The assistive exercise is merely a modification of the resistive exercise, and is frequently used for diminishing the natural resistance. The case of the fracture of the patella cited above will serve as a useful example to make this idea clear. The patient has flexed his knee in a manner described; for the extension we want to use his quadriceps, which, however, unaided would not be strong enough to lift the leg; furthermore, the tension put on the quadriceps in trying to lift the leg might be harmful to the injured patella and aponeurosis. Therefore we assist the action of the quadriceps by supporting the foot. In that way, instead of the whole weight of the lower leg, which is about eight or ten pounds, the patient will have to lift only one or two pounds, while the rest of the work is done by the operator's hand. This also demonstrates the close coöperation of both resistive and assistive movements as now cited, because in this case for the flexion resistance and for the extension assistance is furnished. In many text-books much emphasis is laid on the distinction of resistive exercise during the phase of positive action and that during the phase of negative action; the former called concentric, the latter eccentric movements. These distinctions have played a prominent role in the Swedish system, more than they deserve in our opinion, because the eccentric resistive movements are of a very limited use.

The ways and means of application of resistive and assistive exercises are innumerable. In this chapter a few typical examples are cited to show in a more general way the most useful methods of approaching the single joints as well as combinations of several joints.

Shoulder.—The shoulder is treated in upright position, standing, or sitting, or in reclining position. In most cases we begin with the patient lying on his back, the head supported by a low pillow and the elbow resting on another pillow or on the operator's hand (Fig. 2). The advantage of a supine compared with an upright position in many cases of painful and

limited motion, as well as in many cases of paresis and paralysis, is obvious when we consider the law of leverage. Taking for example the problem of lifting the arm from an upright position, the work for the lifting muscles, especially the deltoid, will be increased until the maximum is reached when the arm is lifted up to the horizontal line. In many pathological conditions it is difficult if not impossible to raise the arm to the right angle or at least any attempt to do so will cause pain and muscle spasm. If the patient is able to lift the arm at all he does so by abducting the scapula to the extreme while no motion takes place in the shoulder-

FIG. 2.—Practical position for certain resistive exercises of the shoulder, especially rotation. The right arm steadies the scapula.

joint proper. On the other hand, when the patient is lying down while the arm is raised forward and upward, according to the law of leverage the relative weight of the arm becomes gradually lighter the more the arm approaches the vertical position. It is therefore a frequent occurrence that in a lying position a greater angle of motion can be obtained with greater ease. In the majority of cases the patient while recumbent will be able to lift the arm up from the table; otherwise the operator has to assist up to the point where the better leverage enables the patient to control the movement himself. How much of this motion should be of a

resistive, assistive or simply passive nature, depends on the individual case. In most cases, however, it will be advantageous if not necessary to hold and support the scapula because the tendency is to keep the arm adducted in relation to the scapula.

In a more advanced stage of the treatment exercises in upright position are added as may serve the purpose. For the raising of the arm assistance is given whenever the first tendency to move the scapula is noticed; in lowering the arm resistance is used in order to exercise the axillar muscles as well, because as we have seen, simple active lowering of the arm is done by a negative action of the deltoid and has nothing to do with the axillar muscles. Furthermore, the resistive exercise of the arm in being lowered is important in regard to the effect on the deltoid. In many cases of arthritis and subacromial bursitis contraction of the deltoid causes pain, especially in that stage of the movement where the tuberosity must slip under the acromion or in lowering slips out again. If for the lowering motion resistance is applied, the deltoid is put out of function and the described action is accomplished without difficulty. Rotary exercises are done in various angles from the adducted to a more and more abducted position, one hand being always used to control the scapula. Frequent use is made of a light cane, in that way rendering the power of the good arm of practical assistance. Cane exercises can be done by the patient alone or, still better, with assistance of the operator, who has to control the scapula and furnish further assistance and resistance.

Elbow.—As long as the elbow needs support this is best done by having the whole upper arm, including shoulder and elbow rest on a table. One hand of the operator holds the shoulder while the other steadies the forearm which is to do flexion and extension against resistance and assistance (Fig. 3).

In the same position pronation and supination may be performed while the one hand holds the elbow or the lower end of the humerus and the other hand takes hold of the forearm, somewhat proximal from the wrist.

Wrist.—The most comfortable position for exercise of the wrist is with the patient sitting in an armchair (Fig. 4) or in

Fig. 3.—Position for active and passive movements of the elbow.

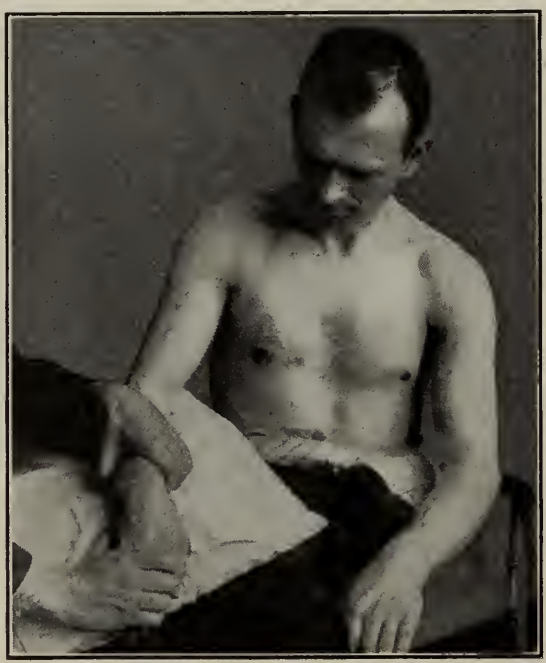


Fig. 4.—Position for active and passive movements of the wrist and forearms.

front of a low table with the forearm resting on a hard pillow and supported by the arm of the chair or by the table. It is essential that the forearm rests firmly on the pillow while the muscles of the elbow and shoulder are completely relaxed. The hand which extends over the edge of the pillow is supported by the operator, who gives resistance or assistance as needed. Dorsal and palmar flexion, adduction and abduction, as well as circumducting movements are thus carried out in various positions of the forearm, supination, pronation and the middle position.

The same position as described for the wrist is also used for exercising the forearm, supination and pronation.

Fingers.—The fingers are exercised with the forearm and hand supported in the same way as described for the exercises of the wrist. It will depend on the conditions of the fingers whether all five are exercised together, or the thumb alone and the four fingers combined, or each finger individually. As to the various joints, it depends on the condition whether each joint is to be treated individually or two or more in combination. In any severe lesion it is advisable to begin with an individual treatment of each joint separately. In that case the operator has to support with his one hand the patient's hand and that part of the finger which is proximal from the joint to be treated, while the peripheral part of the finger is held and guided by the operator's other hand. After the end and middle joints have been treated in such a way, both those joints are treated in combination, an exercise which is frequently called doubling up of the finger; then the proximal joint is treated alone and in combination with the doubling-up motion. In a more advanced stage, the patient having obtained somewhat better control, two or more fingers might thus be treated at once. Also lateral motions of the fingers, grasping exercises, touching the point of the thumb with the point of every other finger and spreading apart again, as well as other combinations are practised.

In doing resistive flexion exercises of the fingers, most patients will show a tendency to flex the wrist at the same time. As palmar flexion of the wrist obviously renders the mechanical conditions less favorable for the flexion of the

fingers, it is necessary to avoid such simultaneous motions. This is attained by appropriate support of the hand in slight dorsal flexion, and still more by educating the patient to do a dorsal flexion of the wrist simultaneously with a palmar flexion of the fingers.

Hip.—Resistive exercises of the hip are best done when lying on the back; for flexion, assistance is given, if necessary, while the extension is done against resistance. The knee is held in slight flexion, because the raising of the leg with the knee extended affords greater difficulties, particularly if any spasm exists in the hamstring muscles. Lateral and rotary motions are made both with the knee extended and flexed; the operator, in supporting the leg, commands: outward, inward, upward, downward. Often it is necessary to hold the pelvis with one hand, or a second assistant is even required to do this while the operator supports and conducts the leg. For the extension and hyperextension as well as for rotary movements the prone position affords advantages if it is at all convenient for the patient to lie that way. This is possible only in cases where no permanent flexion of the hip exists. Certain motions also may be done in sitting, particularly the abduction and adduction in a flexed position as well as the rotary motions.

If weight-bearing is possible the hip exercises may also be done in standing, the operator furnishing assistance or resistance such as needed.

Knee.—The knee is exercised in lying on the back, while the lower leg extends over the edge of the table. For the extension assistance is given; for the flexion, resistance. Also the prone position is of value with assistance and resistance being reversed.

Foot.—The foot is exercised with the patient lying on his back and the knee supported by a pillow at an angle of about 30 degrees. In order to relax the posterior muscles of the leg, the operator holds the foot with one hand while the other hand steadies the leg, because in doing lateral motions of the foot most patients will show a tendency to rotate the whole leg in the hip-joint. In many cases, especially paralyzed children, the prone position with the knee flexed to a

right angle affords greater advantages, in that the muscles of the leg are well relaxed and the foot can be easily conducted, applying assistance or resistance according to the individual indication (Fig. 5). Another position of advantage for exercising the foot is with the patient sitting on a high table and his heel supported by the operator's knee, who is to sit in front of him on a chair low enough to have the patient's thigh and knee well supported and the muscles sufficiently relaxed.

The toes are exercised in the same position as the foot.

Fig. 5.—Active and passive movements of the foot shown from lying prone.

Cervical Spine.—Exercises of the cervical spine are done in a sitting or lying position. The patient is sitting on a chair with a back high enough to have the scapulæ rest against it. The operator stands behind the patient; holding his head on both sides and lifting it slightly up he gives resistance or assistance as needed. In this position which is sufficient for many cases a complete relaxation cannot be obtained, because the greatest part of the cervical muscles as well as of the muscles of the trunk in general is held in a static contraction for the purpose of weight-bearing. Therefore, whenever complete relaxation is required the position of lying on the table deserves preference. For anteroposterior and lateral movements the operator supports the head with one hand, assisting in forward, resisting in backward, and guiding in

lateral movements. For the rotation either the head rests on the table or it is raised up with both hands grasping it on the sides or, better, one hand on the forehead and the other on the occiput.

Fig. 6.—Lateral pushing of the spine against resistance. Exercise completed.

Dorsolumbar Spine.—Exercises of the spine are best done with the patient sitting on a stool or on a table. The patient has to relax the spine as much as possible. For forward flexion the operator holds one hand against the chest and the other against the sacrum or lumbar spine; then he straightens the spine passively to some extent and lets the patient flex

it against his resistance. In doing this flexion the trunk ought not to be materially moved forward, as this would mean an action of the flexor muscles of the hips and not, what it is intended for, a localized action of the muscles of the spine proper.

Fig. 7.—Rotation of the spine against resistance. Exercise completed.

Dorsal flexion is done either with the hand in the position described applying assistance, or with the hands reversed applying resistance. For this exercise a sufficient support of the spine is necessary, as otherwise the patient may slip forward on the table, or in order to prevent such slipping must contract muscles which are not to be exercised. Thus the exercise would not be well localized.

Lateral motions are done in two ways: one (Fig. 6) in which the spine is bent toward the side, and the other in which the thorax is moved over the pelvis with the shoulders held approximately level. For both motions the hands of the operator are adjusted in the same way, one on that side of the thorax toward which the motion is done, and the other on the opposite crest of the pelvis.

Rotary motions may be done with the trunk being held straight, supported under the axilla by the operator's hands or in combination with lateral and anteroposterior flexion (Fig. 7). Furthermore, rotation may be combined with moving the thorax sideward as described above. Of course exercises of the back may be done in a great many more ways, as in lying prone and supine, knee-elbow position, standing, etc., but the described way of sitting suggests itself for many purposes, and serves best for well-localized and measured resistive exercises.

PASSIVE EXERCISE.

Passive exercise plays a much less prominent role as a therapeutic factor than active exercise, a point, however, which is, as we have said before, not at all generally recognized. This is proved by our almost daily experience in the medico-mechanical department, as well as by the study of the medical literature. Most of the patients are sent from one of the out-patient departments, bringing a note with a prescription or suggestion of treatment. In nearly all cases which are recommended for the treatment of stiff or otherwise handicapped joints, these prescriptions read, "passive motions." Likewise in medical papers and text-books the prescription "passive motion" is so common and typical that anyone who is familiar with the methodical active gymnastics cannot but be astonished at the rather thoughtless recommendation of methods which are not only much less valuable but involve a distinct danger in such unlimited application.

Passive movements are done by another person or an apparatus, while the patient remains inactive. The effect of these movements is partly local, partly general. The

local effect consists in an action upon the moved joint and its neighboring structures. The general effect concerns mainly the circulation.

For the passive exercise the patient must be brought into a comfortable position and has to remain entirely relaxed. The movement must be done with great ease, evenly and without jerks. The angle of motion to be obtained depends on the excursion under normal or pathological conditions. A valuable form of passive movements is the relaxing exercises, which will be described in another chapter, also the so-called forcible stretching manipulations, which will be discussed later, for the limbering up of stiff joints are essentially passive movements.

PASSIVE-ACTIVE EXERCISE.

The application of passive-active exercise may be best described by the following example: We have operated on a knee-joint. As soon as motions may be begun the patient is advised to flex his knee and to raise it somewhat from the bed. Thereby he performs an active exercise of his hip-joint and its muscles, while the knee itself is moved passively. The same exercise may be done just passively when the operator raises the knee without the assistance of the big flexor muscles of the patient.

Another form of passive-active exercise is used as the so-called promotive exercise by certain apparatus of Zander, Herz, Krukenberg, and others. These apparatus are constructed with a pendulum or a revolving wheel. The centrifugal power of the pendulum or the wheel "promotes" the movement, which thereby is done half passively and half actively.

CHAPTER III.

FREE EXERCISES.

In the foregoing chapter the system of resistive and assistive exercise has been discussed in detail, the ideas underlying it, its reasons and technic. With this, however, the ways and means of therapeutic exercise are not at all exhausted. Besides exercises done with apparatus which will be discussed in the next chapter, there is a great variety of movements which can be done by the patient alone without assistance of the operator. Here again only a few typical examples are given as suggestions, leaving indications and further discussion to the special part.

BREATHING EXERCISES.

We begin with breathing exercises, which are also frequently used in connection with resistive movements and exercises with apparatus.

The idea of the breathing exercises is to strengthen the respiratory muscles, to promote good posture, to teach the patient how to ventilate all parts of the lungs, to facilitate the circulatory system and to aid in particular the circulation in and function of the subphrenic organs, and thus to produce a very material effect on the health and strength of the whole body. Indeed, there is hardly any case in which breathing exercises could be entirely omitted during the course of the treatment without failing to do justice to all indications.

Respiratory exercises may be executed in any position, but the greatest effect will be produced with the body straight, as in lying supine and in standing. Both the costal or thoracic and the diaphragmatic or abdominal types should be practised; single, combined, and alternating. While generally the inspiration represents the more active part and the expiration the more passive part

of the whole respiratory movement, there are many cases where the expiration requires special consideration, as for instance in the treatment of bronchial asthma or emphysema. In such patients the so-called interrupted expiration or the expiration against a resistance is frequently used. The expiration may be done so that the patient divides the whole expiratory movement into two or more parts, holding the breath during these parts one or more seconds. It is of advantage to use a metronome and have the patient count aloud. Expiration against a resistance is accomplished by having the patient exhale through a thin tube or blow up a ball of soft rubber. In hospitals or special institutions a respirometer may be used for this purpose, recording at the same time the effect of the expiration.

Respiratory exercises are in a large measure combined with exercises of the trunk as well as of the extremities; the movements away from the body, as extension, abduction, supination, outward rotation, lifting up, etc., are done simultaneously with the inspiration; the movements toward the body, such as flexion, adduction, pronation, inward rotation, pulling down, etc., are done simultaneously with the expiration.

This is particularly evident for the elevation and abduction of the arms, as by that movement the ribs are drawn up through the action of the pectoral muscles.

One should also teach the patient to practise breathing exercises both with the intercostal muscles and the diaphragm only, as well as by using more and more of the auxillary respiratory muscles up to the possible limit.

EXERCISES IN STANDING.

For most of the typical resistive exercises position in standing is not very useful, as in that position practically all muscles of the legs and trunk are in action, and thereby the intended localization cannot be correctly obtained. But that position is very suitable for the purposes of free exercises, as it permits a great variety of movements of the arms, legs and trunk, as well as combinations of these. Before we let the patient

do any exercise in standing we make sure that he knows how to hold his body in correct posture. We teach him to stand straight, with the heels close together and the feet at an angle of about 60 degrees, or, for easier balance the feet, slightly turned outward, may be set about one foot apart.[1]

The middle of the patella ought to fall over the second toe. The pelvis should be held somewhat tilted backward with the lordosis of the lumbar spine only moderate and rather decreased. The thorax is brought forward; the shoulders in line with the pelvis and not backward from it. The head is held so that the chin stands somewhat over the sternum, not bent, but drawn backward, *i. e.*, the chin down and not "up in the air." The arms hang at the sides, with the shoulders down and slightly back. Any free exercises in standing position, for whatever purpose they may be chosen, should be preceded by a training in good posture. After that is accomplished exercises of the body, the arms, the legs or combinations of them may be done standing still or with locomotion.

Exercises of the Trunk.—Bending forward, backward, sideward; twisting in extended position as well as in combination with forward and sideward motions. The bending forward can be done with flexion of the spine combined with hip motion, or with hip flexion alone with the spine held rigid. Another lateral motion can be done in a way similar to that of resistive exercise, whereby the body is moved sideward against the operator's hand. The hands are set firmly upon the crests of the pelvis, though in more developed exercises they may be clapsed behind the neck, etc.

Exercises of the Arms (with or without Dumb-bells or Indian Clubs).—Elevation forward, upward, sideward, backward. Circling of the arms held forward or sideward. Great care must be taken that a proper balance and correct posture is maintained during these exercises.

All these exercises can be done in combination with the

[1] In some school gymnasiums the children are taught to stand with the heels and toes close together during exercise. This instruction, which has probably resulted from a misunderstanding of the proper statics of the foot and leg, seems to us irrational because it increases the difficulty of balance and does not comply with the laws of physiological economy.

bending of the body forward and forward sideward, as well as with twisting and circling motions of the spine. Another exercise of the arms is that of clasping the hands behind the neck and drawing the elbows forward and backward. Instead of clasping the hands the fingers may be just placed on the occiput touching each other with the tips. In this exercise the tendency of the patient to bend his head forward is often noticed, and should be corrected at once. A combination of this exercise with the leaning of the straight spine forward may be done. The lateral bending of the body may be connected with a movement of the arms in that with bending to the left the right arm is elevated, the elbow flexed and the forearm held over the head, and *vice versa* for the other side.

Exercises of the Legs.—Raising one leg with the knee flexed and extended. Abduction and hyperextension of either leg; rotation outward and inward of either leg or both legs. The last exercise must be done with sufficient consideration of the weight-bearing line, thus the legs must be twisted over the heels, while the toes indicate the angle of rotation. In all these motions care should be taken not to shift the body more than balance necessitates, but the correct posture should always be carefully maintained.

Further exercises are tiptoe raising of the body, flexing the knees. Combinations of arm and leg exercise can be done in manifold variations; such as raising the arms sideward with abduction of one leg, etc. Also breathing exercises can or rather should be connected with all free exercises. In general these exercises should be done slowly in the tempo and rhythm of the respiration, not more than six to eight times in one minute.

For certain purposes quicker exercises may be done, as swinging of the arms. The use of Indian clubs is of particular value with such exercises.

Exercises of the body, arms and legs may further be done with one leg falling out two or three feet, forward or half sideward. Of the many combinations we make frequent use of the following: The right foot is set half sideward, the right knee flexed, the left leg held straight and the heel slightly lifted from the floor. The body is held forward over

the right knee in line with the left leg. The arms are held forward upward in line with the body; or somewhat easier, the right arm is held forward and the left arm backward. From that position which is maintained for two or three seconds the patient returns to the original position. The exercise just described may be connected with bending the body with the arms forward, to touch the floor with the tips of the fingers, or at least to bring the hands near to the floor. A similar exercise can be done with the body bent backward instead of forward, combined with an elevation of the arms above and behind the head or sideward.

Exercises with Locomotion.—The left foot is set forward a step of about a foot and a half or two feet, the body held straight, the right leg in hyperextended position and the arms raised over the head. Inhaling is done with the raising of the arms and the position is held for a few seconds, then the arms are lowered while exhaling. Then the right foot is set forward and so on. A good posture should be maintained throughout the whole exercise. Ten to twenty steps may be done in that way, and the patient then be allowed to rest for a few minutes.

In cases in which weight-bearing or balancing meet with difficulties, *e. g.*, in certain cases of paralysis or injury, it is of advantage to have the patient exercise standing between two chairs, having his hands rest on the backs of the chairs. It depends on the individual need whether the patient is to take off more or less of his weight from his feet, or whether the support is merely to steady the balance.

EXERCISES IN LYING.

Exercises in lying may be done with the arms, or legs, or the body, or combinations, in supine, prone, or in position on either side.

Lying Supine on the Back.—If the patient's body shows good or fair posture he may lie perfectly flat; if the posture is not correct it is advisable to have the body with the middle dorsal spine lying on a flat pillow, thus bringing the thorax forward and widening its upper aperture. Abduction and

elevation of the arms may be done (eventually with dumb-bells or a cane); furthermore, raising either leg with the knee flexed or extended. Another rather difficult exercise is raising both legs, which may be done in two ways: (*a*) Both knees are drawn up near to the chest, then the legs are extended up in the air and lowered down slowly. (*b*) Both extended legs are raised as high as possible, and lowered again. For these exercises the patient may steady his body with the hands on the side of the couch. The exercise may still further be increased in difficulty by the patient tilting his pelvis forward, when the legs are up in the air; he may even raise up his buttocks from the couch.

Raising of the Body.—The body may be raised up to sitting position. Until the patient has obtained sufficient control of his muscles the operator should hold his feet; later this exercise should be done without any assistance. The exercise is made more difficult when the arms are raised over the head or the hands are clasped behind the neck.

Lying Prone on the Abdomen.—From this position hyperextension of either leg may be done; also raising both arms sideward backward. Raising of the head, raising of the head and body, with or without the backward raising of the arms gives further exercises. Here again the operator should hold the feet, until sufficient strength and control is obtained. The raising of the body may also be combined with twisting of the body, or circling motion. These last exercises may be done with the legs and pelvis resting on the table and the rest of the body projecting over the edge. In that position arm exercises may be done in various combinations with holding the body in horizontal position, such as swimming exercises, or with movements of the trunk. The help of a second assistant is advisable until the patient has acquired sufficient control; one holding the feet and the other directing the exercises, giving assistance whenever necessary.

Lying on One Side.—This position is of special use for the training of the abduction of the hip, both with the knee and hip extended and flexed.

Rolling.—Rolling from one side to the other; rolling from the supine to the prone position, etc. Also these exercises

may be combined with movements of the arms or legs, and need no further description.

Exercises in Knee-elbow Position.—These exercises have special importance in connection with resistance, as has been described, but may also be done as active exercises by the patient alone. In this position hyperextension of either leg may be done.

Creeping Exercises.—The creeping exercises have been developed by Klapp into a real system for the treatment of lateral curvature, and will be described in that chapter.

EXERCISES IN SITTING.

The sitting position is of particular value for resistive movements, and is not so much used in free exercises, though a number of the movements may be done in that position whenever standing affords difficulty, as in paralysis, or in cases where weight-bearing is difficult or is contraindicated. Many of the exercises for free standing may be done in sitting, including an exercise similar to that of falling out with one foot. That exercise is best done with sitting sideward on a small stool, having one leg straight behind and the other leg flexed forward. Combinations of movements of the arms and the trunk can be done in that position in analogy to those described for the similar exercise in standing (Fig. 8).

EXERCISES IN HANGING.

Exercises in hanging are done on a Swedish ladder, a bar, or rings. Pulling up to bring the chin level with the bar; raising one or both legs with the knee flexed or extended to a right angle or higher; swinging the body somewhat sideward and similar exercises may be done which could be greatly modified on the Swedish ladder.

EXERCISES IN THRUST POSITION.

To be sure, this position itself is an exercise, but it can also be used in combination with movements of the legs. The more the body approaches the horizontal position in this exercise the more difficult will it become. It is of value only

with perfect control of the joints and muscles of the arms and is done in the following way: The patient thrusts his straight arms against the edge of a sideboard or the like, leaning the body slightly forward. The scapulæ should be fixed so as to remain in the same position as in correct standing.

Fig. 8.—Raising of trunk.

Now the elbows are flexed, thus the body is brought still more forward until the head comes near to the hands, and then the arms must be straightened out again. This exercise may be combined with tiptoe exercise, with hyperextension of either leg, etc. To make it more difficult the arms are thrust against a chair or even against the floor.

CHAPTER IV.

APPARATUS, SPORTS AND GAMES.

It is not astonishing that the remarkable progress which the technic has made in the last fifty years has been reflected in the practice of massage and exercise. Since Zander created his first apparatus an endless number and variety of apparatus for all kinds of mechanical manipulations, passive and active exercise, have been constructed. As it is the purpose of this book to give suggestions for practical and useful application of massage and exercise an enumeration of all those systems cannot be attempted. We shall, however, try to show how by simple constructions which are within the reach of everybody, mechanical means may be devised which help the patient to do many exercises that otherwise would need the coöperation of an assistant.

CANE EXERCISES.

The simplest apparatus is a cane, four or five feet long; a broomstick will serve almost as well. A cane is very useful in many affections of the shoulder or elbow whereby the power of the other arm can be used as an assistant.

The following may serve as examples of cane exercises:

1. Raising forward and upward. In cases in which elevation of the arms is limited these exercises, if at all indicated, are best done in the horizontal position according to the principles of leverage discussed above. When the patient shows the tendency to raise the affected shoulder we have him do the cane exercise before the mirror and advise him to raise the cane only as high as he can with both shoulders in perfect symmetry. Raising the cane may be done in two ways: (*a*) with the arms straight; (*b*) by flexing the elbows and lifting the cane up in front of the

chest; from this position the cane is brought forward or upward or to any angle desired.

2. One end of the cane is raised up over one side of the body while the other is placed on the other side. This exercise may be done with the cane being held in front or on the back.

3. The cane is held in front of the chin with the hands about three feet apart; then it is moved horizontally toward one side and then the other (Fig. 9). This exercise can also be done with the cane on the back of the neck.

Fig. 9.—Pushing cane sideward; abduction of arm.

4. The following cane exercise has been found of great use in cases of moderate limitation of the shoulder and of the extension of the elbow. The cane is held on the back, then the affected arm is raised up as high as possible and the patient has to bring scapula, elbow and wrist as much as possible in a straight line, pressing these three points against the cane. For comparison and to get a right idea the same exercise is done also on the other side. In this exercise the affected arm extends actively, the other hand pushes passively, and both together force the shoulder and the

elbow in a straight line (Fig. 10). In Chapter XIV several other cane exercises are described.

FIG. 10.—Pushing cane upward; extension of shoulder and elbow.

EXERCISES WITH ROPES AND PULLEYS.

Another cheap and simple apparatus is that made of a rope and a few pulleys. Figs. 11 to 16 will serve as examples, though the varieties which are possible with this arrangement are numerous. In most houses or apartments the screws for the pulleys can be applied without any damage to the walls and doors.

A weak and lame shoulder may again serve as an example. In such cases if motion is at all possible the elevators of the arm are frequently too weak to lift it with sufficient ease and comfort. The deltoid, which often atrophies very quickly in affections of the shoulder must be assisted, because danger exists that most of the elevation is done by the anterior serratus, with

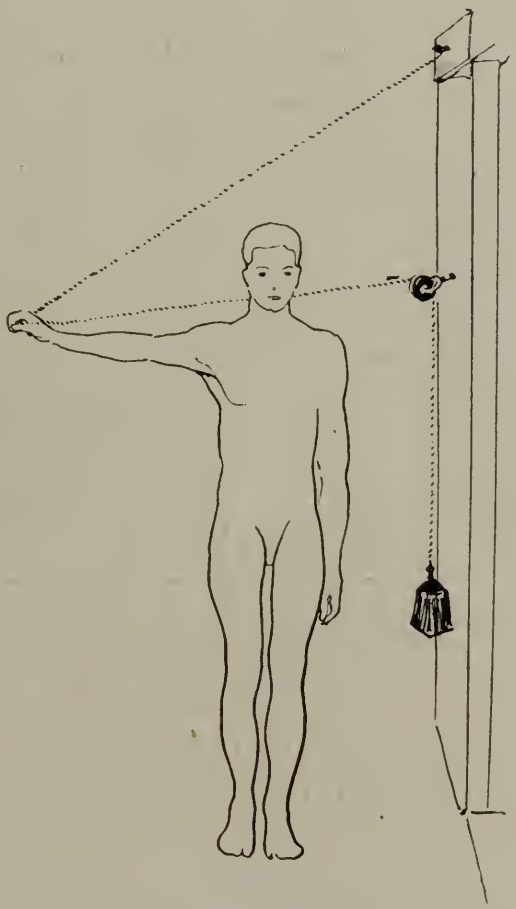


Fig. 11.—Abduction of arm.

scapula and humerus held in muscular fixation; instead of a movement of the humerus in the humeroscapular joint the scapula is abducted alone, and thus the deltoid exposed to tension which is decidedly unfavorable for a weak muscle. This danger is still greater when the deltoid is paralytic or paretic, or when the tendon of the supraspinatus muscle or

its insertion has been injured. In such cases the sand-bag will assist the deltoid and supraspinatus; it will allow movement in the humeroscapular joint and thus an exercise may be done which otherwise would require the help of an assistant.

It cannot be denied that technically perfect apparatus will serve somewhat or perhaps much better, but what is chiefly needed is to bring such means within the reach of everybody which enable the physician to advise his patient as to simple and inexpensive constructions.

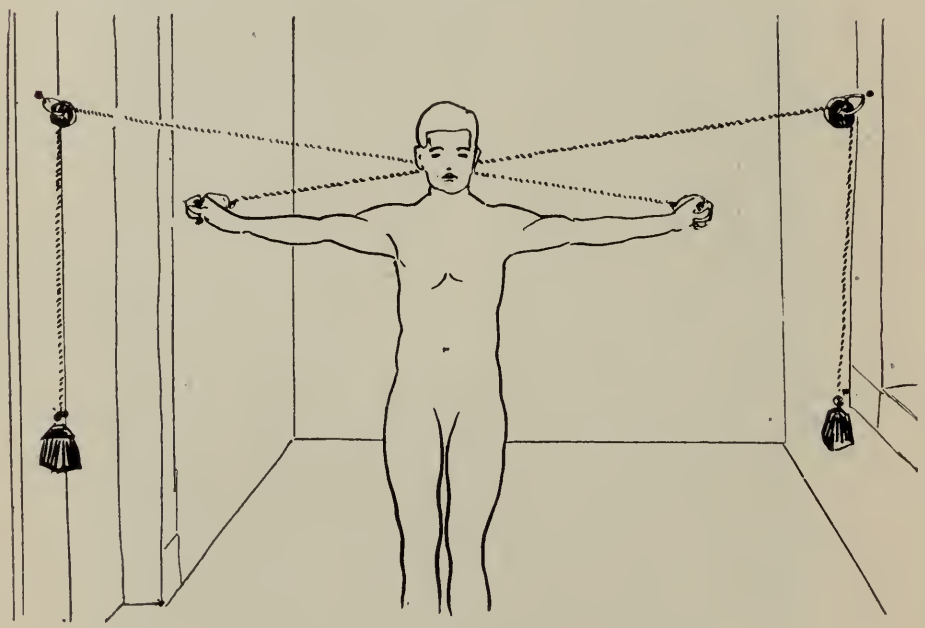


FIG. 12.—Abduction of both arms.

The importance of such suggestions has become evident to us in the Medico-Mechanical Department of the Massachusetts General Hospital, as not infrequently patients and even physicians living at a distance remarked that they could not enjoy exercise treatment at their homes as they did not have such "wonderful machines." My answer has always been: "Rational exercise treatment can be carried on everywhere and on the whole does not require machines, valuable as they may be for a large hospital or a special institution."

Although the plan of this book does not actually demand it, a brief review of the most important and frequently used apparatus for passive and active movements will be given.

Zander's System.—The oldest system is that of Gustaf Zander, a man gifted with both technical talents and medical

Fig. 13.—Active drawing down and passive pulling up of arm.

inspiration. He began to construct his apparatus in 1864, when he was medical instructor in a normal school for girls. His original idea was to construct mechanical apparatus for resistive exercise which make the patient independent of the reliability and faithfulness of the assistant. This plan Zander has accomplished in a very serviceable and almost perfect way, proof of which is the fact that even now,

about fifty years after Zander's first construction, his apparatus are used over the whole world, and probably more

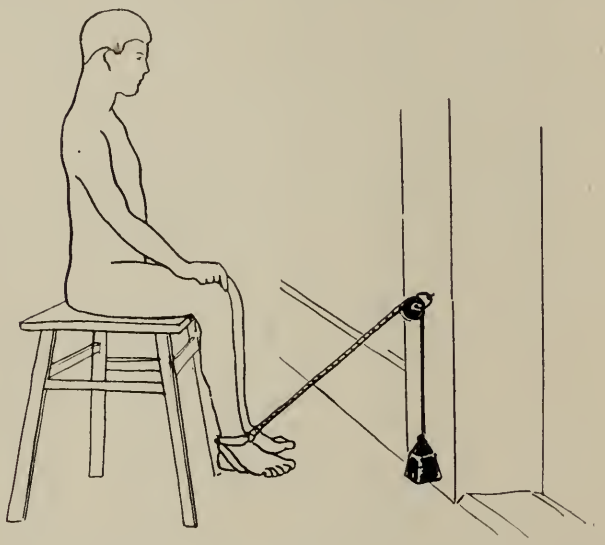


FIG. 14 —Active flexion and passive extension of knee.

FIG. 15.—Active extension and passive flexion of knee.

frequently than any other system. Zander's apparatus, which are more than seventy in number, are divided into

those for active resistive exercise, for passive and for active-passive exercise, for certain massage manipulations, such as friction, hacking and vibration, and a number of special apparatus for the treatment of lateral curvature.

The apparatus for active exercise are constructed after the principle of the lever; the weight can be changed from a very light, almost balancing, to a very heavy one. The advantage of using the lever is, according to Zander, that the muscle does not pull with equal force, but has the optimum

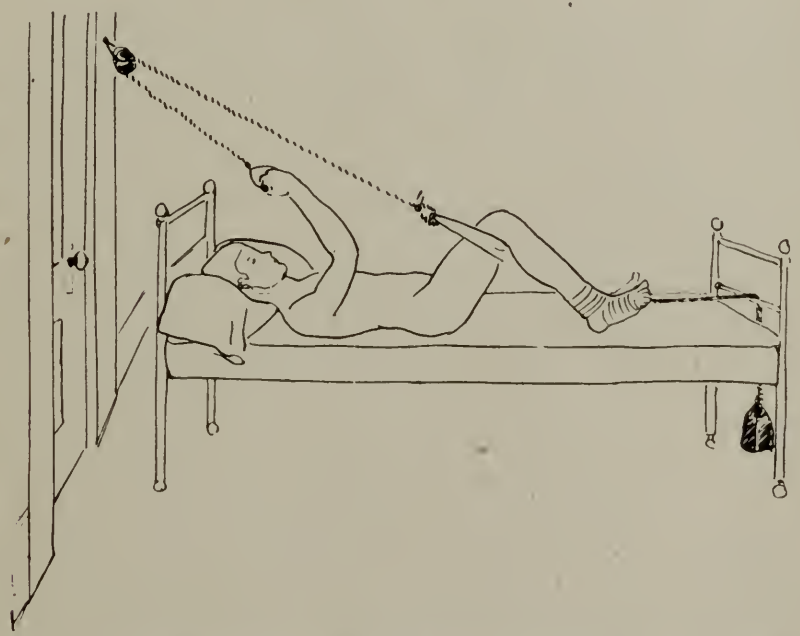


FIG. 16.—Passive-active flexion and extension of hip and knee.

about in the middle and has less strength at the beginning and the end of the contraction. The lever in the active apparatus is arranged so that the optimum of the muscular work corresponds to the horizontal position of the lever. This principle has been disputed by Max Herz, who by exact measurements found that the maximum amount of work of the muscle in varying position will result in a curve different for each joint. He calls this curve the "joint-muscle diagram," and has constructed his apparatus in such a way that the resistive exercise is done in accordance with

that diagram. The differences seem to the author to be largely theoretical, for it cannot be denied that Zander's apparatus serve the purpose very well indeed.

A number of Zander's as well as Herz' apparatus are constructed with a turning wheel, the centrifugal power of which helps to promote active exercise, giving it rather an active-passive character. Others are fitted with a pendulum. The principle of the pendulum is introduced into medico-mechanics by Krukenberg, who has constructed a number of very simple and useful apparatus, some of which can be improvised with the simplest means in any household. The pendulum apparatus are of great value in that they favor a kind of exercise which can hardly be done by manual treatment in an appropriate manner. The value is seen especially in cases where joints are stiff to some extent by muscle rigidity and spasm, and where a gentle rhythmical change of agonistic and antagonistic motions often helps very much to overcome that spasm and rigidity. Also in many cases of paralysis the pendulum apparatus affords special advantage. We shall say more about this in the special part.

Another class of Zander's apparatus is that for passive exercise, where the power is given by an electrical motor. The value of these apparatus which are constructed for the circumduction of the hip, the twisting of the spine, the palmar-dorsal and radio-ulnar flexion of both wrists, etc., is evident in many cases of paralysis and in certain types of internal affections.

Finally, we should mention Zander's so-called balancing apparatus which if properly used force the patient to perform rhythmical exercises of the spinal and abdominal muscles, and are very serviceable in certain abdominal and constitutional affections, as well as for patients with relaxed posture and weak back.

Scholz,[1] in his *Manual of Mechanotherapy,* says that every apparatus for medico-gymnastic exercises should fulfil the following chief requirements:

[1] Cited by Berger, Arch. f. Orthopædie, No. 10, p. 27.

1. It must be constructed in such a way that the patient in the apparatus has the correct original position; thus the apparatus must prevent the possibility of any unintentional indirect secondary contractures of the muscles. This aim is attained by arrangement for support and fixation.

2. The apparatus must allow the intended motion to be properly done from an anatomical, physiological, as well as from a medicogymnastic point of view.

3. It must allow exact dosage and control of the quantity of the exercise.

4. Apparatus for resistive movements must allow exact dosage and regulation of the resistance which is to be given.

Scholz believes that only the Zander and Herz apparatus fulfil these requirements.

As we have said before, apparatus are generally not necessary for the problems of massage and exercise, though we admit that they may serve as excellent assistants which do not tire and which are always faithful and reliable, provided that they are used intelligently and under proper direction. However, in many medical cases, such as those with affections of the cardiac or the respiratory systems, or with certain abdominal and constitutional affections, it cannot be denied that properly managed Zander institutions will show results which can hardly be obtained by simple manual treatment; but, and to repeat, the great value of such institutions lies in the possibility of treating a great many cases at the same time. On the other hand, we cannot agree with those directors of Zander institutions and similar places, who claim a great superiority of their work in all cases, and who do not use the manual methods of massage and exercise, or at least only to a minor extent.

ATHLETIC EXERCISES.

The great influence which athletics, games, and sports have in building up and maintaining health, strength, and vigor of the body, in refreshing the mind overworked from the burden of daily life, and educating the senses is generally recognized. The value of these factors, however, lies rather

in the field of hygiene and education than in that of therapy with a number of exceptions of which we shall speak later, although we admit that the border-lines between therapeutic and hygienic measures are often very narrow. Thus for instance, in summer-time we send many of our little patients with round shoulders and weak back to the playground or to the seashore. The benefit they will derive from this will in the end also aid our treatment in regard to both the general medical as well as the orthopedic indications. Nevertheless we should not call this a part of the treatment itself. In the following we shall briefly discuss some of the athletics, sports and games which might be of use for therapeutic purposes.

Walking.—The simplest and most natural exercise within the reach of everyone at any time is walking. It is of special value if done in parks and woods in the fresh air, and its effect can be greatly varied on hilly ground. The results derived from experiments on the metabolism, and on the function of the heart, lungs and intestines show the great differences in rest, or walking on even ground and on hills and mountains, and the physician taking into account his patient's condition and the locality in which he would prescribe walking for certain hours can guess fairly well the amount of exercise desirable. In certain health resorts, as for instance, Meran and Bozen in the Tyrol, paths are laid out in beautiful surroundings having a well-known slope and length, thus enabling the physician to give very accurate prescriptions. These places are much frequented by convalescents from diseases of the heart and lungs, and patients suffering from constitutional diseases. The actual *mountain-climbing* so refreshing and invigorating for the healthy would hardly be rational for the sick, and would involve grave dangers for the convalescent. Oertel's treatment, of which more will be said in Chapter XXIII, was originally designed as mountain-climbing, but many competent clinicians have warned against such exaggeration. The great difficulty lies here, as usually in the recommendation of sports for therapeutic purposes, in the entire lack of supervision and control. Everything depends on the intelligence and care-

fulness of the patient, but experience teaches that these are generally not to be trusted too much.

Bicycle Riding.—The same can be said about *bicycle riding.* No doubt this sport does benefit people who have too little exercise in life, but it should be employed with great care only, and especially on hilly and rough ground its usefulness for therapeutic purposes may well be doubted. The fact that bicycling is usually done on dusty roads makes it rather contraindicated in any affections of the respiratory organs or their sequelæ. Furthermore, bicycling should not be prescribed for any therapeutic purpose unless the patient has already learned it previously. Any form of racing must be strictly forbidden.

Horseback Riding.—Riding on horseback is an excellent exercise and is frequently prescribed in certain types of neurotic cases. Its value, however, is greatly restricted in that it is not available to many people.

Swimming.—Swimming offers the advantage of fresh and dust-free air, and, furthermore, the danger of overheating is here entirely avoided. There is rather the danger of too great a reduction of temperature. If done carefully swimming is an excellent exercise for people with defective muscle tonus if they are not anemic, and is frequently recommended for older children with round shoulders or lateral curvature. Also, certain cases of paralyses make good use of this exercise whereby the buoyant effect of the water lends considerable assistance to the weak limbs. It is hardly necessary to add that real value can be derived from this form of exercise only under careful supervision as it is found in many of the boys' and girls' camps. With any defect in health the duration of the swimming should not be too long; also bathing in the surf is contraindicated because this form of exercise is entirely uncontrollable. Cardiac cases and patients with marked arteriosclerosis, or anemic and feeble persons should be warned against swimming, especially in the ocean.

Rowing.—Rowing offers advantages similar to swimming, inasmuch as it is also done in clear and fresh air. Practised with care it represents a very excellent exercise, which

could be well used for certain therapeutic purposes; the danger lies, as always, in the fact that patients are so often unable to judge the real amount of their strength and are likely to overtax themselves. This makes rowing a rather dangerous form of exercise in cardiac cases, although in theory the kind of movement required would seem to have certain advantages. It is, however, of great value in young adults with stooped shoulders and depressed thorax when it is connected with good deep breathing.

Canoeing.—Paddling a canoe does not offer this same advantage, because in the period of stroking the chest is rather compressed. The position of sitting in a canoe invites rather than prevents round-shouldered posture. All these exercises in and on the water may be very beneficial in neurotic cases.

Skating.—Skating offers the advantage of fresh invigorating air, and is an exercise which, as a rule, does not tax the strength of the body too much. If done without actual racing and for a moderate length of time it may well be recommended to younger people who suffer from the lack of fresh air and healthful occupation. With a not entirely strong and healthy body, however, a game such as hockey should not be allowed.

Ball Games.—The usual ball games, tennis, baseball, and football, all excellent exercises for the healthy, are hardly of much use in therapy. That there are exceptions, however, may be seen from the advice of an authority such as Allen,[1] who says in a note concerning exercise in the treatment of severe diabetes: "The exercises now suggested are running up and down stairs, jumping rope, throwing a heavy medicine ball, and turning somersaults." "Tennis and other hard games should probably be beneficial."

Fencing.—Exercises such as fencing, especially floret fencing and dancing, may prove to be of benefit in certain nervous disorders and even certain paralytic conditions. They offer the advantage that they can be done under the careful supervision of a teacher or gymnast who is advised as to the condition of the patient.

[1] Boston Med. and Surg. Journal, November 11, 1915.

Golf.—Golf is an exercise which is coming more and more into use for therapeutic purposes in the cases of elderly people who suffer from lack of motion. It is in reality walking interrupted by some exercise of the arms and more or less all muscles of the body. Its advantage lies in the quiet manner in which this game is usually played.

CHAPTER V.[1]

PHYSIOLOGY OF EXERCISE.

EVERYONE knows from personal experience how great the influence of exercise and of games and sports is upon general health. The man who works all day in his office sitting at his desk, seeks a recreation in an hour of golf or walking in the fresh air. The importance of exercise in the education of our children and young people is generally recognized.

The explanation of these facts is given by the definite influence which muscular action has, more or less, upon all organs and structures of the body. In the following we shall discuss the effect of exercise upon the motor structures, the circulatory, respiratory, digestive, genito-urinary and nervous systems, and add some remarks on its effect upon the general metabolism.

THE INFLUENCE OF EXERCISE ON THE MUSCLES AND BONES.

The proper combination of rest and exercise is essential for the health of the body in general as well as of its various organs. Excess of either one is liable to do harm.

The effect of excessive rest is nowhere so conspicuous as in the muscles, as the daily observation of splinted and bandaged limbs makes evident. Lack of use causes atrophy of the muscles, where the much-disputed question may be left open whether the atrophy of certain muscle groups following infections or injuries of joints is due to lack of use only, or as Hoffa and others maintain, results chiefly from reflex neuro-

[1] For this chapter the excellent publications of Zuntz (Handbuch der Physikalischen Therapie, i, 2, 154) and A. Bum (Handbuch der Massage und Heilgymnastik) have been freely used.

trophic influences. Splints and bandages which cause pressure on the muscles aid still more in producing atrophy by interfering with their circulation and nutrition.

On the other hand, the effect of exercise on the muscle is an established fact. It is found in the increase of its volume, its strength and its endurance. Observations of daily life disclose a physiological hypertrophy of the muscle from hard work, as the shoulders and arms of a blacksmith, the calves of a dancer or mountain climber show. The increase of the volume of healthy muscle tissue corresponds to the increase of its maximum work as measured by the dynamometer.

Of still greater importance is the increase of endurance. Any person not accustomed to a certain kind of work will quickly tire and be unable to keep on while one accustomed to it may do the same work all day without feeling more than an ordinary fatigue. Exact experiments have been made by Treves in the following way:

A person is made to lift a maximum weight with the forearm to a certain height, while the upper arm is fixed. In order to obtain the same height in the same rhythm the weight must gradually be diminished until a weight is reached with which the movement can be often repeated without fatigue. This final weight can be considerably increased by practice, while the difference in the first maximal weight will not be so great after training. In a series of experiments the initial maximum weight was 35 kg. and was increased by a few weeks training to 40 kg.; whereas the final weight which could be lifted very often without fatigue was raised from 11 to 29 kg., or fully two and a half as much as in the beginning.

The effect of muscle action is not only seen on the muscle itself, but also on the structures which are moved by the muscle. This is of particular interest in regard to the bone, its shape, external and internal structure, and its nutrition. The bones of a strong, active, muscular man are thicker and heavier than those of a fat and flabby, or weak and anemic individual. The ridges, crests and spines where the muscles are inserted are more prominent in the former type than in the latter.

The scapula of a muscular, well-built person compared with

that of a weak, poorly developed, round-shouldered individual will show the effect not only of correct posture, but also of proper muscular function. In the former we can feel the inner edge of the scapula convex and fairly thick; in the latter it is concave and very thin in consequence of the poor muscular development and function. Moreover, lesions which lead to atrophy of the muscles will usually show also a distinct atrophy of the bony structure as seen in the *x*-ray picture; this atrophy will slowly disappear with proper functioning of the muscles.

The famous investigations of Julius Wolff have shown that the bone adapts itself to any change in the pulling and pressing forces in such a way that the greatest possible firmness is obtained with the least amount of bony material. The regularity with which such reactions are seen have induced Wolff to state this law: "Every change in the formation and function of the bones, or their function alone, is followed by certain definite changes in their internal architecture and equally definite secondary alterations of their external conformation in accordance with mathematical laws."[1]

CIRCULATORY SYSTEM.

The effect of active voluntary muscle action upon the circulation of the blood is seen in several ways. The intermittent contraction and relaxation of the muscle act like a pressure and suction pump, chiefly upon the veins within and near to the working muscle. The direction of the venous blood stream is maintained by means of the valves. This mechanical effect is materially aided by two factors: first, the intermittent tension and relaxation of the fasciæ, and secondly the intrathoracic negative pressure.

The large veins in the axilla, the neck, the groin and other regions are in intimate relation with the fasciæ. Thus backward bending of the head causes the jugular veins to be emptied, while in forward bending they are filled again. Lifting the arms empties the axillar veins, lowering aids in filling them; extension and outward rotation of the thigh

[1] Bradford and Lovett: Orthopedic Surgery.

empties, flexion and inward rotation fills the femoral vein. Emptying and filling are here understood in a relative sense only, and are dependent to a great extent on the position of the body in consideration of the effect of gravity.

Within the thorax a negative pressure is generally maintained, the intensity of which varies with inspiration and expiration. It is greater during inspiration and decreases during expiration; when expiration is forced and at the same time mouth and nose are kept closed it may become even positive. The negative pressure causes a suction of the venous blood, which therefore will be greatest during inspiration. For reasons to be discussed below inspiration is deepened during exercise; this in turn favors the suction of the venous blood.

However, not only the venous circulation is influenced by muscle action, but also the arterial circulation. The arterioles found so abundantly around the muscle fibers are expanded during exercise, an effect which is caused probably by two factors. It is supposed that simultaneously with the motor impulses other impulses are sent to the vasodilator nerves. Furthermore, the working muscle fiber absorbs oxygen and produces carbonic acid to a much greater extent than when it is at rest; thus a so-called local dyspnea is caused which demands an increased supply of oxygen. This increased supply is furnished by the expansion of the arterioles as an effect of the increased demand.

It is possible that a pumping and sucking effect of the contracting and relaxing muscle as explained for the veins is also accomplished for the arteries; some authors consider such an effect even the most important one in the whole circulation process. However that may be, it cannot be doubted that the circulation is very much aided by exercise.

We shall discuss next the effect of exercise upon the heart itself, on the blood-pressure and the rate of the pulse. The work of the left ventricle is roughly the product of the amount of blood thrown out during each systole and the resistance which the blood finds in the peripheral circulation. For the blood-pressure there must be added to both these factors the strength of the heart itself. When, as we have seen, the arter-

ies are expanded by muscular action over a large area of the body and thus the total circulation is being enlarged, when also by the effect of exercise on the veins the capillary circulation is aided, we have every reason to suppose that the resistance within the peripheral circulatory apparatus is lessened to a certain extent. Theoretically we should expect a reduction of the blood-pressure by exercise and such an effect has indeed been established by exact sphygmomanometric experiments of Hasebroek, who noticed that resistive movements caused a lowering of the blood-pressure after an initial raising of it, the latter perhaps to be explained by increased action on the part of the heart. By the resistive movement the heart receives a passing impulse to more energetic contraction, but after the short time of increased work of the heart an alleviation takes place because the resistances are decreased by the lowered tension of the arteries (Bum).

The result of Hasebroek's experiments just mentioned are in direct contrast to the observation of Zuntz and others, who have found the blood-pressure decreased in the initial stage of exercise followed by a marked increase. Zuntz himself interprets these observations in the following way: The alleviation of the peripheral circulation should cause in theory a decrease of the blood-pressure. If it does not do so or only for a short time there must be other factors compensating the effect of the reduced resistances. Those factors consist in the action of the abdominal circulation and of the respiration. The abdominal, especially the portal circulation and that of the rest of the body with the exception of the lungs, are in a state of balance as frequent experiments and clinical observations undoubtedy show. When, to state it briefly, the peripheral circulation suffers a sudden decrease of its tension due to an expansion of the caliber of its arteries, blood will flow in greater quantity from the abdominal vessels, especially the portal veins, which represent a kind of reservoir enabling them to hold a very large part of the total amount of the blood. In that way the output of the heart will be increased. This effect is still further augmented by the above-mentioned increased suction of the venous blood from forced inspiration.

This striking dissension of opinions as to the effect of mus-

cular action upon the blood-pressure seems to find its easiest explanation when we consider that the experiments have been made under different conditions. There can be no doubt that the effect must greatly differ when we observe the blood-pressure in a person doing carefully directed resistive exercises (Hasebroek) of one part of the body after the other, *i. e.*, in employing methods which are indeed frequently used in therapeutic gymnastics, or when we have the same person run fast or climb a hill (Zuntz).

In another chapter these interesting observations and conclusions will be further developed to show what an important therapeutic element exercise represents, when it permits us to produce at will effects so diametrically opposed to each other.

In a similar way as with the blood-pressure so the pulse rate is influenced by muscular action. When we have a person run upstairs we find his pulse rate much increased, whereas our daily experience shows that carefully directed resistive exercise may lower the frequency of the heart beat.

RESPIRATORY SYSTEM.

The intimate connection between the circulatory and respiratory systems in regard to the effect of muscular action has been already mentioned several times. We shall further discuss the direct influence of exercise upon the lungs and the musculature of the thorax. But before doing so brief mention should be made of the pulmonary circulation and of the effect of deep expiration upon the heart.

The effect of exercise upon the minor circulation is practically identical with that upon the major. The blood stream of the lungs is favored particularly by a continuation of methodical deep breathing with the exercise of other parts of the body; thus the supplying of the lungs with blood and their nutrition is materially aided.

The rhythmical action of deep inspiration and expiration has a marked effect upon the heart, as Boehm's experiments have shown. Boehm, in making experiments on the resuscitation of asphyxiated persons, was able to demonstrate that with the heart not acting a fairly active blood stream and distinct

arterial tension could be maintained by forced artificial respiration with rhythmical compression of the thorax.[1]

In the ordinary low breathing the lungs may not be evenly ventilated, especially the apices and the lower parts are usually somewhat neglected; facts which may become of greatest importance under pathological conditions, as we shall learn in a later discussion. Methodical deep breathing as an exercise and the forced respiration caused by vigorous muscular action in games and sports are the best means to strengthen the respiratory muscles, to increase the expansion and the capacity of the lungs, and to fill the poorly ventilated parts.

The influence of systematic training by breathing exercises upon the development and function of the upper parts of the respiratory system, the nose, throat, larynx and trachea is generally recognized and is much used by teachers of singing and public speaking.

DIGESTIVE SYSTEM.

The influence of exercise upon the organs of the digestive system is intimately connected with that upon the circulatory and respiratory systems. As we have mentioned above, the abdominal vessels, particularly the portal veins, represent a kind of reservoir which is able to hold a considerable part of the total amount of blood and we have learned to recognize the value of the balance between the portal and the peripheral circulation. In rest and still more under pathological conditions such as marked alteration of the posture, etc., a congestion of the intestinal circulation takes place, which is favorably changed by systematic exercise and there can be no doubt that the relief of such congestion must have a helpful effect upon the function of the digestive organs. This is largely aided by the action of the diaphragm which by its descending and ascending movements causes an intermittent pressure and movement of the liver, the stomach, etc., thereby and also through the rhythmical contraction of the abdominal muscles in many exercises the peristalsis is dis-

[1] Boehm: Archiv. f. exp. Pathol. u. Pharmakol., Bd. viii, S. 68.

tinctly favored. The effect of exercise on the secretion of the glands of the stomach and intestines is dependent on its effect on the intestinal circulation.

The decrease of the amount of blood in the intestinal vessels which, as we have seen, takes place during exercise may reduce the secretory function of the glands, but is largely compensated by the stimulation of the peristalsis (Zuntz). The immediate result of intense muscular action may be somewhat unfavorable to the digestion, although systematic training generally leads to an easier consumption of a greatly increased amount of food. Observations made by Zuntz on military recruits have shown a decrease of the weight during the first months which is always followed by an increase above the original standard during the following period. The systematic training of football teams leads to a very remarkable increase of the number of calories which can be absorbed. The data of Jaffe taken on a Californian football team may serve as an extreme example: Constant weight was observed with a consumption of 260 gr. proteid, 416 gr. fat, 710 gr. carbohydrates; 7885 calories. The daily amount of work was estimated to be 700,000 mkgr., *i. e.*, $2\frac{1}{2}$ times as much as an average workman accomplishes. That such enormous efforts may lead to exhaustion by overtraining, possibly resulting in decrease of the muscular accomplishments, in disturbances of the digestion, insomnia and nervous irritability, should be carefully considered by trainers and physicians.

GENITO-URINARY SYSTEM.

A relieving influence of exercise upon the function of the kidneys is accomplished by the relief of venous congestion and further by the simultaneously increased function of the sweat glands. On the other hand, it is well known that certain disturbances of the function of the kidneys are made worse by muscular action; thus it is very important for the physician prescribing exercise to investigate the condition of the kidneys, and if they are in any way not entirely normal, to study carefully the effect of the exercise upon the urine.

The influence of exercise on the sexual organs goes hand in

hand with that on the circulation as well as on the nervous system. It is well known that appropriate exercises and the physiological fatigue caused by them exert a valuable effect in cases of sexual irritability as they are frequently seen during puberty. As Zuntz points out; the biological law that vigorously active organs reduce by their own demand of blood its supply to other organs here plays an important role.

NERVOUS SYSTEM.

The influence of exercise upon the nervous system is one of the greatest problems of physical education as well as one of the most important indications for its therapeutic use. Prompt motor innervation, quick coördination, accurate cooperation of the sensory organs, and perfect economy of the muscular power are accomplishments which can be attained to a high degree by systematic gymnastics, games, and sports. It is the training of the nerves in connection with that of the muscles which leads to the results highly valued both by the teacher and the physician.

Every complicated motion has to be learned. The child learns to walk. We learn piano playing, tennis, etc. This means not only a training of the muscles, but also of the nerve centres to work with perfect coördination, to avoid unnecessary incoördinate motions, and thus to cultivate economy in the expenditure of energy. In a like manner in therapeutic exercise the patient must be trained; he must learn to restrict his efforts to the effects wanted. A patient who has had an affection of the knee-joint, who has been operated on for the repair of an injury and has to relearn the use of the joint, will at first in the effort to lift the knee from the bed involuntarily contract all the knee muscles and raise the whole leg with the muscles of his hip and trunk. The patient with a partially paralyzed limb who is asked to perform contractions of certain muscle groups will perform contractions of many others before his coördinative functions are sufficiently restored. The patient with a cardiac affection or general debility will very likely overexert his strength if

special care is not taken to train him in the proper economy. All this is training of the central nervous system. In any affections of the nervous system, such as locomotor ataxia or lateral sclerosis, where correct coördination and innervation have been lost, systematic exercise will frequently recover this lost function to a very high degree, as we shall see in the special part. Likewise in psychical affections appropriate exercise will produce sedative or stimulative effects capable of reducing improper irritation or insufficient function.

METABOLISM.

The effect of exercise on the metabolism can be understood by its effect on the circulatory, respiratory, and digestive systems. The working muscle, which is richer in blood and tissue juice than the muscle in rest, will consume an increased amount of oxygen and produce an increased amount of carbonic acid besides other products of metabolism.

This effect is obtained by even the slightest muscular effort. Thus the gas exchange is greater in standing than in lying; its increase, though slight in relaxed standing, is raised by 20 per cent. in forced standing, and by much higher percentage in walking, running, climbing, etc. Calorimetric experiments by Atwater and Benedict[1] show that the formation of heat in rest and work is in direct proportion to the gas exchange.

The effect of the various foods for the production of muscle power has been a subject of frequent discussion. Especially has sugar been frequently considered a most important source of energy. Zuntz, from exact studies in his laboratory, believes that the three main foods—proteids, fat and carbohydrates—have equal value in relation to the amount of calories, but that proteids alone enable the animal to do great muscular work, while the others can show such effects only with simultaneous consummation of proteids.

The consumption of oxygen and the formation of carbonic

[1] Metabolism of Matter and Energy in the Human Body, Washington, 1899.

acid is, as we have seen, in direct proportion to the amount of work. Such a proportion does not exist for the metabolism of proteids or nitrogen. Argutinsky has emphasized the fact that an increase of the nitrogen in the urine, as observed after great muscular efforts, takes place for several consecutive days and is usually greatest on the day following the exercise. This is explained by an alteration of proteid molecules in the muscle which are then gradually excreted. The amount of such excretion of proteids, however, is not necessarily proportional to the amount of work: in moderate work of long duration it is generally smaller than in shorter but very vigorous work, although the total amount of effort may have been much larger in the first instance. Moreover, it has been demonstrated by Caspari that with long-continued work of equal daily amount the excretion of nitrogen gradually diminishes to a certain extent.

Zuntz has made exact studies to measure the energy consumed, the increase in calories, the consumption of fat and excretion of water. His interesting results are given in the accompanying table.

Only a small proportion, not more than about one-fifth of the whole amount of muscle action, is transformed into measurable work. The rest is transformed into heat. Thus the temperature of the whole body is slightly raised by vigorous exercise. The rise of temperature, however, is much greater for the periphery of the body, the skin, and the adjoining layers, than for the interior. We know from daily experience that the skin which had been cool before the exercise becomes warm and even hot from a certain amount of work. It finally leads to profuse perspiration. These effects are of the greatest importance as the excretion of heat by conduction, radiation and evaporation is thus assured.

Even at excessive temperatures a considerable amount of work can be done when the air is dry, while in damp air working men are much more exposed to overheating and heat stroke. On the other hand, in cool weather nothing keeps us from feeling cold so well as vigorous exercise. The teamster moves his arms violently to get warm; we hasten our steps to produce more heat in cool weather.

REQUIREMENT OF ENERGY AND NUTRITION OF A MAN OF 75 KGR. WEIGHT (WITH CLOTHES) FOR SEVERAL MUSCULAR FUNCTIONS, AND THEIR EFFECT UPON THE PERSPIRATION.

1	2	3	4	5
Function of muscles per hour.	Consumption of energy for the unit of work.	Increase of the metabolism for one hour of activity.	Consumption of fat.	Amount of water whose evaporation corresponds to the heat product of the work.
	Cal.	Cal.	G.	G.
1. 3.6 km. walking horizontal	40.3 pro kilo.	144	16	249
2. 6 km. walking horizontal	47.2 " "	283	30	488
3. 8.4 km. walking horizontal	78.6 " "	660	70	1138
4. 6 km. walking horizontal with 25 kg. baggage	64.1 " "	385	41	664
5. Climbing 300 m.	49.0 " 100 m.	147	16	169
6. Steep path or stairway (32–68 per cent. incline)	58.0 " 100 m.	174	18	200
7. 3 km. way with 10 per cent. incline	89.0 " kilo.	267	28	376
8. 9 km. bicycling horizontal	20.3 " "	183	19	231
9. 15 km. bicycling horizontal	20.8 " "	313	33	396
10. 22 km. bicycling horizontal	25.9 " "	571	60	722
11. 9 km. bicycling with 3 per cent. incline	35.1 " "	316	33	384
12. 15 km. bicycling against wind of 10 m. per hour	40.1 " "	601	64	727

All these facts have to be carefully considered under pathological conditions where therapeutic exercise is prescribed, and with particular care in such cases where the machinery of the human body is seriously out of order.

CHAPTER VI.

GENERAL REMARKS ON MASSAGE.

Massage (from the Greek $\mu\alpha\sigma\sigma\omega$ = I knead) means a variety of manipulations of the tissues of the body for therapeutic purposes. Massage is an important and valuable part of therapy and requires in the first place a thorough understanding of the individual needs of the patient. The ideal requirement of Hoffa, Zabludowski, and others, that only the physician should give such treatment will probably never be fulfilled, but we should at least strive to have every physician become thoroughly familiar with the technic, the physiological effects and the therapeutic indications so as to be able to prescribe, not simply "massage," but in detail the form and amount which he considers necessary. We cannot agree with the opinion of certain physicians that the lay masseur should instruct the physician, nor should we depend upon the masseur for the best way of carrying it out. On the other hand, the masseur must have a good knowledge of the anatomy, physiology and pathology which his work will require. He must realize that technic and skill alone will not suffice, but that correct understanding of the case and good judgment as to the indications are the chief factors.

The following points require special discussion:

Relation of the Operator and the Patient.—As massage brings the operator into a very close personal contact with his patient, the greatest delicacy is required. This is particularly necessary in handling nervous, sensitive patients. To the simply mechanical application of massage the personal influence is added, often representing the most valuable part of the whole treatment. The patient must realize that the operator understands his ailment. He must

have full confidence that the masseur knows how far he can go, and the masseur must be worthy of this confidence.

Environment and Position.—The treatment should be done in a moderately heated and well-ventilated room and all disagreeable influences should be excluded, such as might be caused by distressing noises, light falling in the patient's face, etc. The patient should be brought into a comfortable position which should also allow the operator to work with sufficient comfort. Standing bent over a low bed or couch for some length of time causes the operator's back muscles to tire, and may result in lumbago. It will therefore interfere with the efficiency of his work. The muscles of the massaged patient must be relaxed, his joints held in a middle position. The arms and shoulders may be treated in a sitting or lying position, the rest of the body lying. We do not favor the sitting position for the legs, though this may be done for the foot and calf if the patient is sitting on a table and the operator is in front of him on a chair.

Clothing.—Massage must be done directly upon the skin of the patient. Hoffa calls it quackery, when the masseur works through the patient's clothes. We agree with him in general, but allow some exceptions; *e. g.*, in cases of a septic hand where some granulations or superficial sinuses still exist, and where delay until these openings are all healed would cause adhesions and scars to become still firmer and stronger, kneading and friction may be done with benefit through a sterile sponge or towel, thus protecting the patient's skin as well as the operator's fingers. Or, in the treatment of a sprained foot it may be necessary to have the ankle strapped with adhesive plaster. This need not interfere with the massage, and a good deal of effect can be obtained by friction and kneading of the strapped region, though we must admit that the effect cannot be the same as over the bare skin.

The patient should be loosely dressed; all restricting clothes, such as garters, corsets, tight drawers or sleeves must be removed. Thus, in treating a man's leg, it is not well to do so when the drawers are rolled up, because that

would interfere with the circulation and so deprive the massage of its most important effect. All parts which are not treated at the time should be covered, and with patients who are very sensitive to cold, massage of the back or abdomen can well be done under a loose sheet or blanket.

Care of the Skin: Cleanliness.—That the operator prepare himself with the utmost care and cleanliness is self-evident.

The care of the patient's skin is an important but not at all difficult problem. In our large out-patient clinic we have the rule that the part to be treated must be washed with alcohol before and if possible after the treatment; patients are advised to bathe and change linen frequently. With these simple precautions, to which it may be added that the masseur be required to wash his fingers before taking up the treatment of every patient, we practically never see such troubles as furuncles or sore skin.

Much discussion is found in text-books on the use of grease. It seems to us that this point which has been made a question of principle may safely be regarded from the point of view of one's common sense. When we apply a mild effleurage over large areas of dry skin, as the back, it is often best to use a small amount of cold cream or white vaseline. (It is better to use such ointment from tubes rather than from jars, because with the latter the fingers may have to be put in again after the massage has been begun, and thus contamination is unavoidable.) On the other hand, when we apply friction for loosening up of tight tissues, we need a good deal of adhesion and ointment would greatly interfere with the work. In kneading, a small amount of ointment may be useful, or the massage may be done without it. We frequently use powder, which gives to the hand just that amount of smoothness which is required for most manipulations. The operator who knows his case and knows what physiological effects he may expect from the treatment will find without difficulty what amount of smoothness or adhesion he needs at the given place. Colombo recommends lather of soap, which certainly favors cleanliness, and may be of use for kneading and effleurage of large parts; for friction

it would be entirely useless. Any medium used, should be unscented and fresh.

We do not think it well to shave the skin for the massage treatment. With proper technic and with the use of one of the mentioned mediums to smooth the skin, even long hair will never be disturbing. But after shaving the new growing hair gives the skin a rather rough exterior, which is irritating both to the patient and to the operator.

Force and Speed.—The sensation which is caused by massage should on the whole be of an agreeable nature. Thus the amount of force needed is usually moderate. Massage requires the fine, delicate touch guided by anatomical knowledge rather than the strong, athletic hand, though we will admit that a person doing such work for the greater part of the day needs a good surplus of strength. But he should use it wisely; he should not squeeze and pinch his patient and cause him to cry and complain of pains for many hours afterward, as we have seen done. We cannot agree with Zabludowski, who says that the patient may have pains for some time up to twenty-four hours, and believe that all needed effects can be obtained without such abuse of force. Colombo quotes from Metzger's practice that his patients frequently left with blue spots on their bodies, but adds that what a man of his reputation may do, should not be made the rule. Incidentally we may remark that small ecchymoses or blue spots often occur on very tender tissues by only a moderate force, and as Hoffa points out, usually do no harm. However, we should not try to produce them.

As to the speed of massage manipulations, no definite rules can be given. It seems to us, however, that for most cases a slow or moderate speed will give better effects than very quick motions, with the exception, of course, of tapotement and vibration, which requires a quick tempo.

Order of Parts to be Treated and of Manipulations.—Generally it is advisable to treat the most affected part first and to pass to the neighboring or distant parts according to their need. In cases of very poor circulation or edema of a leg or

arm we recommend starting near the trunk and working gradually down toward the periphery as we have described in Chapter VII under the subject of Kneading. This is done as it seems rational to prepare the paths of the return circulation from the swollen area and then go over to the latter. It is with this understanding that in the chapter on Applied Massage we have taken the order of the parts away from the centre, rather than from the periphery toward the centre. But it should be made clear that the direction of each single manipulation is to follow the course of the lymphatic vessels.

In general massage the amount of body surface to be treated depends upon the effect desired. Often the whole body including neck and head must be treated, while in other cases massage of the fleshy parts of the extremities will suffice.

Duration and Frequency of Treatment.—In advising a patient to have massage, I have frequently been asked how much the masseur will charge an hour, the patient seemingly having the idea that the longer the treatment lasts, the greater will be its value. This is not generally true, and we agree with Nissen in his statement that an expert operator will produce the desired effect in half the time required by one who is not sufficiently trained. Moreover, the time needed depends very largely upon the effect required. In the case of a fresh injury a treatment of five or ten minutes' duration will usually suffice, and indeed a longer treatment may cause undesirable irritation. On the other hand, a general massage which is prescribed for a patient suffering from obesity who needs a stimulation of his depressed vascular tonus may safely be done for forty to fifty minutes. It is wise, however, to begin the treatment with short sessions and according to the reaction increase the time if necessary. With children and old people the time should be relatively shorter than with young or middle-aged adults. With convalescent or weak patients the treatment should at first be very mild and short, not longer than fifteen to twenty minutes, and only with increasing strength of the patient may the duration of each treatment be somewhat extended.

The frequency of treatment will depend very largely upon social conditions. In many surgical cases twice a day would be most advisable, a requirement in which we agree with Zabludowski, Bum and others. But, as a rule, in the hospital as well as in private practice we must often be content to see the patient three times a week or even less than that because he may live too far away, or, as in women, the patient cannot leave her household oftener. I usually answer the patient's question, "How often must I return?" by saying, "As often as you can." This is of course different in cases of neurasthenia, general debility and certain internal conditions where a too frequent treatment may easily overstimulate.

CHAPTER VII.

TECHNIC OF MASSAGE.

The technic of massage can be learned only by practice on patients. Any description must fail to a certain extent, because the fine and accurate touch which represents the most valuable part of massage cannot be described. All that we can do here is to give a brief account of the most important manipulations. The student of massage must have a good knowledge of normal and pathological anatomy and must compensate by his own ardent study and by personal instruction of an expert teacher for what cannot be described in words.

In our classification we follow in general the example of Hoffa, Bum and others, to be as simple as possible. For the advanced student the study of the books of Zabludowski, Colombo and others, who describe scores of various manipulations will be very instructive.

There are three main groups of massage manipulations:

The rubbing manipulations.
The kneading manipulations.
The clapping and shaking manipulations.

RUBBING MANIPULATIONS.

The rubbing manipulations are divided into: (1) simple rubbing, and (2) effleurage or stroking.

Simple Rubbing.—Rubbing is the simplest form of massage. It is done with the tips of one or more fingers or with parts or the whole of one or both hands over the skin of the patient. It is stimulating or irritating to the skin according to the amount of pressure or the sensibility of the patient. It is frequently used to cause a counter-irritation, an effect which may be increased by the use of a camphor or chloroform

liniment. In suitable cases this may be left for the patient or a member of his family, since it does not require as much training as the other manipulations.

The physiological effect of rubbing is very similar to that of effleurage and will be described with the latter.

Effleurage.—Effleurage is stroking in the direction of the lymphatic flow. It is usually employed at the beginning and end of the massage treatment, but may be freely mixed with other manipulations, particularly kneading and friction.

Effleurage may be used over any part of the body, but it is of special use and value over the muscles. The hand follows as much as possible the anatomical outlines, *e. g.*, the flexors and extensors of the forearm or upper arm, the peronei, the quadriceps, etc. If a muscle is too large to be covered sufficiently with one hand, both hands are used, or the muscle is divided into two or more parts, as in the muscles of the calf or in the deltoid. The hand tries to fit itself as closely as possible to the muscle. It begins with a slight pressure over the distal attachment; the pressure is then increased over the fleshy part and again slightly decreased toward the proximal end. Where it is possible to lift up the muscle, as with the flexors and extensors of the upper arm, effleurage is combined with a grasping motion, stroking the muscle by means of the thumb and four fingers, the thenar and antithenar (Fig. 17). Where lifting up is not possible, the hand in stroking presses the muscle against its underlying base.

Over small muscles, as the interossei of the back of the hand, stroking is done with the point or the side of one finger. Over the long back muscles or over the outside of the thigh and other parts effleurage is done with the side or the ball of the hand, or if stronger effects are wanted, with the knuckles (Fig. 18).

Both hands may work simultaneously if the part to be massaged is well supported, and if no inflammatory condition exists. Frequently one hand has to support or to steady the limb. Often, for instance, in the upper arm the flexors and extensors are alternately treated, one hand supporting and the other massaging. The hand, after finishing the centrip-

etal stroke usually glides down toward the peripheral end of the muscle, touching the skin lightly, and begins the same movement over again.

As to the speed, no special direction can be given, since it depends on the effect wanted. In irritable cases a slow, gentle stroke may produce a very marked effect, while in treating an atrophic limb of an otherwise healthy person, considerable speed up to fifty or sixty times a minute or more with a good deal of pressure may safely be applied.

FIG. 17.—Effleurage of triceps.

As has been said before, effleurage may be used over any part of the body, not only over the muscles; but it should always follow definite anatomical outlines.

We have sometimes seen insufficiently trained persons apply effleurage to the forearm, elbow and upper arm in one stroke without any anatomical discrimination. Such a method is

entirely unscientific and may involve great dangers if the elbow-joint is at all affected.

The chief aim of effleurage is to empty the veins and lymphatic vessels, to press their contents in physiological directions, and, as the elastic walls of the vessels tend to spread and suck blood and lymph from behind, to act as a

FIG. 18.—Knuckle effleurage of forearm.

kind of pump. Thus the current of the circulation is rendered quicker and the nutrition of the tissues favored. If effleurage is repeated a number of times, varying with different individuals, the skin will become reddened because an arterial hyperemia is produced which may last for a considerable time. The temperature of the treated skin will be raised. Furthermore, an effect on the sensory nerves of the skin and

the deeper parts is noted which may vary from a very soothing agreeable sensation to a disagreeable irritation or even pain, according to the strength of the manipulation and the individual irritability. By the effleurage of larger areas of the body these effects on the sensory nerves can be generalized and an effect on the central nervous system thus be obtained.

THE KNEADING MANIPULATIONS.

Pétrissage.—Pétrissage is deep kneading and is usually combined with manipulations, such as grasping, lifting, wringing, rolling, pressing, etc., all of which, therefore, will be treated under this heading.

In analogy to effleurage it is usually employed with the treatment of muscular parts, but may be used over most parts of the body. Together with friction, it may be considered the most important massage manipulation. The hand grasps a part of the muscle or muscle group, lifting up as much as possible of it from its base, and kneading or wringing it. Then the hand glides easily up an inch or two and repeats the same manipulation and so forth over the whole of the muscle from one end to the other. Often the other hand is needed to support the limb. When this is not necessary both hands may be used (Fig. 19); often one hand starts the manipulation at one end of the muscle and the other makes the next move close to it, etc. (Fig. 20), or both hands simultaneously, or more often alternately, cover opposite parts of the limb, as for instance, the flexors and extensors of the elbow.

In taking the axillary muscle groups, both these groups may be treated by having the one hand knead the pectoral and the other the scapular muscles (Fig. 21); or one hand is used as a pad over which the other hand is working (Fig. 22); whichever is most convenient. Often with muscles which cannot be lifted up, as the long muscles lying beside the dorsal spine, pétrissage is done more by rolling and pressing or describing small circles as in friction. As much as possible of the surface of the hand or fingers is used, and is held

close to the skin; thus pétrissage is never in any way like rubbing.

As in effleurage the anatomical outlines must be strictly followed. Each single manipulation should be done in the direction of the lymphatic flow, but as to the succession of the single manipulations, no rule exists. It may be centrifugal or centripetal. In case of edema or of an otherwise

FIG. 19.—Kneading of upper arm.

greatly disturbed circulation, it seems more rational to begin at the proximal end of long muscle groups and work gradually down in order to clear the path for the venous and lymphatic flow from the peripheral parts.

Grasping alone is not much used, but more in combination with kneading, rolling, or pressing. These latter manipula-

tions are more often used where special attention is given to limited parts of the muscle group. In rolling, one hand or both grasp the muscle and roll it over its base. In pressing, one hand or both grasp the muscle and make a rhythmical pressing manipulation.

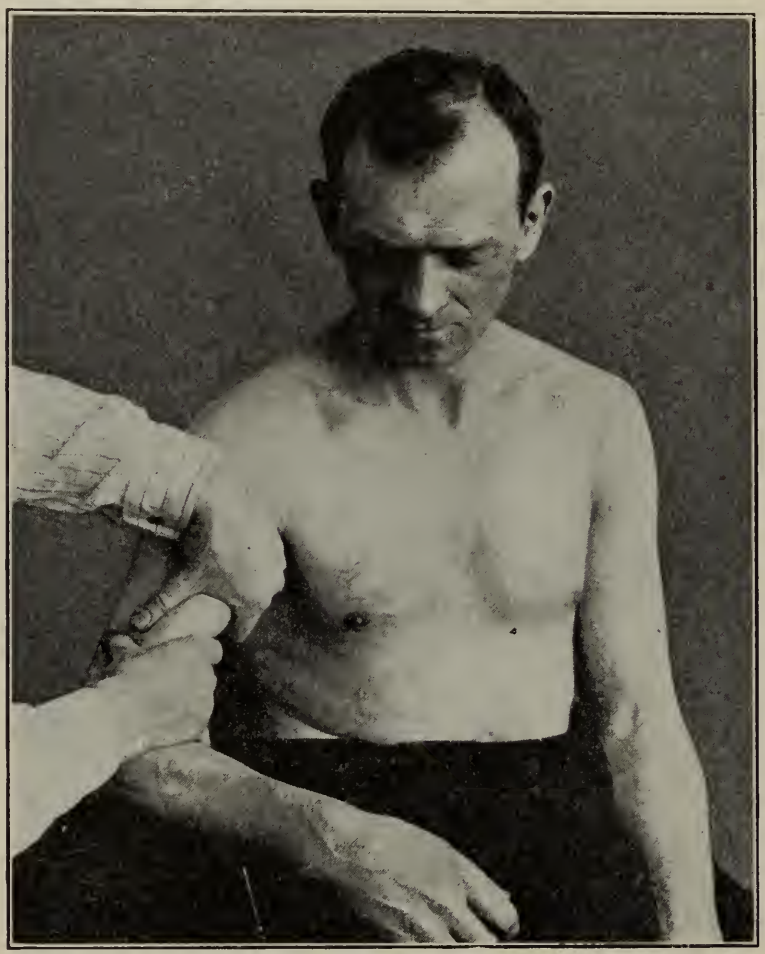


FIG. 20.—Kneading of biceps.

A similar manipulation over parts such as the ham-string tendons has been described as harping, where motions are done similar to playing the harp. According to various regions of the body and various indications an infinite variety of pétrissage manipulations may be described, and every masseur develops details of such a technic in a more or less

different way. These may safely be left to the knowledge and common sense of the operator. Much more important than the knowledge of a great many technical points is, in our opinion, the knowledge of what kinds of mechanical stimulations are required in the given case, and a good knowledge of the anatomical outlines.

FIG. 21.—Kneading of anterior and posterior axillar muscles.

Kneading has a stimulating effect on the vessels, especially the smaller arteries of the deeper parts. It stimulates the muscle tonus and acts as a kind of passive exercise of the muscles. In connection with effleurage it relieves the fatigued muscle by removing its contents of waste products. Retracted muscles and tendons are stretched, and thus

limitation of motion may be relieved. Done over a large part of the body, kneading raises the blood-pressure considerably, more so than effleurage alone, although this effect is best accomplished by a mixed massage and by vibration and shaking of the whole body.

FIG. 22.—Kneading or stroking of posterior axillar muscles.

Friction.—There is some dissension among writers on massage as to the use of the term friction. Some interpret it as rubbing *over* the skin in small circles; others use it in the meaning of rubbing *over* and *with* the skin; while others again call friction a manipulation which consists in moving the skin *over* the underlying parts. Following the lead of

authorities such as Metzger, v. Mosengeil, Hoffa and others, we use the term friction in the last-mentioned sense only, while similar manipulations done "over" the skin are dealt with under the heading "Rubbing." There is a very decided difference in the technic as well as in the effect of these two manipulations, and they should not be confused, though we admit that the word "friction" itself would allow various interpretations.

Friction consists of a variety of manipulations done with one or more fingers or with parts or the whole of one or both hands. The finger is closely applied to the skin and moves it over the underlying tissue. This may be done with the points of one or more fingers in small circles, or moving up and down or sidewise; or the tips of the thumb and second finger or the tips of the identical fingers of both hands may lift up a wrinkle of skin and move it in small circles or up and down or in a way similar to two mill-stones, kneading and grinding the skin and deeper tissues between them; or one finger is kept still and serves as a support against which the skin is moved in the manner described.

Friction is a most important massage manipulation for the treatment of the smaller parts, such as the hand, foot, joints, face, etc. It is for these parts what kneading is for the large muscular parts, and is rather closely related to that manipulation.

The effect of friction consists in the loosening of adherent skin, of scars or deeper parts, such as the tendons of the back of the hand or fascia over joints. In infiltrated or edematous parts it strives to dispose of the waste matter and to press it into the circulation. This process is hastened by an appropriate combination of friction and effleurage.

Friction is frequently combined with pressing, constant or intermittent, *e. g.*, over nerve points or over the point of fracture in cases with delayed union of the fragments.

THE CLAPPING AND SHAKING MANIPULATIONS.

Tapotement.—Tapotement consists in clapping, slapping, hacking, or tapping the skin, usually of large fleshy parts,

with the hands, fists, or fingers. It is done with one hand, and more frequently, in an even rhythmical way, with both hands.

We distinguish the following ways of tapotement:

(*a*) Clapping with the fist: the hand is more or less closed to a fist and strikes the part either with the ulnar side or with the knuckles. The more firmly the fist is closed the harder will be the effect of the striking (Fig. 23).

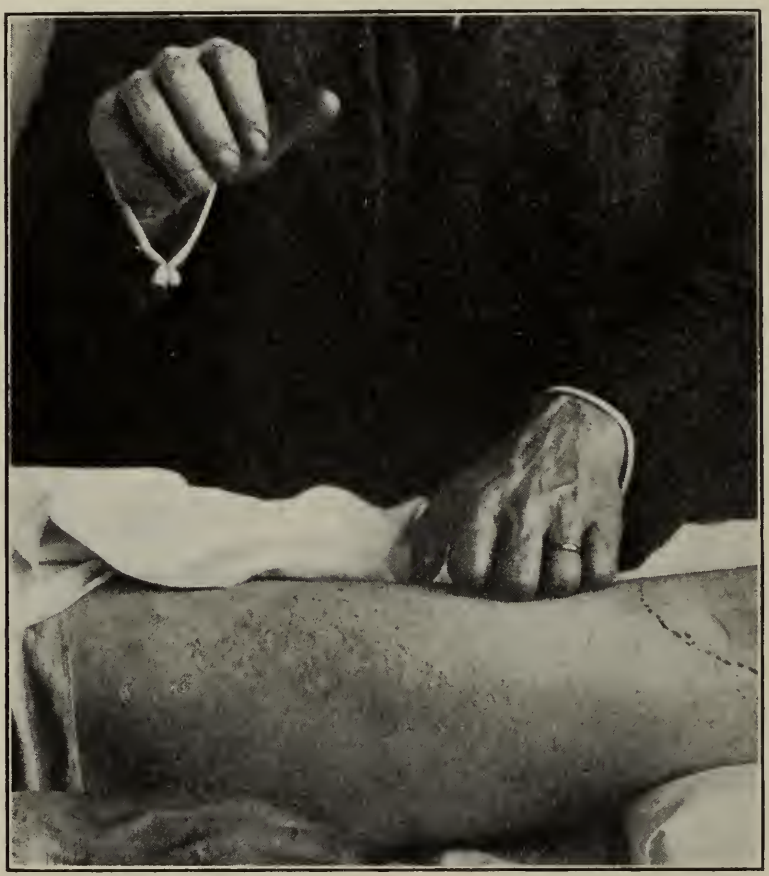


FIG. 23.—Clapping.

(*b*) Slapping is done with the palmar side of the opened hand.

(*c*) Hacking is done with the ulnar side of the fingers which strike the part so that the fifth finger comes in contact with the skin first and is followed by the others in quick succession, each coming to lie close behind the preceding one, while the hand is slightly supinated (Fig. 24).

(*d*) Tapping is done with the tips of the fingers which are held as in playing the piano (Fig. 25). A very light kind of this massage is called "rain douche" massage.

FIG. 24.—Hacking.

FIG. 25.—Tapping.

Shaking.—Shaking is done on any part of the body which is fairly loose and mobile, as the hand, the arm, large muscle groups, and the abdominal wall, especially when it is relaxed and flabby. The operator grasps with one or both hands the part to be treated, and shakes it in very quick rhythm. When a large muscle group is subjected to treatment it is grasped as in kneading, with which shaking is frequently combined.

Vibration.—Vibration consists of a very quick rhythmical movement with the forearm through a small angle while the hand, or the fist, or the tips of the fingers firmly rest upon the part to be treated. The movements are made either in the direction toward the part or to and fro. The forearm is held at nearly a right angle to the upper arm, hand and fingers being held stiff. Vibration is rather difficult to learn and is quite tiring to the operator; it may therefore be done with greater effect by an electrical vibratory apparatus.

Shaking and vibration are related to each other as are kneading and friction.

The physiological effects of tapotement, shaking and vibration are similar and will be discussed together. All these manipulations increase the tonus of the vasomotor nerves; moderate vibration and tapotement stimulate the vasoconstrictors, a strong application chiefly the vasodilators. Vigorous application of these manipulations therefore reddens the skin. Also the sensory nerves of the skin and deeper parts are stimulated. Very strong application of vibration upon sensory nerves may cause their exhaustion, a fact which is useful in the treatment of neuralgia of the trigeminus, the sciatic nerves and others. The effect on the muscles consists in contractions of the fibrillæ; thus the tonus of the muscle is increased. This is also true for the heart muscle and the smooth muscle fibers. Vibration and hacking of the heart may reduce the rate of the pulse. These manipulations, therefore, have been called the "digitalis of gymnastics" (Hasebroek). The effect on the muscles of the flexure and rectum has been particularly studied by Zander in using his vibratory apparatus over the sacrum. The secretory nerves are also stimulated as Colombo's experiments have shown.

CHAPTER VIII.

APPLIED MASSAGE.

We have emphasized that every massage manipulation should be given with the full understanding of the anatomical outlines. In this chapter we shall demonstrate how the most important manipulations, stroking, kneading and friction may be properly applied to the various parts of the body in the average routine work of general and local massage. It is of course evident that each case must be considered individually, and that changes of the position as well as of the manipulations may become advisable.

Head.—The operator stands behind the patient who is sitting on a chair resting his head against the back of the chair, or against the chest of the operator. For the massage of the head friction is most important (Fig. 26), though over the forehead and the cheeks effleurage may also be used. Friction is done by moving the soft tissues over the bone, using more or less pressure, or if pressure against the bone is to be avoided the soft tissues are lifted up between the fingers of both hands and moved in small circles; especially in those cases where infiltration exists and the circulation is to be stimulated, friction and stroking should be freely mixed. In most cases massage of the head is combined with that of the neck.

Neck.—For the massage of the neck the same position may be used as in that for the head. The four fingers begin immediately below the lower jaw and follow the direction of the large vessels on the inner side of the sternocleidomastoid muscles, while the thumbs rest against the cervical spine. Or with the described manipulations of the four fingers, the thumbs and parts of the hands may be used at the same time to effleurage the lateral posterior muscle

groups down to the shoulders. The massage of the neck may also be done by the operator sitting in front of the patient, starting with the four fingers at and behind the mastoid process and going gently downward with the second finger following the anterior border of the sternocleidomastoid muscle (Fig. 27).

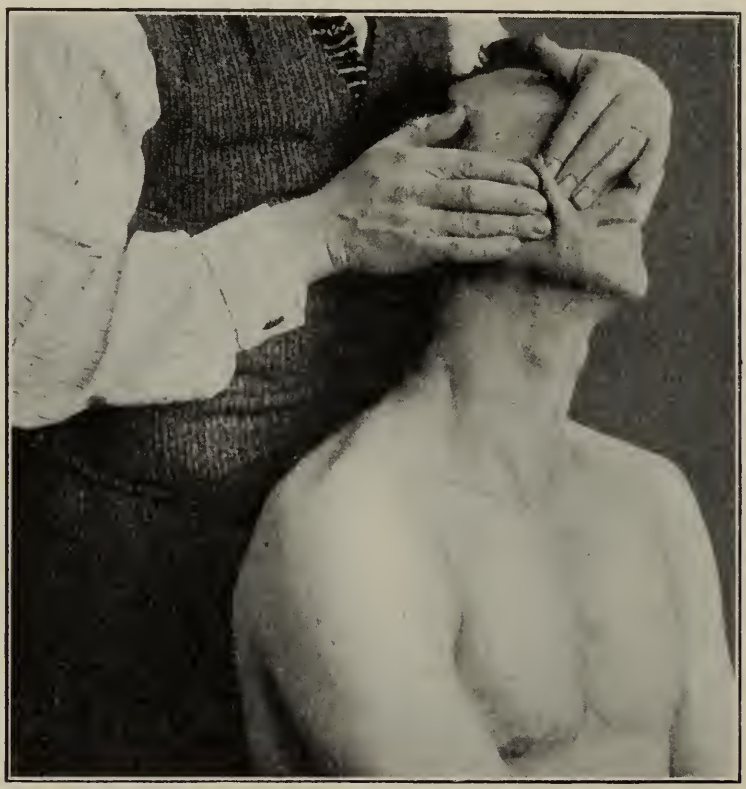


FIG. 26.—Friction of face.

The kneading of the lateral groups (trapezius, levator scapulæ, etc.) is best done from behind (Fig. 28), lifting the muscles up and kneading and rolling them between the points of the fingers or larger parts of the hands. When there is any rigidity or muscular spasm it is advisable to have the patient lie down, because in the upright position the muscles of the neck will be too much contracted to allow thorough manipulations.

Chest.—Massage of the chest is not very frequently done, except for the pectoral muscles and the anterior serratus

which are subjected to treatment in all shoulder affections. Effleurage of the pectoral muscles is done by the operator's right hand grasping the muscles between the thumb and the four fingers while the arm of the patient is somewhat abducted and elevated. The thumb serves as a pad over which the other fingers stroke and press the muscle tissue in the

Fig. 27.—Effleurage of neck.

direction of the axilla. Or both sides may be treated in the supine position, the operator beginning with his hands flat on the sternum and stroking toward the axilla. The anterior serratus is preferably treated in the lying position, the operator's left hand raising and supporting the right arm of the patient somewhat, and his right hand applying effleurage and kneading over the lateral part of the thorax

toward the scapula. Stroking and kneading of the intercostal muscles are also best done in the lying position, the fingers following the intercostal space from the back forward, giving effleurage and friction.

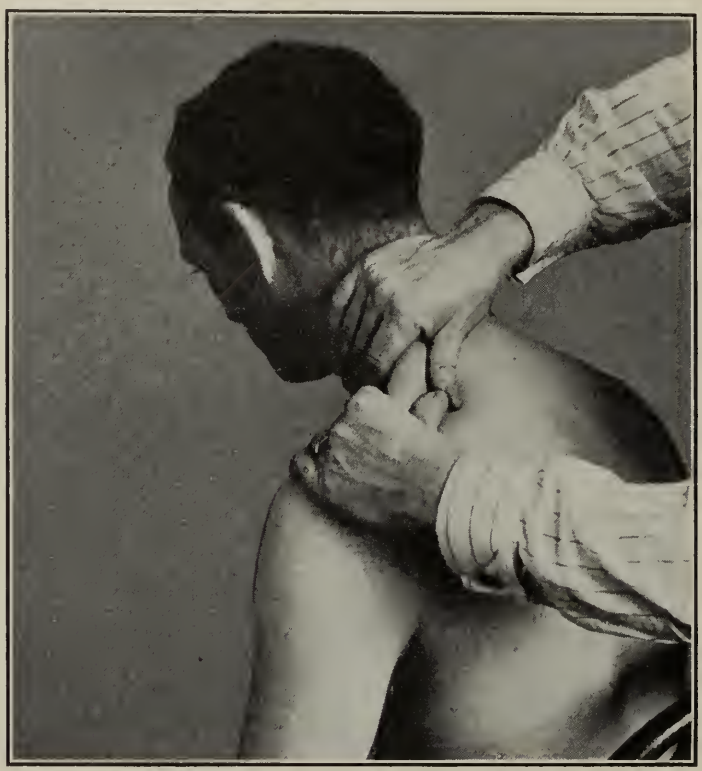


Fig. 28.—Kneading of trapezius.

Back.—For the massage of the back the patient lies prone, his arms hanging over the sides of the table or lying close to the body. The operator stands on the left side of the patient.

The muscles of the back are divided into two large groups (Fig. 29): (1) the so-called erector spinæ, really a number of muscles situated on both sides of the spinous processes, and (2) the broad flat muscles, latissimus dorsi, trapezius, rhomboidei, and the muscles of the scapulæ. The lymphatic drainage of the latter is directed toward the cervical and axillar glands, while, according to v. Mosengeil, Bum, Hoffa and others, two different lymphatic systems are situated in different layers of the erector spinæ, one draining into the cervical

and the other into the inguinal glands. Therefore the effleurage of these muscles should be done both in upward

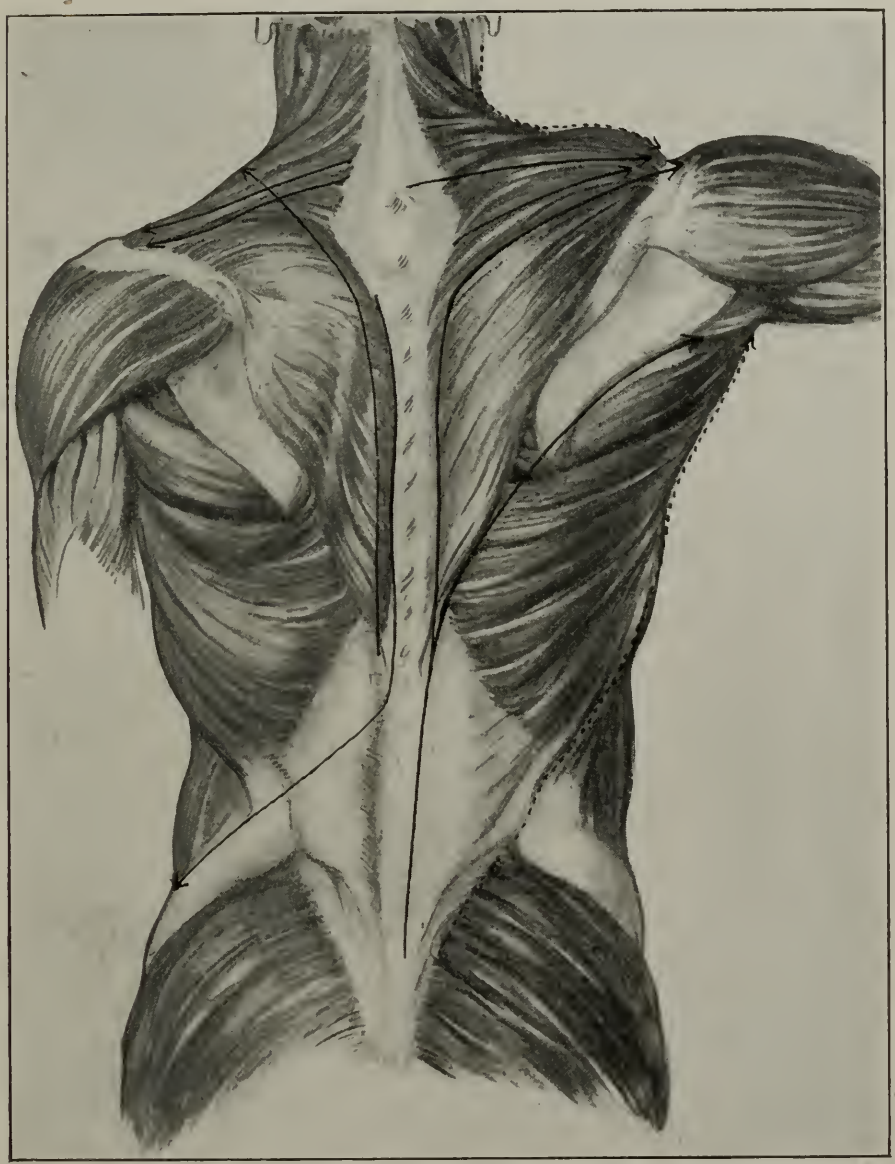


Fig. 29.—Muscles of the back. In this and the following anatomical pictures the straight lines indicate the direction of the thumb, the dotted lines that of the four fingers.

and downward direction—the only muscle group of the body thus treated—while the flat muscles require massage in the direction toward the shoulder-joint.

For the effleurage of the erector spinæ the operator begins by grasping the neck, then stroking with both hands

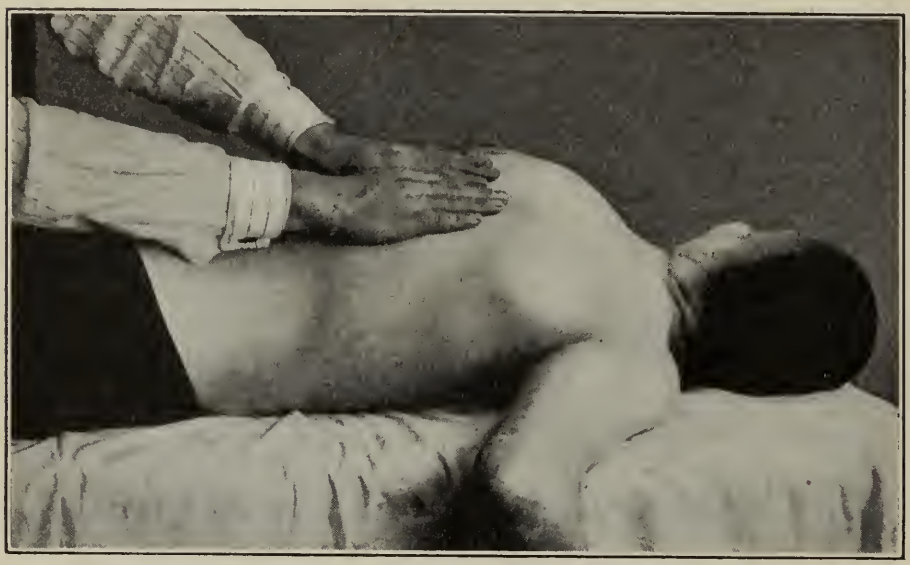


Fig. 30.—Upward or downward stroking over the muscles along the spine.

Fig. 31.—Downward stroking over the muscles on both sides of the spine.

close to the middle line along the spine (Fig. 30), down toward the pelvis, where the hands separate and move just

above the crests of the ilia forward to the anterior superior spine. Most pressure is given with the thenar, the thumb and the second finger, while the other fingers glide more lightly on the side of the erector spinæ. Downward effleurage can also be done with the right hand, the thumb and second finger on the left side, the others on the right side of the spinous processes, while the left hand increases the pressure by assisting the right hand (Fig. 31). The lateral motion above the crest is intended for the connection of the lymphatic system of the erector spinæ with the lymphatic glands of the groin; it also takes hold of the lateral lumbar muscles. Then the hands begin from the lower end of the erector spinæ and glide upward in a similar way, closing with an effleurage of the posterior muscles of the neck. With stout persons the effleurage may be done with the knuckles, to obtain a more thorough effect. An actual pétrissage is possible only in the lumbar segment where one hand grasps the muscles from the side and the other hand performs the kneading and rolling manipulations between the supporting hand and the spinous processes (Fig. 32), or both hands grasp and knead both lumbar segments simultaneously (Fig. 33). In the dorsal segment typical friction is done after the effleurage and freely mixed with the latter.

The flat muscles of the back are effleuraged by the whole hand on each side, while for the kneading each side is taken singly and the muscle lifted up, grasped, rolled and kneaded, gradually working toward the axilla. For the kneading it would seem more rational to lift up the soft tissues in folds parallel to the direction of the muscle fibers instead of transverse, as we have often seen it done. The rhomboids and large parts of the trapezius are treated with the erector spinæ. The other parts are treated with the scapular muscles in the following way: for treatment of the right scapula the right hand grasps the infraspinous, the left hand the supraspinous part of the scapula with its muscles. The thumbs are effleuraging from the inner edge toward the shoulder while the other fingers support from below and above (Fig. 34). Kneading is done in the same way. For the massage of the back, as everywhere, it is necessary to have

FIG. 32.—Kneading of lumbar muscles.

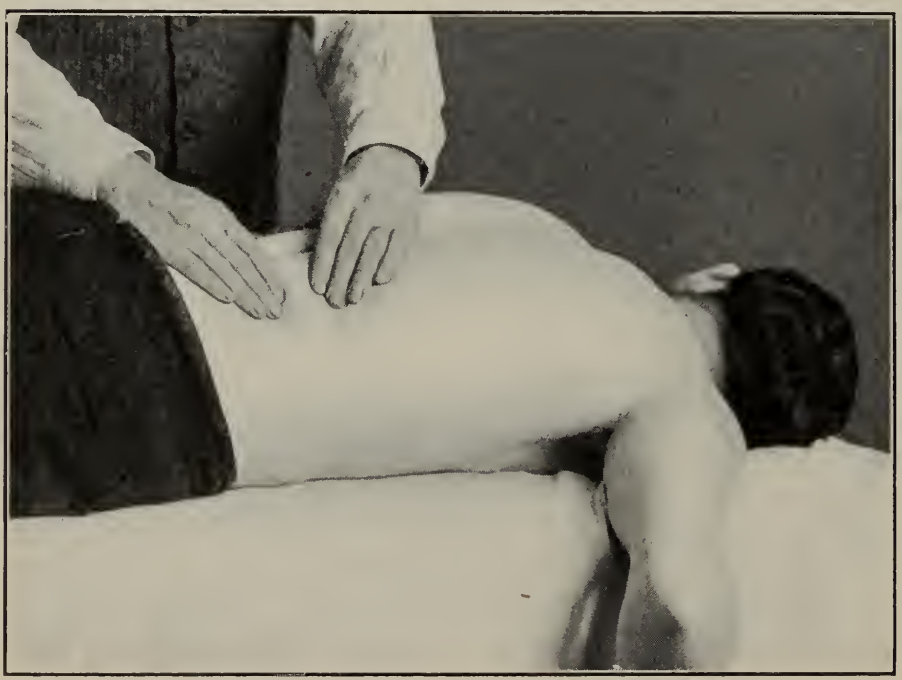


FIG. 33.—Kneading of lumbar muscles.

the patient lying so that the muscles are entirely relaxed; especially in individuals with a marked lumbar lordosis it is of advantage to have a pillow under the abdomen in order to straighten out the lordotic spine to some extent.

Fig. 34.—Effleurage and kneading of scapular muscles.

Upper Extremity.—Massage of the shoulder is done in the sitting position or lying if marked spasm of the muscles exists. To cover all shoulder muscles sufficiently both a prone and supine position should be taken, or the patient must lie on the other side.

The deltoid muscle is usually divided into two or more parts. The operator, who sits on the right side of the patient, strokes with his right hand over the anterior, with his left hand over the posterior, part of the deltoid. This manipulation can be done more effectively when for the posterior part the operator places his left hand underneath the deltoid and the adjoining muscles, using it as a pad over which the muscle is effleuraged, and *vice versa* for the anterior side; the right hand is used as a pad and the left hand strokes. We also find this method very useful for kneading, which can also be done by both hands at the same time, the

thumb of each hand acting as a pad against which the muscle is kneaded by the four fingers.

Another way for the massage of the deltoid is to have the patient lying supine and the arm supported in a somewhat abducted and elevated position; thus the muscle is much more relaxed than in the sitting position, and both effleurage and kneading may be done much more thoroughly. The pectoral muscle is also treated in the supine position, while massage of the scapula and flat back muscles is better done in the prone position or lying on the other side. As we have seen before, in massage of the upper trapezius the sitting position with the operator standing behind the patient is more suitable. The lying position is especially useful for massage of the shoulder muscles in cases of irritation of the shoulder-joint or its bursæ.

The muscles of the upper arm are treated in the sitting or lying position; the flexors separately from the triceps. Each of these muscle groups can be lifted up to a large extent from its base. In effleurage the thumb of each hand glides along the lateral, and the four fingers glide along the medial sulcus bicipitalis, while the whole of the hand is used to get a full grip on the lifted muscle tissue. Effleurage is best done with both hands alternating; the right hand strokes over the biceps and the left over the triceps from the elbow up to the shoulder. If one or both of these joints are affected, however, we use one hand to support the elbow and effleurage only one group at a time. The same applies to kneading, which usually can be done alternately. Care should be taken not to press the vessels and nerves against the bone.

The muscles of the forearm are divided into the flexors and extensors. For the effleurage of the flexor group the thumb glides along the edge of the radius and the four fingers along the ulna in the direction of the internal epicondyle, lifting the muscle tissue between them. For the extensor group with which the brachioradial muscle is connected, the thumb glides along the back of the ulna and the four fingers between the flexor and the brachioradial muscles (see Fig. 35).

For the kneading of the forearm alternate grasping and rolling is very useful, though we often use the millstone kneading between both hands, working gradually downward or upward.

Fig. 35.—Muscles of the right upper extremity; front view.

Effleurage of the interosseal muscles is done with the edge of the thumb gliding between the bones. The small thumb muscles and the fingers are best treated by friction that is preceded and followed by stroking. On the fingers stroking may be done over the whole of the finger passing over the interphalangeal joints, a procedure which, as we have stated, is not permissible over the large joints of the body. If, however, the finger-joints are affected, it is safer to do stroking over each phalanx separately.

Lower Extremity.—Effleurage and kneading of the gluteal muscles is done in the prone or half sideward position. For the effleurage the gluteus maximus is divided into two parts. The hand glides from its lower insertion on the thigh up toward the crest of the pelvis, taking at first the medial and then the lateral part. For the effleurage of the abductor muscles of the hip, the gluteus medius and minimus, the hand grasps the trochanter and glides up toward the crest of the ilium. Knuckle massage is very useful because of the thickness of the fascia.

For the massage of the thigh and leg it is best to have the patient supine with the knee somewhat flexed and supported by a firm roll; thus the muscles are best relaxed. The muscles of the thigh are divided into five groups or less, according to the circumference: the quadriceps in front, the tensor fasciæ latæ on the outer side; the adductor group on the inner side, and the hamstring muscles, which often must be divided in two groups.

The effleurage of the quadriceps (see Fig. 36) should begin, if no contraindication exists, below the knee, as the patellar tendon is really the tendon of this muscle. With the thumb on the outside and the four fingers on the inside, the hand glides gently over the patella without pressure, and strokes over the quadriceps up to the anterior superior spine of the ilium. It must be remembered that the vastus muscles, especially on the inner side, reach far down over the upper part of the knee-joint, and as these muscles atrophy first of all, they are easily neglected if the effleurage begins too high up, but on the other hand, one should consider that these muscles cover in part the upper recessus of the knee-joint, and with any inflammation existing great care should be taken. Effleurage of the tensor fasciæ latæ of the right leg is done with the left hand, beginning above the knee-joint; the thumb gliding on the lateral edge of the quadriceps, the four fingers on the lateral edge of the biceps, the hand pressing against the tensor fasciæ. Thus the stroking is continued up to the anterior spine, where the thumb and the four fingers meet. On account of the very strong fascia knuckle effleurage is especially suitable on the outer side of the thigh. Also kneading may well be

done with the knuckles. For effleurage of the adductors of the right thigh the thumb of the right hand glides on the

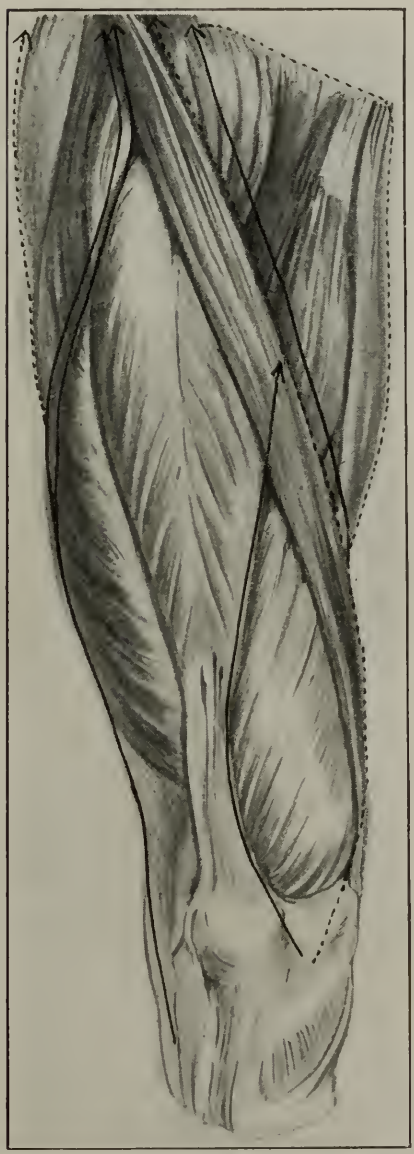


Fig. 36.—Muscles of the front of the right thigh.

medial edge of the quadriceps, the four fingers on the medial edge of the inner hamstrings up to the groin. The fingers lift up the muscles and the ball of the hand presses from behind.

Massage of the hamstring muscles is done with the patient lying prone, with a pillow under the foot, thus flexing the knee somewhat and relaxing the hamstrings (see Fig. 37).

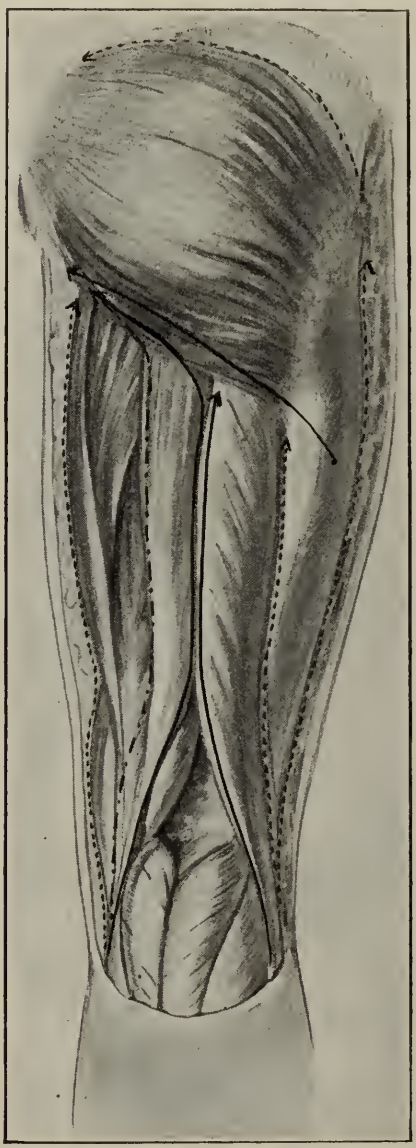


Fig. 37.—Muscles of the back of the right thigh and gluteal muscles.

The muscles of the lower leg should be divided into three or four groups: the anterior group, the peronei, which may be taken together with the anterior group, and the gastroc-

nemius and soleus, which are best divided into two parts. For the kneading the anterior and lateral groups may be taken in connection with the lateral half of the triceps.

Fig. 38.—Muscles of the right lower leg; seen from outside.

If they need special attention, as they frequently do, the kneading between the thumbs or knuckle kneading will be most useful (see Fig. 38).

Abdomen.—For abdominal massage the patient lies on the back with the knees somewhat flexed and supported by a pillow. The operator stands on the right side of the patient. It is wise to begin with very gentle movements because many patients are in the beginning rather sensitive and react with muscular spasm to any manipulations which are too strong or quick. We begin frequently with Mitchell's introductory massage: "The operator puts both hands under the patient until the fingers meet in the lumbar region, and draws the hands forward, compressing and lifting at the

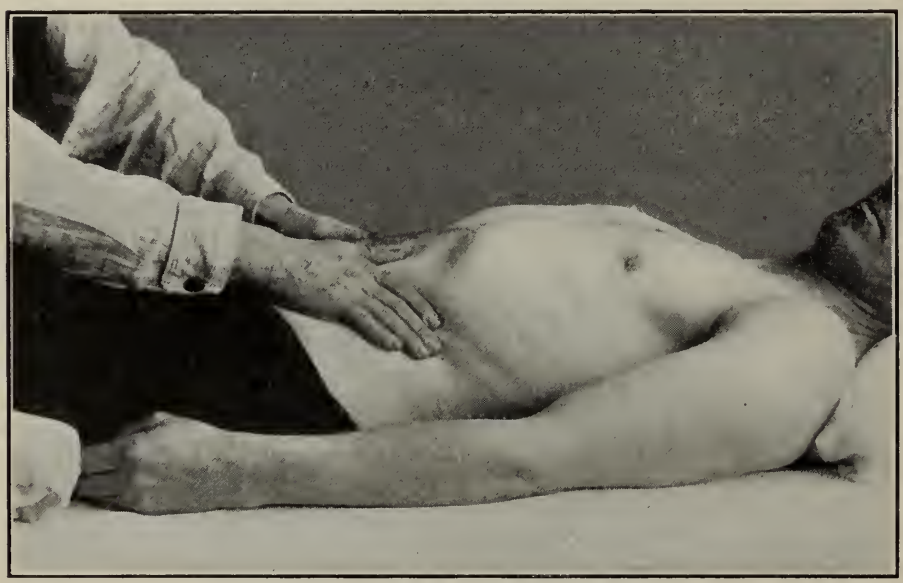


Fig. 39.—Effleurage of abdomen.

same time till they meet in the middle line of the abdomen" (Fig. 39). This movement is repeated several times and usually followed by a few gentle stroking manipulations over the flanks and the middle abdomen. Then kneading is done in a systematic manner over the whole of the abdomen, beginning at the right lower quadrant. This is done for the lateral parts by the left hand pushing and lifting the flanking muscles and viscera up and forward, while the right hand, especially the heel of the palm, describes kneading, rolling, and grinding movements. These manipulations are at first superficial, but become gradually deeper, until one hand can

distinctly feel the other through the abdominal wall when the patient is not too fat (Figs. 40 and 41). In spite of the

FIG. 40.—Kneading of abdomen.

FIG. 41.—Kneading of abdomen.

thoroughness they must be gentle and easy, never rough and quick. In the middle of the abdomen the kneading is done

by one hand, usually the left, pressing the tissues downward and toward the other side while the other hand performs the millstone-like movements just described. Thus both hands try, in a measure, to meet underneath the rectus muscles which are somewhat lifted up. We use the kneading manipulations frequently in connection with deep abdominal breathing. During inspiration the hands are placed on both sides of the rectus muscles and give a certain resistance to the abdominal wall which is somewhat protruded during inspiration. When at expiration the muscles are relaxed the

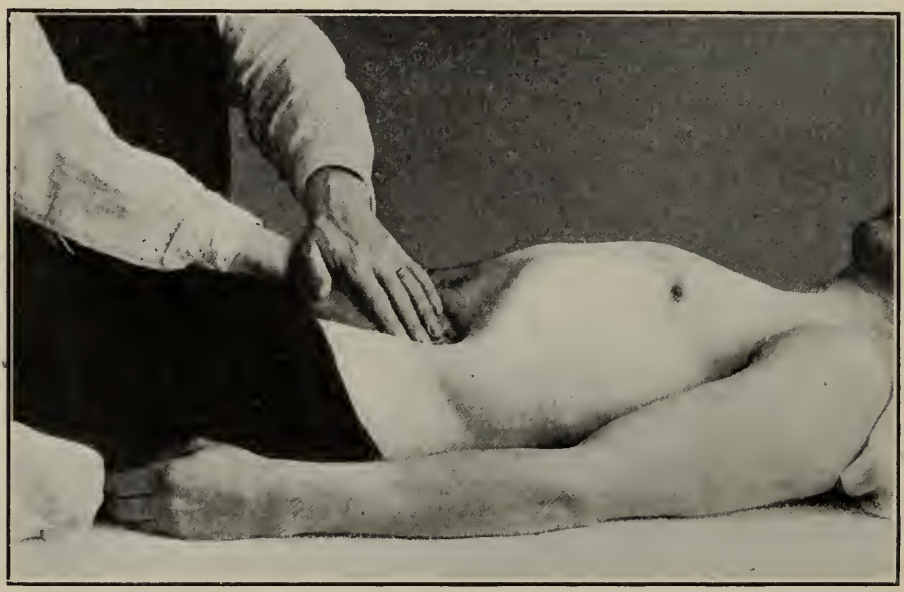


Fig. 42.—Friction of abdomen.

hands follow the sinking abdominal wall and perform a few vigorous and deep kneading and rolling manipulations. These movements are especially effective because the muscles are then well relaxed and allow very deep pressing of the abdominal wall into the cavity.

These kneading manipulations which represent the most thorough and efficient part of abdominal massage, are followed by friction in small circles which is usually done along the course of the colon in the following way: The operator presses the tips of the four extended fingers of the left hand upon the abdomen in the right lower quadrant;

the four fingers of the right hand are placed upon those of the left hand or *vice versa*, and both hands describe small circles of a diameter of about two inches, the left merely being used as a pad (Fig. 42). With each circle the hands are moved somewhat along the course of the colon until the whole procedure is finished over the flexure, then to be started over again. This manipulation should not be used unless the patient is able to relax the abdominal muscles sufficiently.

Tapotement, shaking and vibration may be added to the other manipulations. Tapotement is best done with the back side of the fingers which are somewhat flexed, as shown in Fig. 23.

For shaking, the right hand with the fingers spread out is placed over one side of the abdomen and by rapid rhythmical flexion and extension in the elbow with the wrist kept stiff the abdomen is shaken, one part treated after the other. Vibration of the celiac and splanchnic plexuses may be done with the fingers placed over the epigastrium pressing the abdominal wall way down toward the spine and making quick vibratory movements.

Colombo and others advise massage of the liver which is done by effleurage, kneading and vibratory manipulations underneath the right costal margin and by strong shaking over the lower ribs.

In cases with enteroptosis and marked atony of the abdominal wall massage is to a large extent applied to the muscles directly. Also here kneading between both hands is most effective.

Abdominal massage is generally combined with exercises, such as deep breathing, raising of the body from lying to sitting position, and others.

Massage of Joints, Tendon Sheaths, Bursæ, etc.—For rational massage of joints exact knowledge of their anatomical relation to the surface of the body is necessary. We begin with a thorough effleurage and kneading of the muscles which serve the joints to be treated and repeat these manipulations at the end. Effleurage and friction are most suitable for joint massage, only for the knee-joint regular kneading and rolling manipulations can be applied.

For massage of the *fingers, hand* and *wrist* the forearm is placed in the same manner as described for the resistive exercises. The operator holds the finger slightly flexed with his left hand and begins with effleurage of the whole finger. Then frictioning of the interphalangeal and the metacarpophalangeal joints follows. These joints are exposed on the back and the sides of the fingers. Friction is done with the points of the thumb and second finger of the right hand, or with the point of the right second finger against the second finger of the supporting left hand. Stroking over the back and the sides of these joints is freely mixed with friction.

For the tendon sheaths of the fingers friction is best done with the point of the right second finger against that of the left hand, thus working from one end to the other. The proximal ends of the flexor tendon sheaths which cannot be reached in this way are treated with friction by the tip of one or two fingers moving the soft tissues in small circles against the metacarpal bones as a base. Then the thumb and second finger grasp the soft tissues on the palmar side of the finger and move it from one side to the other and in small circles.

Friction over the tendons on the back of the hand is done by placing the points of the second and third fingers on either side of each tendon and moving the soft tissues up and down, sideward, and in small circles. Then the points of two or three fingers are placed on one side of the tendon and pressed against it until the tendon slips underneath the fingers to the other side, repeating this movement to and fro several times at a certain speed. Effleurage along the tendons is again freely mixed with friction.

The wrist-joints can be directly reached only near the styloid processes of radius and ulna. The points of thumb and second finger are placed on either side of the styloid processes of the radius, moving the soft tissues in small circles toward each other and the base, and likewise for the ulna. The carpometacarpal joint of the thumb can also be reached in that way, while massage of the other parts of the wrist-joint is more or less coincident with that of the

tendons and tendon sheaths, which is best done by friction in small circles. On both sides of the tendons of the long common extensor, however, the fingers will reach the joint structures quite well. In simple cases friction can be performed for the dorsal and palmar structures of the wrist simultaneously by grasping the joint between the thumb and two or three of the fingers, and moving the skin over it in small circles, sidewise, and up and down.

The *elbow-joint* is largely covered with muscles. The capsule comes near to the surface only on both sides of the olecranon and a short distance upward on both sides and underneath the triceps tendon; between the external epi-

Fig. 43.—Part of the outlines within which the elbow-joints can be most easily reached by massage.

condyle and the head of the radius as well as around the latter (Figs. 43 and 44). These are the points where massage of the joint structures is most effective, though a certain effect will also be obtained by friction through and with the muscles on both sides. Forward from the internal epicondyle the fingers come rather near to the joint, but massage on the flexor side should be done with special care on account of the large vessels and nerves. Also the posterior groove of the internal epicondyle should be handled with care to avoid injuring the ulnar nerve. In fractures and dislocations of the elbow I advise my assistants to be very cautious with massage because of the danger of overstimulating the newly formed callus and the injured periosteum (see p. 189).

Shoulder-joint and Its Bursæ.—The shoulder-joint proper can be reached only through other structures; the deltoid and other muscles and in most places the bursæ covering it, especially the subdeltoid bursa. In many lesions of the shoulder, however, these bursæ are more or less involved, and will need treatment together with the joint. They will be considered later. We approach the shoulder-joint from the front, from behind, and from the axilla. Only the upper part of the joint cannot be reached, as it is covered by the acromion. In the axilla we locate the joint by palpating

Fig. 44.—Thumb friction over the elbow.

along the inner margin of the scapula up to the glenoid process which is distinctly felt. Effleurage and friction are done in the usual way and need no special description. A form of massage which is very useful in fresh injuries is a kind of kneading between both hands whereby an excellent support is given to the joint and its neighboring structures. A great deal of pressure on the joint can thus be produced without pain or harm (see p. 171). In a similar manner pressing and kneading can be applied from underneath to the front or the back of the joint.

A word must be said about the position in which massage of the shoulder-joint can best be done. We prefer having the patient supine with the arm slightly abducted and elevated, the elbow resting on a pillow or on the operator's knee. Thus the muscles are fully relaxed and the fingers can push toward the joint more easily. The kneading between two hands can also be done with the patient sitting up. This position is more convenient with fresh injuries. By placing a small pillow between chest and arm a slight abduction is obtained which helps to relax the deltoid. The positions advised in the books of Hoffa and Boehm—placing the patient's arm behind his back for massage of the front of the joint, and placing his hand on the other shoulder for treating the posterior section—have in our opinion certain disadvantages: (1) Often just those patients who need this kind of massage cannot rotate the arm sufficiently to reach the positions indicated, or by an attempt to do so will strain and hurt the joint; (2) it seems to us that with such a twist the shoulder muscles must be considerably stiffened, thus interfering with the massage. We admit, however, that in those positions the parts of the capsule accessible to the massaging fingers may be somewhat enlarged.

The shoulder-joint is to a large degree, though varying in different subjects, surrounded by bursæ. We distinguish two or three of them on the average, which may all connect with each other: the subacromial, the subdeltoid, and the coracoid bursæ. The first two are usually in such wide connection that they appear as one. This bursa cannot be reached where it is situated underneath the acromion. The exposed portion is easily subjected to massage, especially through the broad and short aponeurosis of the deltoid. If abduction is at all possible in such cases friction over the bursa can be done most effectively in the lying position by having the patient's arm somewhat abducted and elevated. Thus the subdeltoid bursa will be slightly folded just below the acromion. The shoulder-joint is not accessible at this place, as we have seen.

Foot.—Massage of the toes and of the forefoot resembles that of the fingers and hand. Among the tarsal joints those on the inner side of the foot between the astragalus, scaphoid, first cuneiform and first metatarsal bones are most easily reached; on the outer side that between the os calcis and cuboid, and less freely that between the astragalus and os calcis. This latter joint can also be reached to some extent on the inner side and at its posterior aspect in front of the Achilles tendon. The ankle-joint proper is not very easily reached. We get nearest to it on both sides of the extensor tendons.

A knowledge of the tendon sheaths is of particular importance for foot massage. We differentiate three systems of tendons and tendon sheaths; one on the front of the ankle-joint for the anterior tibial and the long extensors of the toes underneath the crucial ligaments; one behind the internal malleolus for the posterior tibial and the long flexors; and one behind the external malleolus for the tendons of the peroneus longus and brevis. The tendon of the posterior tibial in many feet lies somewhat forward on the internal malleolus, crossing it obliquely. Massage manipulations, especially effleurage and friction may be employed by passing the fingers along the groove underneath and behind either malleolus; the effleurage is followed up toward the muscle tissues of the calf. It is wise to have the foot slightly dropped and the knee somewhat flexed in order to relax the muscles.

Knee.—The knee-joint is more exposed than the other large joints. It is near the surface on both sides of the patella and for a considerable distance above it, though here partially covered by the tendon of the quadriceps and the vastus muscles. It can also be easily reached on both sides of the leg between the condyles of the femur and the tibia back of the hamstring tendons. On both sides of the patellar tendon the plicæ alares and variable masses of fat are between the joint and the surface. Because of the large size of the joint and the ease in reaching it the methods of massage usually employed are somewhat different from those used with other joints. Here both

hands are usually employed in kneading manipulations, as in the large, fleshy parts of the thigh. We may grasp the joint from either side and move especially the parts on the side and above the patella, rolling with the heel of the hand toward the bone and toward the other side (Fig. 45); or while the hands press from the side forward, the thumbs make stroking manipulation upward; or the left hand presses the contents of the joint from the outer toward the inner side, where the right hand then performs stroking, kneading and frictioning manipulations; or the left hand grasps the knee

Fig. 45.—Kneading of the knee from both sides.

from the popliteal region and the right hand works in front with slight circular kneading, rolling and pressing manipulations; or one hand works from above and the other from below the patella (Fig. 46).

If there is stiffness of the patella or adhesions in the region of the knee a typical friction is added in all places where the joint is easily reached (Fig. 47). Lateral and up-and-down motions of the patella are done which may be connected with frictioning manipulations, using the patella itself as the part which is moved. The quadriceps extends far down over the upper recessus of the knee-joint, especially on the inner side, thus the manipulations of the knee-joint

will also be of benefit to these muscles which are more or less atrophied in all cases of injury or inflammation of the

FIG. 46.—Kneading of the knee from above and below.

FIG. 47.—Friction of the tissues on both sides of the patella and the capsule of the knee-joint on the outside. The outline shows the borders of the knee-joint.

joint. The effleurage is done with the thumb and thenar eminence of either hand, stroking from the head of the tibia near the patella toward the upper recessus in the quadriceps muscle. This can be done with both hands at the same time or with one hand at a time, using the other as a support for the patella and its tendon.

Here would be the place to mention an exercise which we consider in a way equivalent to a very effective massage manipulation, *i. e.*, the rhythmical contraction and relaxation of the quadriceps muscle. The contraction is done while the knee is in a straight position, in order that no part of the leg is moved except the knee cap, which is pulled tight. We make very free use of this "exercise-massage," which has the advantage that the patient can do it at home at regular intervals, and can do it even if his leg is splinted or placed in a plaster cast. We use this exercise following Hübscher's suggestions.

Hip.—The hip is so well covered that massage manipulations will hardly reach the joint itself with sufficient effect. The same is true for the sacro-iliac joints. The trochanteric bursa may become the subject of massage; it is reached over the surface of the trochanter and behind it in the retrotrochanteric fossa. For massage of this part it would seem wise to abduct the leg somewhat, in order to relax the fascia lata.

Nerves.—For massage of the nerves we must know those points where the nerve trunks or their branches can be pressed against a hard base, as bone or fascia, and places where the latter are perforated by nerves. Such places are the holes and grooves for the various branches of the fifth nerve, and for the occipital nerve behind the mastoid process. The median nerve can be reached all along the inner bicipital sulcus, and is followed along the forearm just underneath and radialward from the projecting tendon of the palmaris longus. The ulnar nerve is located along the inner bicipital sulcus whence it passes behind the internal epicondyle. The approach of the massaging finger to the radial nerve is more difficult, because it is deeply buried in soft tissue, although its nearness to the humerus

allows it to be pressed against it through the muscles. Lower down it comes nearest to the surface just behind the head of the radius. The sciatic nerve, which is of particular clinical importance, is found on the back of the thigh along a line slightly outward from the middle in the upper half, about underneath the biceps, and the lower part in the angle between the hamstring tendons. The peroneal nerve is easily reached behind the head of the fibula.

The type of massage must depend upon the case and will vary from a gentle stroke to a vigorous vibration combined with considerable pressure. There are not many cases in which the vibration is so serviceable as when applied right over nerves.

Massage of the nerve ends is practically identical with massage in general. We shall find further discussion in the chapter on Neurosis.

CHAPTER IX.[1]

PHYSIOLOGY OF MASSAGE.

The manifold obvious effects which massage produces on many structures and organs of the body, and under many physiological and pathological conditions, has called forth eager search by physiologists and clinical men for a theoretical illumination of the therapeutic experiences. Thus we find in the medical literature, especially that of the old world, a great number of physiological experiments referring to the effect of mechanical stimulation by the various manipulations of massage. In the study of a therapeutic method which, from a simply technical point of view, can easily be learned by anybody, and which is perhaps more often exploited by incompetent persons than any other branch of medical therapy, a thorough discussion of the experimental research and the clinical observations would seem necessary in order to learn the possibilities as well as the limitations of the method and to understand its scientific value.

As massage consists of a number of different manipulations it is obvious that a difference exists as to the physiological effect of each of these manipulations. We have therefore added to the technical description of every manipulation a brief paragraph containing its chief physiological effects, which in this chapter will find further and more complete description. We differentiate in the following between the local or direct and the general or indirect or dynamic effect of massage.

LOCAL OR DIRECT EFFECT OF MASSAGE.

Skin.—The skin serves primarily as a protective covering of the body against mechanical, chemical, and thermal

[1] For this chapter the book of Carl Rosenthal (Die Massage und ihre wissenschaftliche Begründung, Berlin, 1910) has been freely used.

injuries by its epidermis aided by the secretion of the sebaceous and sweat glands as well as by the hair. It also secures a small part of the respiration, and it carries sensory nerve endings. Finally it is capable of absorption, though to a small extent. The most striking effects upon the skin are obtained by those manipulations by which movements are done over the skin, such as rubbing, stroking, and tapping. By rubbing and stroking the hand produces a cleaning effect in that the superficial layers of the epidermis as well as a part of the greasy deposit are removed. Thus the openings of the sebaceous glands are freed and their secretion is favored; this latter effect is further increased by the direct stimulation of the glandular epithelium and by the improved circulation.

The use of alcohol or alcoholic solutions, as well as soap, will naturally favor these effects. Also the function of the sweat glands will be stimulated and the respiratory and absorptive function of the skin improved. The striking influence of manipulations upon the skin is particularly noticeable in treating a limb which has been splinted or bandaged for a considerable time, where the function of the integument has materially suffered.

The skin becomes warmer by the rubbing manipulation. Rosenthal found an average increase in temperature of 2.2° C. by stroking; of 3.25° C. by vibration, and 0.8° C. by kneading and tapotement. Neurasthenic persons showed under similar conditions a higher increase of the temperature of the skin; women showed higher temperatures than men. These differences are explained by Rosenthal by the fact that the whole nervous system, and thus the vasomotor nerves, are more easily stimulated in women than in men, as also in neurasthenics than in normal individuals. These observations show that the increase of the temperature is not only to be explained by the simple direct mechanical effects, but by indirect vasomotor action as well. Experiments on the bloodless arm, however, have shown that the mechanical effect is of much greater importance than the vasomotor action.

Calorimetric measurements have shown that the arm

which is treated with effleurage for five minutes produces considerable heat; the temperature of the arm in the apparatus rose about 2° C. A strong massage applied to the abdomen while one arm is put into the calorimeter lowered the temperature about 0.3° C.

The effect of massage upon the sensory nerves of the skin will be discussed under the heading Nervous System.

Fat.—The general dynamic effect of massage upon fat tissue will be discussed below. The local, direct effect is much discussed by writers on massage and still more by practitioners. One can frequently hear the statement of experienced masseurs that massage is able to reduce the panniculus adiposus of the abdomen. Kleen[1] compares this result with the well-known and not disputed absorption of inflammatory products or hematoma, and Banting, Oertel, Voit, and others have recommended massage for the treatment of adipositas. To decide whether such clinical observations could be explained by local effects, or should not better be interpreted as the dynamic result of massage, frequently in addition to other simultaneous therapeutic applications, such as exercise, diet, etc., Rosenthal has made a series of experiments on animals in order to study the local effect of massage on fat tissue. He applied various massage manipulations upon a circumscript part of the abdominal wall and made a series of microscopic slides of those parts and of remote sections for comparison. In no case did the microscopic examination show any visible change of the fat tissue, though the massage had been vigorous enough to cause frequent small hemorrhages, especially within the muscle tissue and skin, and laceration of the sebaceous glands. It seemed as if the fat by its elasticity and mobility had escaped the pressing and rubbing finger. Rosenthal's experiments evidently suggest a stricter criticism of the explanation of removal of fat tissue by the local effect of massage, whereas its general effect upon adipose persons seems to be undisputed.

Muscle.—The effect of massage upon the muscle has been made the object of frequent studies, though many experi-

[1] Handbuch der Massage, Leipzig, George Thieme.

ments are of a rather primitive and not very conclusive nature. Such experiments have been made by Zabludowski, Brandis, Ruge and others. The experiments were made on man or on muscles of frogs. Most observers found that the muscle fatigued by work or by the electric current will be restored much quicker and much more thoroughly by massage than by rest of the same duration. The difference is often very striking, *e. g.*, while the amount of muscle power after a five minutes' rest was increased to only 20 per cent.; after a five minutes' massage the increase was as much as 100 per cent. or even more.

The curve of contraction as taken by the myograph, which has been decreased in height and increased in length after a certain amount of work, will be restored to the proportions shown at the beginning of the experiment. A muscle, after it has been brought to a state of tetanus by a certain amount of work or by electrical stimulation, needs, when it has rested, much less stimulation to induce a renewed tetanus than a normal muscle. However, when after the tetanus such a muscle is treated with massage a much greater amount of stimulation is necessary to induce tetanus again; in fact, an amount about as great as at the outset.

Men who have served for such experiments unanimously testify to the refreshing influence of massage on muscles tired by work.

In his experiments, Zabludowski has found that massage seemed to decrease the electrical irritability of the muscle. Rosenthal, surprised by this strange result, made a series of experiments on men, rabbits, and frogs, and proved conclusively that the opposite is true, that the electrical irritability of the muscle which had been considerably reduced by electrical tetanus was again increased by massage, while rest of the same duration did not show any effect or rather led to a further decrease. To eliminate as far as possible any disturbance from psychological causes, some of these experiments were made on hypnotized persons.

Mosso and Maggiora[1] made experiments on men with the

[1] Ueber die Gesetze der Ermüdung, Arch. f. Anat. u. Physiol, 1890.

ergograph and the ponometer, which, on the whole, proved the same facts. Of particular interest is the following experiment of Maggiora: The flexor muscles of the middle finger were to lift a certain weight so and so many times until fatigue took place. After fifteen minutes of rest the finger had to repeat the test and accomplished a similar result. After another period of rest of fifteen minutes, however, the actual work accomplished was greatly reduced. If, however, instead of simple rest, massage of fifteen minutes was applied to the working muscles, the first amount of work could be repeated not less than eight times. After that fatigue took place very rapidly.

Another series of experiments was made on a person fatigued by hunger. It was found that such a person could do a much greater amount of work after massage of the working muscles than without such a preparation.

These experimental results are in full accordance with frequent clinical observations that convalescent persons fatigued by disease and recumbency feel much refreshed and strengthened by proper massage.

Another question was decided by these experiments, namely, what form of massage manipulations would show the best result. Effleurage, kneading, and tapotement were tried, each singly and in proper combinations. The greatest effect was obtained by a mixed massage, while single kneading gave a better result than any of the other manipulations alone.

When we seek the explanation of such experimental and clinical observations, we must consider the theories of the fatigue condition of the muscles. It is generally believed that in consequence of the metabolism of the working muscle products of fatigue result, the most important of which are carbonic acid and lactic acid. That those products have, indeed, a strong influence upon the muscle has been proven conclusively by experiments. It is, however, possible that a direct influence is exerted upon the structure of the muscle fiber by the mechanical stimulation (Ruge[1]). Furthermore, Mosso and others believe that fatigue is a reaction of the

[1] Zur physiologischen Begründung der Massagewirkung beim Kalt- und Warmblüter, Deutsche Medizinal Zeitung, 1904, No. 59.

central nervous organ, and compare the sensation of fatigue with the sensation of hunger.

The first-mentioned theory seems to be in accordance with most of the observations cited concerning the effect of massage on the fatigued muscle. As we shall learn in the following chapter, massage exerts a striking influence upon the circulation, and it would be a very plain and simple explanation to consider that the products of fatigue collected within the muscle by its work are eliminated and brought to quick absorption by massage. This assumption is supported particularly by the experiments of Ruge on fatigued muscles. He found that the circulated muscle reacts quite differently from the muscle deprived of its circulation. While the former showed the described effect of massage, the latter showed the contrary; it did not gain in strength by massage, but rather seemed to lose still more.

It cannot be denied, however, that part of the influence of massage on the fatigued muscle may be explained by the direct manipulation of the muscle fiber, because, as Rosenthal points out, it is particularly the kneading manipulation which has the greatest effect upon the muscle, while in comparison the stroking manipulation exerts a greater effect upon the circulation.

Finally the nervous element should not be entirely omitted. As we have mentioned before, the experiments made for the study of this interesting question have not led to a consensus of opinion. Brandis,[1] who worked on men, while recording the refreshing effect of massage on the tired muscle, could not state the influence upon the actual increase of working ability except in one of his cases, that of a student of medicine who was familiar with the idea of the experiment. Brandis himself is inclined to explain his negative results by the theory of a nervous reaction, while Rosenthal is of the opinion that a different arrangement of Brandis' experiments may account for his failure to prove the results obtained by most other observers.

Our personal experiences are in accord with these many

[1] Ueber die Ursachen der Muskelermüdung, Ztschr. f. orthop. Chirurgie, 1894, Band iii, S. 366.

clinical observations and physiological experiments. We agree with Graham[1] when he says that "Muscles give a much more ready, vigorous, and agreeable response to work, and to the faradic and galvanic currents, after massage than they do before, especially if they are somewhat deficient in contractility." We may therefore conclude that massage lessens irritability, but increases power of action.

As we shall see in the special part, massage of the muscles is very generally used and recommended for any condition leading to atrophy or relaxation of these structures, such as in cases of injury, arthritis, and many more. In accordance with those experiments we usually begin the treatment, *e. g.*, of a stiff knee-joint, with a thorough kneading and stroking of the thigh muscles, and use the same manipulation repeatedly when the muscles have been fatigued by the exercises, because, as we have learned, massage is the best substitute for rest.

Blood- and Lymph Vessels.—The effect of massage on the vessels is manifold and can be observed with the naked eye. In stroking over the forearm in the centripetal direction one notices that the veins are emptied for a short time, the blood being pushed centrally, not only within the main veins, but also in the smaller branches. The veins by their elastic walls and by the power from behind are quickly filled again, and repeated stroking will therefore hasten the circulation in the massaged part as well as in the whole extremity. The same effect, though not visible to the eye, takes place within the deeper veins and the lymphatic vessels, as experiments of Lassar and others have demonstrated. A similar effect is obtained by kneading, pressing and other manipulations, because the valves of the veins allow the blood to flow toward the heart only.

Another noticeable effect is the reddening of the skin. This is due to the dilatation of the smaller arteries, an effect which takes place not only on the surface, but through the whole massaged part, according to the depth of the manipulation and the force applied. The skin also becomes warmer,

[1] Treatise on Massage, p. 85.

an effect which, as we have seen, is only in part due to the stimulated circulation.

That even the volume of the massaged extremity is increased has been shown by experiments of Zabludowski and Rosenthal. Zabludowski made experiments with the plethysmograph, where he could show that the volume of the arm was increased by massage of the other arm or of one leg.

Rosenthal, in discussing Zabludowski's experiments, makes the criticism that the psychological moment has been neglected, because we know from the research of Lehmann and Weber that psychological influences have a distinct effect on the circulation, as seen by volumetric measurements. Thus to exclude those aberrations, Rosenthal made his experiments on hypnotized persons. On account of the importance of these facts Rosenthal's experiments will be cited in detail.

A person was to work with the flexors of the forearm until the muscles were thoroughly tired. Then the arm was put in the plethysmograph and the person was hypnotized. The record taken showed that the curve, which was much higher than without the work, fell after a short while rather rapidly and considerably. Then the experiment was repeated, but with the addition of effleurage to the arm after it had been tired by work. Now the curve of volume remained for a much longer time at the previous level, later falling but slowly, indicating that the fulness of the arm, due to the work, persisted for a much longer period with the assistance of massage than without it.

These facts are interesting in connection with the influence of massage of the tired muscle which relieves the sensation of fatigue and makes the muscle actually stronger again, an observation explained by the elimination of the products of fatigue.

The volumetric experiments show that both massage and exercise cause hyperemia. Doubtless the hyperemia, which is due to the exercise, acts protecting against the effect of the products of fatigue, but will not quite suffice, because of the continuous addition of such products; whereas massage

in maintaining the hyperemia, but without further production of fatiguing materials, can easily exert its eliminating, refreshing, and restoring influence.

Rosenthal, in addition, raises the question whether the hyperemia of exercise might not have a more passive character, while that of massage might be more of an active nature; whether with the former the speed of the circulation is rather decreased, while with the latter an increase may take place. This assumption seems to us rather doubtful, as we know that exercise stimulates the circulation and accelerates the blood stream. But as we have seen before, the explanation of the refreshing influence of massage on the tired muscle by the elimination of the products of fatigue is not the only one possible.

Experiments showing the effect of massage on the speed of the blood stream, have been made by Pick on defibrinized dogs. He was able to show that effleurage of the leg increased the speed of the blood stream in the femoral vein and further in the mesenteric veins, while that in the jugular vein was diminished. Tapotement and kneading had a similar effect, and with even a longer duration after the end of the manipulation.

Besides those effects of massage which are merely of a mechanical nature, in that the blood is pushed along the path of least resistance, we have further to consider the influence on the nerves and muscles of the vessels. When we scratch slightly over the back we see, with different intensity on different individuals, at first a lighter color, which is soon followed by a reddish tinge, the latter lasting for a considerable period. This phenomenon is explained by the mechanical stimulation of the vasomotor nerves. As everywhere, muscle and nerve action are balanced; in the vessels we distinguish the vasoconstrictor and the vasodilator systems, the former being the stronger ones in analogy to the difference of flexor and extensor muscles. Considering the aforesaid phenomenon, the lightening of the skin is explained by the stimulation of the vasoconstrictors, while the following reddening may be due to a relaxation of these or to a stimulation of the vasodilators. One dis-

tinguishes, therefore, a double kind of hyperemia. In spite of much research work, a great deal of which has been done in order to explain the effects of hydrotherapy and other physical therapeutics, knowledge of these complex conditions is rather limited, and we must in general be satisfied with the fact that the mechanical stimulation of the vasomotor nerves plays a prominent role in the explanation of the well-known and undisputed effect of massage on the circulation.

In intimate connection with the effect of massage on the circulation stands that upon absorption, which is undoubtedly one of the most prominent effects of this method. Many interesting experiments have been made to prove and explain this action of massage, which is so well-known to every masseur. Von Mosengeil[1] injected insoluble Chinese ink into knee-joints of rabbits. Some of these joints were treated with massage, others were left alone for control. In the former infiltration and swelling caused by the injection disappeared rapidly; in the latter very slowly. After a certain time the animals were killed and the joints opened. The joints which had been massaged were found empty; the others still showed a considerable amount of the injected ink. Dissection of the muscles, lymphatic ducts and glands lying centrally from the joint revealed the presence of the ink, whereas in the other legs no traces were found outside of the joint. In Chapter XI, p. 143, we have described the same absorbing effect of massage in cases of hemarthrosis.

Reibmayr and Höfinger have made experiments to study the effect of massage upon the absorption of fluids in the peritoneal cavity. It was demonstrated that this effect is very considerable, and that it is most marked during the first hour after the application of massage. Kellgren and Colombo in many experiments proved that mainly the lymphatic vessels, but also the veins, are responsible for the absorption. Massage distributes the injected fluid over a larger area and presses it into the various layers and lymph

[1] Archiv f. klin. Chir., xix, 1876.

vessels. Moreover, the increased pressure caused by the injected fluid and considerably increased by massage leads to a marked difference in pressure outside and inside of the small veins, which are in addition widened. These deductions suggest that pétrissage and friction must have the greatest effect, which is constantly proved in practice.

The value of these and many other experiments consists in the explanation of the effect of massage on the absorption of hematoma and inflammatory products which will be discussed later on. (See p. 143.)

Heart.—Numerous clinical observations made by Ling, Zander, Hasebroek, Lewis, and others have shown that certain massage manipulations, especially tapotement and vibration, have a very distinct effect upon the action of the heart in that the rate of the pulse will be reduced all the more when it was above normal before. We have often seen cases where the pulse dropped from 100 to 90 by the application of Zander's vibratory apparatus applied for two or three minutes on the back between the scapulæ or over the thorax in front. Kneading and effleurage of the back may cause a similar effect. Whether this effect is caused by a stimulation of the vagus or of the heart muscle and its ganglia, or by a benumbing effect upon the sympathic fibers, is not known; the first seems the most probable, however. Oertel's so-called massage of the heart by interrupted expiration will be discussed on p. 411. In this connection the influence of massage upon the heart in cases of chloroform asphyxia may be mentioned. A number of cases have been reported where this method has been employed either upon the heart directly, which had been freely exposed, or from the peritoneal cavity through the diaphragm. Success has been noted in several cases, though in the majority massage has failed.

Blood. — Experiments and clinical observation of J. Mitchell, Kleen, Ekgren, Rosenthal and others have shown that the number of red and white corpuscles as well as the amount of hemoglobin may be increased by massage. Rosenthal, who made exact countings of white corpuscles, noted that effleurage for five minutes caused an increase of

about 85 per cent.; kneading, 30 per cent.; vibration, 60 per cent.; and tapotement, 45 per cent. Twenty minutes after the massage the number was considerably reduced again, and had become almost normal when tapotement and vibration had been applied. Rosenthal explains these findings by the effect on the circulation. Massage causes a change in the distribution of the corpuscles, many of which are more or less adherent to the walls of the vessels under ordinary conditions, and are pushed into the blood stream by the manipulations.

Nervous System.—The reaction of the nerve upon mechanical stimulation, such as exerted by massage, does not lead to any change of the nerve itself as far as can be determined by macroscopic or microscopic examination. Hence we depend on the reaction of the sensory, motor, vasomotor, and secretory functions.

The effect which can be produced by massage on the sensory qualities of the skin must differ greatly according to the kind of manipulation, the strength of the mechanical stimulation, and its duration. Those differences are still greater under pathological conditions. It is obvious that stroking or other manipulations by which the hand moves over the skin of the patient must act quite differently from those whereby the operator's hand works in close connection with the skin on the deeper parts, and again from those classified under the headings, tapotement and vibration. Furthermore, everybody knows that a strong pressure or a violent rubbing causes pain, whereas it is one of the commonest experiences of everyone giving massage that by a gentle use of such manipulations an agreeable and soothing effect can be obtained and even existing pain can be relieved in frequent cases.

It is also often noticeable that a manipulation which at the beginning causes pain, when sufficiently long continued acts with benumbing and relieving effect. It would therefore seem rather difficult if not impossible to analyze the physiological effects of massage upon the sensory nerves, as so many conditions widely different must be considered. Hence we shall limit ourselves to the report of a few experi-

ments and important observations. In various chapters of the special part these interesting problems will find further consideration.

Mosengeil, in order to study the effect of mechanical stimulation upon the sensory nerves of the skin on his own body, had both his knees massaged for a certain time. Then massage was continued on the right knee only and again after some time the left knee was manipulated. He noticed that the initial pain caused by the strong massage gradually lessened under the treatment, while the left knee when massage was freshly started was just as sensitive as at the onset.

Zabludowski has shown that massage or any other mechanical stimulation when applied with sufficient vigor and for a certain length of time reduces the electrical irritability of the sensory nerves of the skin.

In a similar way, by measuring the effect of massage upon the sense of localization with the esthesiometer, Rosenthal found that after a few minutes of manipulations the stimulus threshold was markedly raised while the sharpness of that sense was much impaired for about ten minutes.

The results obtained in measuring the effect of massage on the sensation of pain by similar experiments were entirely different in that the stimulus threshold was considerably lowered. The explanation of these results may be found in the hyperemia of the skin which is produced by massage. This would be in agreement with the experiments of Schmotin, who proved that the cutaneous sense is often increased by hyperemia, decreased by anemia.

We can, however, stimulate sensory nerves not only at their terminations, but also along the nerve itself, particularly at points where the nerve runs near a bone or at the exit of a bone channel. Such places are the well-known points of the trigeminus and occipital nerves where they leave the bones of the face and skull; the ulnar nerve passing over the inner condyle of the humerus; the sciatic nerve at the so-called notch, etc. Pressure, such as exerted by vibratory massage on such points at first causes pain, which, if the stimulation is continued, will gradually diminish.

On this phenomenon is based the well-known effect of massage in certain cases of neuralgia.

A moderate mechanical stimulation of a motor nerve will lead to a contraction of its muscle. If, however, the stimulation is very vigorous, it may cause a decrease of the irritability of the stimulated nerve. Rosenthal emphasizes the fact that the mechanical stimulation of a motor nerve often causes contraction of the muscle, even when the electrical irritability is greatly reduced. The motor as well as the sensory nerve becomes fatigued by mechanical stimulation of sufficient duration and intensity. Thus we notice sometimes that spasmodic contraction of muscles can be relieved by persistent pressure upon their nerves. The well-known fact of the frequent relief of diaphragmatic cramps by a pressure upon the phrenic nerves or by tension of the cervical fascia may find its explanation in this way.

That the effect of massage upon the sensory and perhaps also on the motor nerves is not only of a local character, but that the central nervous system also can be thus affected, is certain from frequent clinical experiences, particularly in the treatment of neurasthenia with its endless variety of symptoms, although a definite explanation is extremely difficult. A more detailed consideration of these conditions will be found in the chapter on neuroses.

The effect of massage on the vasomotor nerves has been considered in a previous paragraph, while that on the secretory nerves will be discussed in the chapter treating of the influence of massage on the digestive system. Generally it may be said at this place that massage causes an increase of secretion of glands. Whether this is due to the simultaneous hyperemia, the stimulation of the secretory nerve fibers, or the stimulation of the glandular epithelium directly cannot be decided; probably all three factors enter.

GENERAL OR DYNAMIC EFFECTS OF MASSAGE.

In the following we shall discuss the effect of massage on the metabolism (nitrogen-metabolism, diuresis, assimilation

of food, etc.), the general circulation (blood-pressure, pulse) and the respiration.

A great many experiments have been made to study the effect of massage upon the nitrogen-metabolism. The most exact and valuable are those of Bendix. This author experimented with a man, a woman and a child who were brought to the nitrogen balance. Examinations were made of the daily amount of urine and the excretion of nitrogen. Bendix was able to verify the results of other observers in that both the amount of urine and of nitrogen were increased during the period of massage and for two to five days afterward. The increase in this excretion begins a few days after the onset of the massage. Experimenting on the child Bendix measured also the amount of nitrogen and fat in the feces and found that the amount of nitrogen remained the same, while that of fat was considerably decreased.

These facts are most easily explained by the influence of massage on the circulation. By massage the fluid of the tissues, particularly of the muscles, is pressed into the capillaries and lymphatic vessels. The difference of pressure thus obtained causes fresh tissue-juice and blood to fill the emptied spaces. Thus fresh food is furnished and waste products are eliminated. These slacks are carried along partly by the blood and partly by the lymph stream. The latter way may account for the after-effect lasting at times several days, though there is another explanation possible, as Rosenthal points out. We have seen that this author in studying the effect of massage on the fat tissue observed by microscopic examination a number of minor hemorrhages and damage done to muscle fibers and other tissues. It would seem possible that part of the waste products might come from this source, in which case the after-effect would also be well explained.

Diuresis.—Regarding the effect of massage on diuresis, the results of various observers have not been quite constant. Of greatest importance for this question are the experiments of Bum. This author made his studies on curarized dogs; the urine was collected from the ureters directly, and its amount and velocity exactly measured. Massage of the

hindlegs caused a considerable increase of the excretion of urine even after ligature of the abdominal aorta just above its division into the common iliac arteries. But that increase was immediately stopped after the ligature of the vena cava, either alone or together with the ligature of the abdominal aorta. Even the dissecting of the vena cava from its surrounding sheath and the accompanying lymph vessels had the same effect. Further experiments showed that massage of the tetanized muscles of the dog had a still more marked effect on the excretion of urine than massage of the muscles in rest. Similar experiments have been made by Le Marinel with identical results.

Studies of this question have also been made on men by Bendix, Bum, and others, which have led to the same result. The explanation of this phenomenon follows with all probability along the line of that of the increase of nitrogen-metabolism by massage. The stated changes of the circulation, the elimination of waste products with its consequent increase of urea, and probably nervous influences are said to account for the increase of the amount of urine.

Absorption and Assimilation of Food.—In spite of contradictory results we are forced to conclude from the exact experiments of Pawlow that mechanical irritation of the mucosa of the stomach does not lead to secretion.

Pawlow experimented on dogs with both a gastric and an esophageal fistula, the latter to prevent saliva from flowing into the stomach. Before the beginning of the experiment the stomach was thoroughly washed with water until the sour reaction was entirely eliminated. Then the mucosa of the stomach was irritated by a quill and a glass rod for thirty minutes, but not a drop of gastric juice was obtained. Then in order to demonstrate that this was not due to an affection of the stomach the animals were fed. Although the food did not enter the stomach itself, but was thrown out again through the esophageal fistula, a considerable amount of normal gastric juice was soon obtained from the gastric fistula. This effect was not noticed, however, when the right vagus had been cut below the cardiac branches and the inferior laryngeal nerve.

We are therefore not permitted to assume a direct influence of massage on the secretion of the stomach. An indirect influence by way of the vagus is nevertheless possible, though difficult to prove. Colombo's experiments perhaps point in that direction. That the vagus has a definite connection with the secretion of the stomach is proved also by Pawlow's experiments.

The effect of massage on the intestines is undoubted. Frequent experiments show that the excretion of feces can be much favored by abdominal massage. The explanation of this undisputed fact is not difficult. It is possible to push the feces along in the colon by proper manipulations, but this factor is hardly of much importance. Of much greater value is generally considered to be the influence upon the peristalsis, though exact experimental proof is still lacking that mechanical stimulation is able to cause an actual peristaltic movement. At least Nothnagel, experimenting on rabbits in the salt bath, saw only ring-shaped contractions of the intestine with mechanical stimulation, but not real peristaltic movements. Discussing these experiments Rosenthal raises the question whether such ring-shaped contractions alone might cause a locomotion of the intestinal contents in the colon. Undoubtedly the improvement of the circulation which is invariably caused by massage leads to better nutrition of the intestines.

Blood-pressure.—All observers who have made experiments in order to study the effect of massage on the blood-pressure have found that under similar conditions massage of the extremities raises and massage of the abdomen lowers the blood-pressure for a shorter or longer period. Colombo, experimenting on several men, has studied the effect of various manipulations after having previously recorded average data on several days during exactly the same hours. He found the greatest effect of longest duration by deep kneading and by vigorous tapotement. While with effleurage the rise was only 8 mm. and lasted not longer than half an hour, by kneading the rise was on the average 45 mm. and by tapotement over 55 mm., and lasted for two hours; with mixed muscle massage the rise was 50 mm. and lasted for

two and a half hours. On the other hand, vigorous abdominal massage caused a decrease of the blood-pressure of 10 mm., lasting for one and a half hours.

The explanation of these observations is given by considering two facts: (1) The influence which massage exerts on the vasomotor function; (2) the law of the vasomotor balance. It is certain that strong massage causes an increase of the tonus of the vasoconstrictor muscles. This will lead to an increased tension of the vessels; hence the rise of the blood-pressure. François, Frank, and others have observed a constant interchangeable relation between the tonus of the peripheral and the visceral vascular systems, in that the one strives to compensate any marked change of the other. It requires, however, a certain lapse of time before such compensation is completed, during which time the rise or fall of the blood-pressure may be noted.

The rise of the pulse and the blood-pressure stand in an inverse relation; a rise of the blood-pressure is usually accompanied by a fall of the pulse, and *vice versa*. Hence the effect of massage on the pulse is in general opposite to that on the blood-pressure, though here the results of various observers have not been quite as unanimous as in observations on the blood-pressure. Again, the respiratory rate shows a response to massage similar to that of the pulse rate.

To be sure, these results have been obtained under physiological conditions. In pathological cases conditions are much more complicated, and the results may differ a great deal from those just mentioned. We shall come back to this point in the special part; here it may be said merely that massage frequently exerts a regulating influence upon pulse and blood-pressure, in that abnormal variations may be remedied to a certain extent and for a certain length of time.

CHAPTER X.

EXERCISE AND MASSAGE: THEIR RELATION TO EACH OTHER AND TO OTHER PHYSICAL THERAPEUTIC METHODS.

The relations of exercise and massage find frequent consideration in the special part of this book, and will here be discussed only in a more general and theoretical way. The study of the physiological effects of exercise and massage has shown them to be similar in many ways. We have seen that each method accelerates and aids the circulation, favors the absorptive functions, stimulates or irritates the nervous apparatus according to its application, and shows a similar influence upon the general and local metabolism, the digestion, and the secretory and excretory function of various organs. Nevertheless, there are many ways in which exercise and massage differ in their effects and in which they compensate each other. We have described in detail how the muscle which has been fatigued by work can be restored to renewed activity much more speedily and thoroughly by massage than by simple rest of the same duration. In practice we make constant use of this experience in applying massage in the intervals between exercise; this is done in manual treatment as well as in the application of Zander's apparatus. Here usually two or three apparatus for active and active-passive movements are followed by one for massage manipulations.

In the restoration of normal function to motor structures, such as joints, muscles, and tendons, exercise holds undoubtedly the most prominent place, but there are many cases and in a given case there are certain stages, where movements are prohibited, whereas massage, correctly applied, serves as an excellent means of stimulating the circulation and absorption so much needed for the recovery of the tissues and the prevention of permanent stiffness.

A definite superiority of massage over exercise is also

seen in the earlier stages of convalescence in cases of pronounced debility. At a time when the patient is still to remain in bed and when any exercise would easily overtax his strength, gentle general massage can often do wonders. The vitalizing and stimulating effect of stroking and kneading over a large part of the muscles, well dosed and carefully managed with frequent observation of the speed and quality of the pulse is often striking to the patient and the physician.

Max Walter, to whom we owe a number of valuable contributions on these subjects, comments on the compensatory value of massage for overworked muscle function in the following words: "What comes to pass when these natural functions lag; when, for cause, they are reduced to a state of suspension, or morbid action amounting to downright abeyance? What of these morbid states where exercise cannot longer act as a hygienic law, and where for the lack of its normal physical results the patient finds himself on the downward path to dissolution?"

"Here, now, where active exercise is no longer operative, massage comes forward and offers to do its work. Name it, if you please, a mere substitute, and we are more or less content: for what greater amount of praise can be bestowed upon any therapeutic agent than that it is capable of filling the place and doing the work of a regular law of nature?"

Again, in the treatment of paralyses where exercise is of such eminent importance it is often impossible on account of complete loss of muscle power. Hence the physiological functions of the circulation and nutrition are more or less interfered with and we know of no better means of applying proper stimulation than massage. This, on the other hand, is frequently so much overvalued that the right time for starting developmental exercise is passed. Everywhere, as here, it will depend on the judgment of the physician to apply exercise or massage or both in proper combination according to their value and to the needs of the individual case.

In the practice of our clinic, and probably of most others, the application of hot air, electric light, and similar agents is most intimately connected with the use of massage and

exercise. In a large percentage of our cases the treatment of stiff joints or paralyzed limbs is begun with baking of fifteen to thirty minutes at a temperature of nearly 200° F. In our experience there is not much if any difference between the effect of hot air produced by a gas or alcohol flame or an electric heater, and that of the direct radiant heat and light by electric lamps. We use preferably the latter, and have constructed a few simple apparatus for most parts of the body. For use in the patient's home complicated and expensive apparatus can well be dismissed, and the simple application of steamed towels or, if there is electric current in the house, an electric pad will serve almost as well. An excellent means, moreover, to produce hyperemia is the sand-bath. Sand is heated in the oven and placed in a tub about the part to be treated for an hour or so. On clear, warm days the direct application of sunlight is perhaps the best and certainly the cheapest method for baking. The effect of such heating is a considerable stimulation of the circulation with all its beneficial effects, as to absorption, lessening of pain and softening of tissues. Massage and baking are closely related as to these effects, though it rather seems to us as if the influence of baking is somewhat more of a passive nature, while the mechanical stimulation which massage produces has a more active character. At any rate the mixed use of both is of great benefit in practice, though it should not be overlooked that both methods are stimulating and that an overstimulation may easily be produced by neglect of careful dosage. An apparatus for combination of heat and massage has been invented by Goldscheider. This consists of a metal roller filled with hot water. The roller is fitted with a handle by which it is rolled over the tissues. We have had no personal experience with this apparatus, but should at least protest against its name: "thermomassage." This is not massage or only a very poor substitute, as are almost all so-called massage apparatus with the exception of some for vibration, percussion, and hacking.

Apparatus for combination of hot air and pendulum exercise have been constructed by Becker, who claims excellent results from them. Without doubting these claims, we

believe that most such apparatus represent merely interesting technical inventions but will hardly find general recognition and application.

In the chapter on Arthritis we have mentioned the use of Bier's passive or congestive hyperemia, and have stated that in certain cases of acute arthritis excellent results can be obtained with this method which prepares the field for the exercise treatment by reducing pain and inflammation. We feel that this method, which requires no difficult technic and very simple apparatus, should be more frequently used with painful joints, although from personal experience we advise that it be done only by a person who is thoroughly familiar with the method and entirely reliable, as great harm can be done from wrong application.

Electrotherapy is coming much more into use with the cheaper manufacture of electrical apparatus. As the technic in the use of this apparatus is usually very easy, requiring no such careful and long training as is necessary for massage and exercise, many physicians and non-physicians use electrical methods, especially faradic and galvanic batteries and high-frequency apparatus. Undoubtedly these methods can give excellent results when they are correctly used in the proper case, but the number of cases suffering from paralyses, from so-called neuritis or neuralgia, from pain due to arthritis or bursitis that had been treated with high frequency or other electrical methods without results and were then sent for massage or baking "in order to try something else" is very large in our clinic. All these methods have their peculiar physiological effects and their very definite indications, and should rank too high to be played one against the other.

Hydrotherapy is not so much in danger of being misapplied because it requires a large apparatus and trained assistants. Without going into details we may merely state that hydrotherapeutic applications serve often very well in complementing the stimulative effects of massage, both local and general. We frequently mix these treatments, for instance in cases of chronic arthritis, convalescence, obesity, and others, where we give on alternating days hydrotherapy and massage and exercise.

Before we close this chapter we would like to say a word about presenting massage and exercise or other physical therapeutics against drug treatment. We do not wish to be identified with such ideas, and feel that the trained physician should become sufficiently familiar with all recognized methods of treatment to apply or at least prescribe them when necessary. To fill the patient with endless streams of medicine, neglecting thereby the natural resources such as lie in the patient's nerves and muscles, is just as much quackery as to pretend to heal everything with any one physical method. Specialization in such therapeutics involves a certain danger; it often allows a man to forget the limitations of his specialty and to apply the treatment, not because it is the best thing for the patient, but because it is the best thing for the doctor. Just as that surgeon is the best who makes the best diagnosis and uses the best judgment before and during operation, so we must require of anyone carrying out massage and exercise treatment that he have sufficient physiological and pathological understanding, thorough knowledge of the anatomy, and a sane judgment of the proper indications.

From the report of patients who have been treated by osteopaths, from the demonstration of osteopaths, and from the reading of some books we have gained the impression that the important part of osteopathy is more or less identical with those methods of massage and medico-gymnastics which are taught in Swedish and many other schools. The claim in books and oral expressions that osteopathic treatment in its essential technic is something entirely different does not seem to be justified, at least as far as we can judge. A considerable part of osteopathic treatment seems to consist in manipulations on the spine or its parts. These manipulations are done on the assumption that vertebræ are displaced, thus causing irritative symptoms from the pressure of nerves. While we admit that a displacement of one or more vertebræ may take place under certain conditions, we believe, however, that such occurrence will always cause very definite and more or less grave symptoms, and that it is not so common as claimed.

SPECIAL PART.

CHAPTER XI.

PREVENTION AND TREATMENT OF STIFFNESS OF JOINTS.

Injuries, infections, paralyses, and other affections frequently lead to stiffness of joints, ranging from a slight limitation in motion up to a complete ankylosis. The question of preventing such stiffness and of restoring good function of the joints is almost identical with the treatment of those conditions in general and cannot be considered in detail in this work.

But it seems to us to be one of the most important problems of a book like this to consider briefly the functional principles in the treatment of injuries and other affections which often result in limitation of mobility. We shall discuss these principles in a number of chapters; here we shall outline only in a general way what can be done to prevent stiffness or at least reduce it to the least amount possible, and when stiffness has resulted, state how it should best be treated.

Beginning with a theoretical discussion of the physiological and pathological factors underlying the process of stiffening our attention is chiefly called to the following problems:

1. The absorption of hematoma.
2. The stimulation of the circulation.
3. The absorption and the prevention of organization of inflammatory products.
4. The retraction of muscles, tendon sheaths, capsules, etc.
5. The protective muscle spasm.

The Absorption of Hematoma.—A more or less profuse hemorrhage is an almost constant incident of injuries, such as contusions, sprains, dislocations, and fractures. The ability of the body to dispose of a hematoma varies with the location; it will usually be quickly absorbed within the subcutaneous tissue and much more slowly within joint cavities. A large hematoma will need relatively more time for its absorption than a small one.

From experiments and clinical experience we know that extravasations of blood will be much more quickly absorbed when the affected limb is allowed a certain amount of function than when it is kept at rest, and that the absorption can further be considerably hastened by physical stimulation such as massage, hot air, and certain electrical and hydrotherapeutic applications, etc. The speed with which the absorption is hastened by these methods varies according to the beginning of the treatment. Fresh extravasations often disappear completely in a very short time, whereas when the treatment is begun after a period of immobilization their absorption will take a much longer time. We have treated cases of contusion of the knee-joint with a large hemarthrosis where by massage and a very cautious functional stimulation by passive and active exercise almost all of the bloody extravasate was eliminated from the joint cavity in a surprisingly short time. The path which the absorbed blood takes can be distinctly followed with the eye, for the skin along the large vessels on the front of the thigh and over the lymphatic glands in the groin will soon show the characteristic discoloration. The phenomenon is rarely seen when the leg has been kept quiet for some time.

It is true that compression by elastic bandages or splints causes a similar effect, and we make use of both whenever it is indicated. But in many regions of the body such elastic compression has only a very incomplete effect; besides, it often interferes greatly with the circulation and nutrition of the tissues thus treated. In a large number of cases with Colles' fracture which were sent to us for after-care, three or more weeks after the injury, the following was seen: The forearm and hand which had been compressed

between two wooden splints in order to keep the fragments in place were considerably flattened in a palmar-dorsal diameter, while the lateral tissues were markedly swollen and often showed the characteristic discoloration of the skin. A glance at such an arm makes it evident that the treatment must have done considerable damage without accomplishing all of its intended results. It is particularly the muscle fiber, a very highly organized structure, which suffers so much from the interference of its nutrition, so that with higher degrees of compression a rapid waste and degeneration may take place, as studies of the pathology of Volkmann's contracture show. Less markedly developed stages of this affection occur much oftener than is generally realized, as frequent experience in our clinic has convinced us. Every one who has seen the astonishingly rapid absorption of even considerable hematoma by massage will be convinced that this method is a most valuable adjunct to the surgical treatment of injuries as we shall later describe in detail.

The possible objection that hematoma is a valuable stimulant for the knitting of the fragments of lacerated tissues in general, which it doubtless is, may simply be met by pointing to the fact that even with a very thorough absorption of the hematoma there would be left an abundance of material of plastic value, all the more as in such early cases the massage would, as a rule, not attack the point of injury directly, but only its neighborhood and the more distant parts. Causing fresh hemorrhage by the massage would hardly be any point of objection for the same reasons that in the beginning we do not touch the primary focus of injury. Furthermore, the amount of force which is needed for the early absorption should not be so strong as to tear tissues or reopen broken and just loosely occluded vessels. As elsewhere, a great deal depends upon the correct technic.

The Stimulation of the Circulation.—Any injury of a certain severity is followed by a noticeable disturbance of the circulation, particularly in the venous and lymphatic vessels. Fixation frequently increases this disturbance to a very marked extent. (The same is true for many inflammatory conditions, paralyses, and others.) The pathognomonic

significance of this circulatory disturbance has been the subject of interesting theories. While many observers consider it as a noxious sign which needs remedy, others claim that it is merely a symptom of physiological necessity. Bier, in advocating his method of congestive hyperemia, has maintained this latter opinion from a somewhat teleological point of view. He emphasizes that in inflammatory conditions the venous blood stream is reduced in speed and that this represents an effort of nature to accomplish such problems as fighting the infection, knitting the bones, absorbing the hematoma, etc. It would seem that from such a standpoint massage or other means used to accelerate the blood stream would interfere with nature's work.

In direct contrast to this idea stands the opinion of many surgeons who apply certain methods to combat the circulatory changes in inflammatory conditions. Massage has for a long time held a prominent place among such methods. It is especially recommended by Reibmayr and others as the so-called introductory massage, *i. e.*, the application of massage upon the parts proximal to the inflamed area. As we know, however, that massage increases the speed of the venous blood and the lymphatic fluid we see that diametrically opposite methods are recommended under those conditions.

But after all experience is often a better guide than theory, and besides it is still a question, in my opinion at least, in what the beneficial effect of Bier's so-called passive or obstructive hyperemia consists. Furthermore, even if we consider that the reduced speed of the venous and lymphatic flow is in its aim a beneficial and not a noxious symptom which we should not counteract, we may have good reason to suppose that such effort of nature is often overdone as we see under other conditions, such as the abundance of callus in certain fractures. Massage will hardly do away entirely with the natural reactions; perhaps it merely restores a beneficial state of conditions and thus its truly excellent effects in a great number of cases may be explained.

The Absorption and the Prevention of Organization of Inflammatory Products.—When we want to understand in

what way any measure is able to prevent stiffness of joints, we must be sure about the pathological process that is going on in or about a diseased joint. In a work like this a detailed discussion of such a subject would pass beyond its limits. Therefore a few remarks must suffice.

A joint may become limited in motion by causes from within or from without, or both. An acute inflammation of the synovia leads to exudation within the joint cavity as well as between the layers of the synovia and more or less the whole capsule. While during the acute stage rest is generally indicated in order to avoid irritation, functional stimulation is required to favor the absorption of the residual products after the source of inflammation has been removed. In many cases a natural use of the affected parts will suffice to produce the amount of functional stimulation required. But very often this will not be sufficient, either because the amount of inflammatory products has been too large, or because the anatomical condition will render the natural resistances too great, as we often see in affections of the shoulder, the lumbosacral regions, and other parts; or because the patient does not possess that amount of energy necessary to make proper use of his affected limb. In such cases a proper application of exercise and massage treatment is a very rational procedure to ensure a good result and avoid permanent stiffness. Experiments of v. Mosengeil, Reibmayr, Castex, Colombo, and others, give the explanation for the frequent clinical experience that under the influence of massage both liquid and solid inflammatory exudates will be reduced or even disappear entirely. This change takes place by an actual metamorphosis of the cellular and fibrinous substances, followed by the process of absorption. The pressing and tearing manipulations, such as kneading and especially friction, loosen the cells still more from their already loose connection with the surrounding tissues, thus hastening their fatty degeneration and decay. At the same time the lymphatic vessels are emptied and their absorbing power is facilitated. Therefore the danger of organization of the inflammatory products and waste matters is greatly reduced.

In practice it is often very difficult to determine at what time such active treatment may be begun without doing harm. But in our experience such danger is not very great if the treatment by massage and exercise is carried on with sufficient understanding of the individual case; in fact, there seems to be a much greater danger in waiting too long until a great deal of fibrous scar tissue is formed and the stiffening process is much advanced. By coöperation with the surgical department of our hospital, massage and exercise treatment has been started in many cases of even severe local sepsis, at a time when the wounds were still freely discharging, and we remember no case where permanent harm has been done; though sometimes a slight exacerbation has necessitated a temporary interruption of the active treatment.

Retraction of Tissues.—A very frequent cause of stiffness is the retraction of muscles, tendon sheaths, capsules, etc. In traumatic affections, especially in fractures and dislocations the retraction of tissues plays a greater role than the formation of adhesions. Under physiological conditions the muscle is extended to a certain length which varies according to the various positions of the bones moved. When the power of extension is eliminated, as for instance in a fracture, the muscle follows its natural impulse of "elastic retractability." Its ends tend to pull together and will do so until the fragments are reduced. Moreover, the injury to the soft tissues which takes place in fractures, sprains, bruises, etc., will tend to an inflammatory reaction which often results in marked changes: Degeneration and atrophy of muscle fibers, thickening and hardening of the connective tissue, retraction of the perimysium, tendon sheath, ligaments, capsular parts, etc. The retraction of these tissues is often connected with adhesions and may become so severe that its stretching is impossible. Attempts to stretch retracted tissues have often led to tearing and even fractures of the adjacent bones.

All means to hasten the absorption of hematoma, crushed tissue cells and inflammatory products will also combat the retraction of soft tissues. Among these means massage and

exercise rank very high, as we shall see further in this and the following chapters.

The Protective Muscle Spasm.—Many of our sensory nerves work in a rather quiet and subconscious manner under normal conditions. When inflammation takes place they awaken, not to annoy us, as it might seem, but to protect us. Pain sets in as a sign that something is wrong and must be righted. The irritation of the deeper sensory nerves sets that complex reflex mechanism to work which is to protect the inflamed region. Again, a great deal of this work is done below the threshold of consciousness. Not only "we" hold the inflamed joint stiff, but this stiffness results to a considerable extent from a muscle contraction which is not entirely subject to our will-power. Such protective muscle contraction is the more pronounced the more complex the muscular supply and nervous regulations. Thus we find it comparatively rarely in the elbow, with its few muscle groups, while it is quite common in the shoulder with its complicated muscle systems. While to all purposes and intentions this muscle spasm is a most helpful and wise arrangement of nature, we see very often that nature overdoes, just as happens in other reactive processes. Then the spastic contraction of the muscle may persist after the inflammation has subsided and not rarely does harm seem to result from such persistance. In these cases a great benefit can be derived from a cautious application of massage and movements, and the danger of formation of adhesions and permanent retraction may thus be averted.

In addition to these theoretical considerations a few practical points must be discussed in the problem of preventing stiffness.

THE NECESSITY AND TIME OF FIXATION.

Any splint, plaster cast, brace or like appliance interferes with the natural function of the fixed part, and will therefore cause a certain amount of danger; in that immobilization, necessary as it may be, reduces more or less the circulation and nutrition, interferes with the absorbing power, favors

atrophy and retraction of the muscles and other tissues, and facilitates organization of inflammatory products. Immobilization may not necessarily cause stiffness of joints, but it certainly favors those causes which lead to it. It should therefore be well considered in every case whether the advantage expected from the splint or cast is great enough to compensate these unavoidable dangers. Moreover, when immobilization is found necessary the treatment should be directed in such a way as to minimize as much as possible its dangers. This can be done by shortening the time of fixation to the least possible period, and by appropriate application of massage, and especially exercise, during the time of immobilization as will be seen in various chapters.

While the duration of fixation doubtless plays a certain role in the formation of stiffness, it should not be overestimated. After injuries, operations on tendons or joints, and many inflammatory affections, the question of fixation is most important during the first two or three weeks, both in regard to its beneficial as well as its noxious influence. Observations on a great many cases which were sent to the medico-mechanical department from other departments of the hospital and from outside have convinced us that in many affections, especially fractures, it does not make a very great difference whether the joints had been fixed for three or six weeks. Hence we have come to the conclusion that wherever lasting harm was done, aside from such produced by the affection itself, it was done during the earlier stages, when the greatest demands were made on the absorbing process. If this is true it would logically follow that all appliances which secure the necessary amount of fixation, but at the same time do not completely interfere with the functional stimulation must be preferable to those which hold the affected limb in perfect fixation. It is a matter of choice and individual indication whether this is done by the use of traction or the temporary application of movements while using a splint or split plaster cast.

When we say that the factor of time in the application of fixation is often overestimated, we do not intend by any means to advocate that senseless, long-uninterrupted use

of casts or splints such as we see so often in various kinds of affections. A young or middle-aged man with an uncomplicated Colles's fracture should be ready for the use of his hand about six weeks after the injury. Then what is the sense in splinting such a wrist for six weeks, as we frequently see it done, without allowing the tissues that amount of functional stimulation which they need so much? The longest time of fixation on our record for a Colles's fracture was fifteen weeks.

Still more irrational would a very long fixation seem to us in cases such as paralyses where a tendon transplantation has been done. The transplanted muscle is necessarily much weakened by the operation, and demands a proper amount of functional stimulation as soon as this can be done without disturbing the process of healing. Furthermore, the tendon of the transplanted muscle has been pulled for a long distance through tissue which is thus torn and stretched. The normal action of the tendon in its new course must depend on the formation of something like a tendon sheath. Such a structure will not be formed, however, unless by sufficient amount of functional stimulation. If this is not given a firm scar will form around the transplanted tendon, and where the muscle is not allowed to move for a considerable period all hope will vanish that it ever will regain any function. I have seen at least six cases of tendon transplantation where the foot had been fixed for three months and even longer without any chance for the transplanted muscle to contract. The result was always as would be expected, that the tendon was found firmly fixed within the perforated tissues, and the muscle never showed any function. We cannot deny that even so a definite improvement of the function can be obtained, but the real aim of the operation is to utilize the transplanted muscle as an active power and not simply as a ligament.

These examples may suffice at this place to demonstrate the importance of the time of fixation in the production of stiffness. In other chapters we shall learn more about this very important and far-reaching subject.

FUNCTIONAL CARE AFTER OPERATIONS ON JOINTS AND TENDONS.

The problem of restoration of function has been very carefully studied in recent years in the orthopedic department of the Massachusetts General Hospital under the direction of Dr. E. G. Brackett. Our tendency is to reduce the time of immobilization wherever such is necessary to the lowest minimum, and to apply functional stimulation to the operated limb as early as possible and as much as it seems wise to do. In the following we shall cite a number of examples to show in what way these principles are carried out in the practice of our orthopedic ward.

In a case of simple arthrotomy of the knee-joint, as for instance for the removal of a torn or displaced semilunar cartilage, simple passive-active motion may be done immediately after the operation; active use of the muscles is allowed ten days later. Weight-bearing is allowed after three weeks, and a plaster cast which is applied after one week is worn for two or three weeks. Of course, when there has been any inflammation or disease of the joint present this functional management may have to be done more slowly.

In cases where an arthrotomy of the knee-joint is done by a longitudinal incision (splitting of the patella into two halves and opening the whole joint from the upper recessus down to the insertion of the patellar tendon) the after-care is managed in the following way: The leg is placed on a hamsplint for three or four days, then a few slow careful passive-active motions are done by the patient alone at an angle of about 10 degrees, increasing the angle within the next four days up to about 20 degrees. At the end of the third week the patient is allowed to move the knee with his own muscles. After one week a removable plaster cast is applied and the patient allowed to be up in a wheel-chair; after ten days the patient is allowed to get up on crutches without weight-bearing; after one month with weight-bearing, the plaster still in place; and after two months the plaster is removed. In the meantime motion at least no worse than before the operation is restored.

In cases where an arthroplasty has been done in order to restore function to an ankylosed joint the functional after-care is just as important as the operation itself. The following case is chosen to describe in detail how such after-care may be managed.

The patient, a woman, aged twenty-seven years, had had a severe puerperal sepsis in March, 1914, which had led to a pyogenic infection of the right knee and right shoulder. After the acute symptoms had subsided a very severe treatment had been given to loosen up the knee-joint which had become stiff. Not less than nine times had forcible manipulations under an anesthetic been performed. Then for six months, three times a week, forcible attempts to mobilize the knee had been made. When I saw the patient the first time, in March, 1915, the knee was almost entirely stiff, allowing not more than one or two degrees of motion. The *x*-ray picture showed severe changes of the structure of the joint and further attempts of conservative treatment were advised against. About one year later the patient returned with the definite request to mobilize the joint, which was ankylosed in an angle of 50 degrees. The *x*-ray now showed a solid bony ankylosis.

On January 31, 1916, I performed an arthroplasty, excising a bony wedge, removing large parts of the cicatrized capsule and grafting a large flap of fascia and fat taken from the other thigh between the femur, tibia and patella. The leg was placed on a hamsplint under traction applied to the lower leg. One week later exercise treatment was begun in the following way: At first I had the patient perform gentle contractions of the quadriceps which had been preserved in very good condition owing to the patient's constant efforts to regain motion. I also lifted the joint up a few times to an angle of 10 or 15 degrees. These exercises were repeated at first once, later twice a day, with slowly increasing angle. About ten to twelve days later very cautious active exercises were added as follows: The knee was lifted up from the splint about four or five inches—this motion was at that time done with active coöperation of the patient—a sand-bag was placed under the knee and the heel slowly

raised, at first with very slight, later with increasing coöperation of the quadriceps, so that after another week the patient was able to raise the heel and extend the knee alone. Gradually the angle of motion was increased. Then the knee was placed on the edge of the bed, the lower leg projecting over the edge, supported by the operator's hand. In this position active flexion with resistance and active extension with and soon without assistance were done. Six weeks after the operation the patient was discharged with a split plaster cast and advised to do these exercises regularly three times a day for fifteen to twenty minutes. The angle of motion was at that time 50 degrees and increased within another month to 55 degrees. The patient, at the time of her discharge from the hospital, had full active control of the motion to the same extent as passive motion was possible. A certain amount of lateral mobility which was due to the excision of the capsule including the lateral ligaments has still persisted and will require another plastic operation, which was foreseen from the beginning.

In regard to the functional care of sutured tendons similar extremes are found in practice as in the treatment of fractured bones; beginning with the motions immediately after operation represents the one extreme, fixation for many weeks the other. The practice of most surgeons who send their cases for after-treatment to the medico-mechanical department inclines toward the latter extreme, and thus we frequently see such cases with the tendons, tendon sheaths and skin glued together and wherever near to a bone, as in the back of the hand, firmly attached to it; with joints near and even distant to the point of injury involved, stiff and contracted. Many of such cases have needed a very long treatment before they have fairly well recovered.

The following case illustrates this extremely conservative tendency very well:

A young man, aged about twenty-five years, had cut the second and third extensor tendons of the left hand one inch upward from the metacarpophalangeal joints four weeks before. The wound and the tendons were sutured at a hospital, and the whole arm with the hand and fingers was bandaged

tightly on a splint. The wound did not heal by first intention, but was now perfectly solid. Two days before he came to me the patient, while changing the dressing, was struck by the marked stiffness of his fingers, and called on another surgeon for advice. This surgeon sent him to me for functional care. The patient notified the surgeon who had first treated him, and was strongly warned against any attempts of motion before at least two weeks more had elapsed. In spite of this warning the patient submitted to treatment and full motion was returned to his hand within five weeks. The treatment which consisted in massage and active motion was carried on for two weeks and then left to the patient to do by himself.

Since I have developed the functional methods discussed in this book, I have never had a chance to treat a case of tendon suture, but I am sure I would not wait four to six weeks before I started functional treatment. While perhaps the first-mentioned extreme, to begin with movements on the day of the operation, involves a certain danger for the conditions of the wound, which, as a matter of course, cannot always be expected to heal primarily, there seems to be no reason not to begin functional after-treatment at the end of the first week. Thus individualization will be required to meet the demands in different cases, but experience shows that with proper technic a certain amount of motion can be allowed directly from the beginning.

Dupuytren's Contracture.—In cases of Dupuytren's contracture the conservative method by stretching and exercise is, as a rule, not effective. We have tried it in a few cases with and without injections of fibrolysin, but have almost always finally recommended operation. Our experience has shown that the after-treatment in such operated cases is very important for a speedy and thorough functional recovery. A number of these patients who had been operated upon were sent to the medico-mechanical department four or five weeks after the operation and no efforts toward functional recovery had been made in the meantime. The hands of such patients were at times as rigid as a septic hand and the problem which was thus imposed

on the masseur was almost unsurmountable. Therefore in a few cases which I have operated upon myself, I have begun functional after-treatment a few days following the operation. The result obtained has been so satisfactory that I will describe one of these cases in detail.

The patient was a man of middle age, with contracture of the palmar aponeurosis over the flexor tendons of the fourth finger, due to an injury several years previously. The fourth finger was drawn into the palm nearly to the extreme, thus hindering the hand a great deal. A few weeks of conservative treatment consisting in stretching did not show any improvement; therefore under local anesthesia I dissected the fibrous scar of the aponeurosis until the finger could be fully extended. Before closing the skin I had the patient flex and extend all his fingers actively. The hand was bandaged to a splint and after three days light active motions were begun. The splint was worn for two weeks, at first being removed daily for exercise; then it was left off for a few days, but as there seemed to be a tendency of the tissues to retract a small splint was strapped on, holding the fingers in slight hyperextension. This splint was worn two weeks, but was removed daily for exercise. Now, two years later, the hand is practically normal, with just a slight limitation of hyperextension of the fourth finger.

Two years afterward I operated on the right fifth finger of the same patient for contracture of the palmar aponeurosis over the first phalanx and the two neighboring joints. The finger was flexed about half-way. After dissecting the scar tissue no splint was applied, and gentle active motions a few times during the day were prescribed, with the result that the patient has now a perfectly straight finger with complete motion.

This case has convinced me that it is perfectly possible to begin with the functional after-care very early without doing any harm, although I admit that the individual demands may vary in different cases.

TREATMENT OF STIFFNESS OF JOINTS.

The treatment of stiffness of joints is in a large measure based on the same principles as the prevention of that complication of intra- and extra-articular affections. Therefore what has been said above about the circulation, the absorption of hematoma, the organization of inflammatory products, the retraction of muscles and other tissues, etc., will have to be taken into account also in the discussion of the treatment of joint stiffness itself, and does not need further discussion.

A joint may become stiff from causes within or without, or both, and treatment as well as prognosis will to a very large degree depend on the actual changes which have taken place. The exact establishment of these changes is sometimes a very difficult problem, even with the use of the *x*-ray, and the question of the patient whether his stiff joint will ever become movable again, to what extent and when, is likely to bring the surgeon into a considerable dilemma. In many cases we refuse to give any definite answer until closer observation has been made during the treatment. As a matter of course we exclude all cases of true bony ankylosis. Furthermore, in those cases where a bony obstacle limits the motion in one or more directions we do not attempt to gain mobility by conservative methods beyond the limits set by the altered shape of the joint. In the great majority of cases, however, the stiffness is produced by adhesions and retraction of tissues, and it depends largely on the character of these whether exercise and massage will be able to overcome the obstacles, or whether surgical intervention will be necessary, unless the nature of the affection, social or other causes make it seem desirable to give the patient the advice to be satisfied with a stiff joint when the extremity is otherwise serviceable. Very often the first treatments which have a somewhat diagnostic value will enable us to decide whether the case is hopeless or not. In a great many cases the joint appears at the first examination entirely stiff, or allows motion only within a few degrees; when, however, a few resistive movements have been made, when massage and hot air

have been applied, the amount of mobility is often surprisingly increased. We have frequently seen joints which at the first examination showed perhaps 25 degrees of motion, while at the end of the first treatment the mobility increased to about 40 degrees or even more. Especially striking is such rapid improvement during the first treatment in stiff shoulders. We have several times seen cases with a nearly complete stiffness of the humeroscapular joint in all directions which showed after the first treatment, sometimes after the application of hot air alone, 40 to 50 degrees of rotation and corresponding mobility in the other directions.

Such rapid improvement is not to be explained by any breaking up of adhesions or stretching of retracted tissues, but simply by a relaxation of the muscles which had been in a state of spastic contraction caused by the irritation of the stiffened joint. That this explanation is correct is suggested by another fact. It is significant that, as a rule, such joints are lame and painful. They are in an irritated condition which is obviously maintained by the violent constant contraction of the muscles. This is a very important point in regard to the indications for treatment, as I have sometimes noticed that surgeons kept such joints for a considerable time at rest, instead of applying such simple and entirely rational procedures as hot air, massage and gentle resistive exercise, which, if done correctly, will as a rule not increase, but quite on the contrary will diminish, the state of persistent irritability.

The gain of motion, so rapidly developed in these cases is usually lost almost entirely on the following day. We always tell the patient who rejoices at such unexpected improvement, that the joint will be about as stiff tomorrow as today, but we expect even a greater improvement the next time and a steady additional gain.

After a few treatments we shall now better recognize the border-line between the amount of stiffness caused by muscular contraction and that due to actual changes of the joint, or its neighboring tissues, such as adhesions, inflammatory retraction, etc. Before we discuss the important role of exercise and massage in the treatment of actual stiff-

ness, in the loosening and stretching of adhesions and retractions, we have to say a few words on the technic of the treatment of that apparent stiffness which is due to muscular contraction. The first rule should be: Avoid all so-called passive motions. This important principle is not at all sufficiently acknowledged, as I see from the prescription blanks which many of our patients bring from their surgeons. On these blanks is often found the rather typical inscription: "passive motion." This is, however, just the form of movement with which we should not begin the treatment, for two reasons: (1) in such joints we cannot easily produce passive motion, because the patients are not able to relax their muscles in a way necessary to speak of a "passive" motion; (2) when, however, we overcome the muscular spasm by forcible stretching, we are liable to increase the existing irritation and make things almost always worse instead of better.

The only rational way of movement in such cases is the resistive exercise, for reasons which have been explained in the second chapter. There we have said that one of the beneficial effects of resistive exercise consists in the fact that we can exclude one or more muscle groups by letting the antagonists act. Furthermore, we have referred to the opinion of Bum who believes that by resistive exercise the intra-articular pressure can be considerably reduced. This reduction of pressure must be of great value in cases where by a persistent spastic contraction of all muscle groups attached to an affected joint an enormous intra-articular pressure has been produced.

Furthermore, the treatment should not last too long for the first few times. To the careful observer the right moment to stop the exercise will be given by a slight increase of the spasm—often before it is noticeable to the patient. When we neglect this sign it may happen that the irritation which was relieved by the treatment is stirred up again and the patient will leave the operator with a joint more painful than it was when he came for treatment. The same is true for massage, hot air, or any other similar application. It is a grave mistake to believe that in such cases the effect of the treatment depends on the time for

which it is applied. Several times I have seen the following: The assistant in charge of an irritable stiff joint had somewhat overdosed the treatment; the patient returning on the following day complained of pain, the nature of which was not correctly understood. More baking and massage was given and more exercise again beyond the proper amount. When, after several days, the pain did not stop but rather increased, I was asked to see the patient. My advice has always been, let the joint alone for a few days and then begin with short and gentle treatments on alternating days, until the irritation has sufficiently subsided to allow a more vigorous and more frequent treatment.

We come now to speak of the treatment of the actual stiffness of joints by exercise and massage, including what is generally called the forcible manipulations.

We have already mentioned that cases of bony ankylosis and such with bony obstacles should be excluded from these considerations. Moreover, we shall not consider those where a contra-indication is given by the pathological process, such as tuberculous joints. Thus we have mainly to deal with stiffness caused by adhesions inside or outside of the joint, by inflammatory changes, or by retraction of tissue. It depends on the nature of the pathological process which of the changes are most prevalent. As a rule in traumatic cases retractive changes are more prevalent, in infectious cases adhesions, thickening of the capsule, etc.

Adhesions are found in great variety, beginning from slight veils of fibrinous deposits up to the formation of thick and tough fibrous scar-like tissue. The more advanced the stage of the adhesions is and the thicker the new-formed fibrous tissue has developed, the more dubious will be the prognosis. The same is true for the swelling of the capsule. Those cases where we find a very hard capsule which is not movable over the bone give usually a very bad prognosis and when, besides, the *x*-ray picture shows a considerable loss of cartilage they should be excluded from the treatment. Here we have to do with such far-reaching pathological alterations of all the joint structures that it is almost always beyond any conservative form of treatment to restore joint motion. In

some of these cases satisfactory results may still be obtained by an operation.

In a very large number of cases, however, the adhesions can be stretched by appropriate exercise and massage. This is the proper field for friction. The fingers have to work all over the joint; they must try to penetrate into the corners, to squeeze and press any infiltrated areas, and lift up the tissues in wrinkles. Special attention must be paid to scars, which should be loosened and mobilized by friction. The fresher the scar is the quicker will be the result. Strong effleurage over the joint must follow the friction and deep kneading and effleurage of the muscles of the whole extremity should be added. It is wise to have the massage preceded by application of active or passive hyperemia with the hot-air apparatus or the rubber bandage. After a thorough massage exercise is used, in the form of the combination of resistive, assistive and passive movements. We use the active exercise even in those cases where no joint motion is possible, and use the passive movements only as subsidiary to resistive and assistive exercise. As we have described the technic of these movements we shall in this chapter merely point out briefly how we combine the various movements with benefit in stiff joints. As an example let us use a stiff elbow, whose excursion is considerably limited by an old inflammatory process, say perhaps to 20 or 30 degrees. The patient is sitting with his affected side at a narrow table on which he firmly places his upper arm from the shoulder to the elbow (Fig. 3). The operator stands on the other side of the table and makes at first a few light active motions with the forearm at the elbow in order to know the amount of free motion and, what is more important, to become familiar with the reaction of the muscles. These motions should be done slowly, as are all exercises used for the relief of stiffness. Then the simply active movement is gradually transformed into a resistive exercise until a considerable resistance is given, the amount of which while somewhat depending on the condition of the joint, should not be too small. After each single movement the patient should relax all his muscles. One often notices now

that the amount of free excursion is noticeably greater in the resistive movement than in the simple active movement, and that it is still greater in the moment of relaxation. Thus, the following antagonistic movement should start from the extreme point of excursion which can be reached in the relaxed state. During the first days of the treatment the resistance given should be rather slight at the beginning of each movement; it should then increase and later decrease again until it naturally vanishes at the conclusion of the movement. As the condition improves the initial resistance should be increased, until finally the concentric movement may even be transformed into an eccentric movement, one of the few cases where the latter exercise is of real value. If this is done a very considerable stretching effect may be produced. To make this example more concrete: The patient who has flexed his elbow against resistance and then relaxed his muscles, thus allowing still more flexion, is now asked to extend the forearm; but while he contracts his triceps the operator tries to obtain still more flexion. This is often done in the form of a sudden sharp movement, and not rarely a distinct stretching or even breaking up of adhesions can be noticed. After that the extreme resistance is lessened and the patient allowed to extend the elbow. In order to avoid irritation this procedure should not be repeated too frequently. Instead of the eccentric movement a simple passive exercise may be done during the state of relaxation. Zabludowski advises to make actual passive stretching movements more toward the end of the treatment, because they usually cause pain which interferes with the exercise. We wish to add that in all this treatment we do not like to have the patient experience any "lasting" pain. Often no effect can be obtained altogether without pain, but the pain should not last more than a few hours at most. Lasting pain is generally a sign of irritation which will prevent continuation of treatment.

Forcible Manipulations.—As a rule a treatment such as this requires a long time; many patients cannot keep it up long enough to derive the best results from it. If it would be possible, therefore, to shorten the time from the daily

repeated treatment lasting for weeks and months to one or a few treatments this would mean a great deal to the patient as well as to the surgeon. With this idea the forcible manipulation has been introduced. When I first became acquainted with this method it seemed to me to promise many advantages over the more conservative methods. But since that time I have had so much experience with it and have had so many opportunities to compare it with the slower method, that I have come to the conclusion that it should be reserved only for certain well-selected cases. I do not doubt, that in the hands of the wise surgeon forcible manipulations will at times give excellent results, but I do not hesitate to condemn it as a method of choice to be employed recklessly and without sufficient knowledge of the pathological changes in every case of stiff joints, and I have the great satisfaction of having convinced many of my colleagues of the far greater superiority of the methods which have been described in this chapter and elsewhere.

Forcible manipulation under an anesthetic is a well-recognized and very valuable method for correction of a contracted joint, but not for the purpose of simply gaining motion in a stiff joint. Many cases have been sent to our medico-mechanical department where a forcible manipulation had been done just before with the definite intention of facilitating our further work. We have always felt in such cases that the surgeon had rendered a very poor service to the patient and to us, and that the injury thus done had delayed the final outcome. Fortunately this now happens very rarely.

Many surgeons seem to believe that when one manipulation does not help it must be repeated until the victory over nature is won. But nature does not let us play such a game unpunished. A joint is not simply a door hinge, it is an extremely complicated, very delicate living mechanism. Its structures will answer any injury—and forcible manipulation represents a very respectable injury—with definite reactions. Even though it might seem rather paradoxical I venture to say from experience that repeated forcible manipulation in otherwise badly damaged joints favors and hastens bony

ankylosis. The case reported on page 152 is very suggestive in this sense.

I have had the opportunity to operate on a stiff knee-joint which had been forcibly manipulated about five or six weeks before and I was impressed with the enormous amount of traumatism. The case was that of a woman, aged about forty-five years, who suffered from stiff knee-joints due to an infectious arthritis for several years. A forcible manipulation had been done under ether with great violence but not more of an angle than about 30 to 40 degrees had been obtained. When I saw the patient about three or four weeks later her knees were in an almost straight position, extremely sensitive and completely stiff for active and passive motions. I applied very gentle massage and somewhat later tried very delicate motions, but was unable to obtain more than a very few degrees. Therefore on advice of Dr. Brackett an arthrotomy was performed. The capsule was found enormously thickened and containing large masses of unabsorbed blood between its various layers. A joint cavity was hardly seen, as every space was filled with strong adhesions which could be removed only with the scissors. After freeing the patella the joint could be bent about 30 degrees, but only by a moderately strong attempt to obtain further motion the patellar tendon was torn loose from its insertion. It was sewed on again, the artificially produced joint space was filled with oil and tightly closed. The final result was as could be expected, very poor, consisting in hardly more than 10 degrees of motion. The intention of the surgeon who had performed the forcible manipulation, had been to produce a hemorrhage inside of the joint cavity by breaking up the adhesions. The inspection showed that this had not resulted, but that the blood had simply inundated the spaces between the various layers.

Cases like this seem to prove that it does not lie in our hands, at least in many cases, to direct nature. We cannot always determine from the outside how strong those adhesions and shrunken capsules are, and I have several cases on record where the retracted soft tissues had been so resistive that by forcible manipulation they were not torn but instead

the bone was broken; thus, in two cases a transverse fracture of the femur just above the condyle, in another case a fracture of one condyle, and in one case a spiral fracture of the humerus, resulted. The splendid work of Helferich, Payr, Baer, and others, gives us the consolation that even in a hopelessly stiff joint some, perhaps a great deal of, function may be regained by an arthroplasty; although under the present conditions only a limited number of cases can be subjected to such treatment. But constant emphasis should be laid on the demand of directing the treatment from the beginning in the functional sense and to do everything to prevent stiffness from the very start.

CHAPTER XII.

INJURIES.

FRACTURES.

As cases of fractures constitute a very considerable part, about 25 per cent., of the total material of our medico-mechanical department we shall give special attention to this subject. In the treatment of fractures two main problems present themselves: The correct union of the fragments and the restoration of function, or, as we may briefly say, the anatomical and the functional problem. Although these two problems have a very close connection it cannot be doubted that the latter is the more important one. We see frequently patients with fractures not correctly set who nevertheless have a perfect or nearly perfect function of the injured limb. On the other hand, we see many patients who in spite of a very exact reposition of the fragments suffer a considerable loss of mobility in the primarily affected and even in distant joints. In a number of cases sent to us with fractures of the wrist as well as other parts of the body the surgeon had made the following note in the record: "Fragments in good or excellent position, hand, etc., stiff," and several of these patients have never had a satisfactory recovery of the function.

From frequent experiences of this sort we feel distinctly that the old dogma: "normal function depends on correct reduction of the fragments" needs a modification at least for many kinds of fractures. We should rather say: Correct reduction of the fragments is one of the most important conditions, but by no means the only one, for the recovery of good function, and in many cases other factors may play a role so great that reduction becomes even of secondary value. At any rate the anatomical problem should never

overshadow the functional problem, but, on the contrary, every step of the treatment must be directed toward a good recovery of the function. From our experience with nearly 2000 cases we venture to say that neither in the routine of large hospitals, nor in the outside practice, nor also in the teaching of students is the value of this functional problem sufficiently recognized.

Observed from the functional point of view the methods of treating fractures can be divided into three groups:

1. Immobilization until the fragments are united: splints and plaster casts.

2. Relative immobilization allowing a certain amount of function before the fragments become united: traction.

3. The early functional treatment in which the immobilization may or may not be used, but which places the functional part of the treatment in the foreground.

1. So far as we can see the methods of the first group are by far the most frequently used in this country. Complete immobilization, however, simple and useful as it often is in practice, involves the danger of causing stiffness, frequently of a permanent character, as well as favoring atrophy of the muscles and more or less of all tissues. It gives no absolute guarantee for the anatomical repair, though we admit that this depends largely on the technic, but it interferes more or less with the physiological means of nature to restore the damage of the injury.

2. The traction method, which was first used by Buck for the fracture of the femur and later highly developed by Bardenheuer, Zuppinger, and others, for use in fractures of almost all kinds, offers the great advantage of combining anatomical repair with a good chance for the activity of the physiological forces. The writer has had the opportunity to study this method in Bardenheuer's Clinic and has been deeply impressed by the most excellent results. But we admit that the technic is not at all easy, and requires specially trained nurses. Another difficulty under the conditions of this country consists in the fact that not enough beds can be secured in our hospitals to have all cases of fractures, not only of the leg but also of the upper extremities treated

sufficiently long to make full use of the great opportunities of Bardenheuer's methods.

3. The early functional method, though probably used before, was first methodically developed by Lucas-Championnière in Paris, and has come more and more into use in French, German and English clinics. Text-books of this country either do not mention it at all or do so very briefly. Some authors, though not entirely unfriendly to this method, explain its infrequent application in this country by the fact that masseurs have not yet been sufficiently trained to take up this subject. I am personally in agreement with that opinion, though I know of some masseurs' very reliable work along such a line, but I believe that the question should not rest with this excuse of the surgeon. He should himself become familiar with any method which enables him to cure his patient in a shorter time than with the present methods, and that in a great many cases the early functional treatment can accomplish results which are superior to those attained by other methods. As to time and final restoration of the function, everybody will be convinced after personal experience. Though my own experience is rather limited, I have become an enthusiastic supporter of this method, which has not failed me in a single case, and I dare to say that in no branch of surgery are massage and exercise of such great value as in the early treatment of fractures.

The early functional treatment consists of two main parts, massage and exercise, to which temporary immobilization may be added according to the judgment of the surgeon and the individual need of the case. In the first stage, that of the traumatic swelling, the effect of massage consists in hastening the absorption of the hematoma and crushed tissue cells as well as in improving the nutrition and the metabolism of the injured part and the parts peripheral; furthermore, it acts in a way to lessen pain and thus aids in eliminating spastic contractions. The relief of muscle contraction again diminishes displacement and facilitates reduction. It also has a certain diagnostic value for the exact palpation.

The exercise also hastens the absorption and improves the metabolism, but it has another very distinct effect inasmuch

as it aids, when correctly done, in reducing the fragments, as Deutschländer[1] points out, basing his ideas on his studies with the *x*-ray screen and on the biological law of the intimate relationship between form and function, so well known to every student of embryology and deformities. Furthermore, the movements prevent stiffness of the joints; retraction and atrophy of the muscles; also the absorption of the hemarthros and hydrarthros is favored, and thus infiltrations and shrinking of the capsule are prevented.

In the stage of the formation of callus the importance of massage is not so great as in the primary stage, while exercise becomes much more important. A special effect of the exercise on the shape of the callus is supposed by Deutschländer to exist, for he believes that the rhythmical contractions of the exercising muscles may in a way mould the shape of the callus. The functional stimulation also favors the formation of callus.

A number of objections are raised against the general application of the early functional treatment. We have already mentioned the opinion of some surgeons that we have not sufficiently trained masseurs to entrust them with such a difficult problem, and have said that we believe that surgeons themselves should become familiar with this method.

Furthermore, it is said to cause pain. This is not true, but quite on the contrary, existing pain is lessened when the method is correctly applied.

It has also been feared that pseudarthrosis might result from the early use of exercise. While this seems in theory a plausible objection, practice shows that such danger is not greater than with the methods of immobilization, perhaps not as great. Deutschländer emphasizes that in 140 cases he has never had a pseudarthrosis nor that other observers have seen such a consequence.

Although we believe that in expert hands excellent results can be obtained in almost all cases of fractures of the extremities by the early functional treatment, we feel that this valuable method would gain quicker recognition if at least at

[1] Berliner klin. Wchnschr., 1906, Nos. 20-22.

first it is applied in a limited number of suitable cases, and if eccentricities such as eliminating all means of immobilization would be avoided.

Although this is not a text-book on the treatment of fractures we consider it necessary to discuss the method of early functional treatment, for the following reasons:

1. We know of no branch of surgery where exercise and massage can be used with greater effect than here.

2. In the usual routine of hospitals, cases of fractures are sent for exercise and massage treatment so late that very often permanent disability has taken place which could have been avoided by the early functional treatment.

3. All surgeons who have had personal experience with this method are unanimous in the opinion that patients thus treated are ready for work much sooner than when treated by the method of immobilization. Jordan,[1] in a report from Czerny's Clinic in Heidelberg on 71 adult cases which were examined, states that 67 had completely recovered and in only 4 cases was function limited to a certain degree. A wider application of this method would therefore also be of an enormous social importance and interest.

In describing the technic we shall give largely our personal experience, and merely note in passing the suggestions of others, believing that the principles of early functional treatment can be applied to most fractures.

Fractures of the Upper End of the Humerus.—Here we have not in mind those cases with considerable displacement in which surgical interference is needed unless perfect position can be obtained by manipulation and traction. But in a great many cases of fractures of the head and neck impaction is found and the routine treatment in those cases consists in fixation for a period of four to six weeks, after which time, especially in older persons, considerable stiffness has almost always developed. In such a condition we see many patients, and the after-treatment is in the majority of cases very discouraging. We have many cases on record where even after six to twelve months of persistent treatment the func-

[1] Centralbl. f. Chir., 1903.

tion of the shoulder was greatly handicapped. The most striking feature is always in such cases the limitation of outward rotation, due to retraction of the anterior part of the capsule and the anterior muscles, a condition which is often beyond control.

The technic of the early functional treatment is as follows:

The arm is bandaged in the usual way for three or four days, though we take pains to avoid too much inward rotation, and rather fix the arm somewhat more to the side of the body than in front. After three or four days we remove the apparatus carefully and begin massage of the shoulder and arm to stimulate the absorption of the usually very considerable hematoma. The patient sits with the injured arm toward the operator who begins to knead the tissues over the shoulder-blade and the pectorales, by placing one hand in front and the other in back, applying very gentle pressure in rotary motions. We prefer to begin the massage not directly over the point of the greatest swelling but at the periphery, and this would be along the inner and lower section of the scapula and over the broad region of the pectorales. After that we enlarge every day the field of the operation in the direction toward the shoulder-joint, an area of one or two inches, and thus we shall come to the point of the fracture after three or four days, or about one week after the accident.

Special precautions are now necessary in order to keep the fragments entirely unmoved. This is best done by grasping firmly though gently the upper end of the humerus from front and back, and while the palms of the hands exert a steady pressure, massage is done over the deltoid and the acromial region with the thumbs and the points of the other fingers, always working toward each other with small rotary movements. In that way perfect control can be exerted over the fragments without causing any pain (Fig. 48).

We begin with massage of very short duration, three or four minutes being sufficient on the first days of treatment, increasing the time gradually up to about ten minutes. We believe that in a fresh case this is all that is needed to produce the desired effect on the absorption of the hematoma. We want to emphasize that the operator need not look for a distinctly

visible effect of an actual reduction of the swelling while he applies the treatment. An effect as strong as that is likely to produce irritation of the tissues. All that we need is a stimulation of the blood and lymph capillaries to do their work properly, and we have often been impressed by the speedy reduction of swelling in a few days of treatment. A short treatment once or twice a day is preferable to long treatments at greater intervals.

FIG. 48.—Manipulation suitable for kneading and friction of the shoulder in a case of fracture. The hands steady the upper end of the humerus while the deltoid is kneaded and frictioned between the thumbs.

Also for the exercise we follow the same principle of slow gradual approach from the periphery toward the chiefly affected joints. We start with movements of the fingers. It may be objected that the patient can do such exercises alone, and, of course, if he is able to move his fingers he certainly should do so at reasonable intervals; but we have seen enough patients of that and similar types who hold

the whole extremity in a somewhat spastic, rigid contraction, not daring to move one single joint. These patients need help and support in the beginning.

We do the exercises of the fingers, wrist and forearm with the apparatus for fixation of the shoulder in place, just steadying the elbow and wrist with our hands or by a pillow. In this way for the first two or three days the fingers alone are exercised, then the wrist, forearm, and elbow, until at about the end of the second week we begin to move the shoulder. This is approximately the time when the greatest part of the hematoma is dissolved, and the configuration of the shoulder has become more normal again. Here, too, special precautions are necessary.

In a fracture of the left humerus the operator grasps with his right hand the acromion, having the points of the thumb and two fingers rest on the greater tuberosity of the humerus. The operator's left hand steadies the elbow and forearm and at first describes very slow gentle passive motions in an anteroposterior direction at an angle of at most 15 degrees forward and backward from the axillar line. This is at times found to be difficult, the patient not knowing how to relax. In such cases we practise the same exercises at first with the healthy arm until the idea is fully comprehended. The angle of 15 degrees is set as a maximum measure, but this does not mean that the motion must be carried to that extent. The operator must pay careful attention to the action of the shoulder muscles; any irritation by the exercise will cause muscular spasm, which represents a strict contra-indication to further exercise to the angle at which spasm takes place. It may be that muscular spasm prevents any motion at all, but that condition should not be confused with the voluntary muscular fixation.

Moreover, if the treatment has been carried on with sufficient gentleness during the preceding days the patient is, as a rule, sufficiently trained to understand the directions of the operator. For the first two or three days we advise passive exercises with the shoulder completely dropped and the muscles relaxed, the fingers which rest on the tuberosity always controlling so that the upper fragment moves well

with the shaft. Following these precautions it seems almost incomprehensible how any harm can be done to the point of the fracture.

After a few days we begin to have the patient assist in the motions by his own muscles, giving rather an assistance than

Fig. 49.—Impacted fracture of the humerus: Woman, aged sixty years. In this case exercise and massage treatment was begun three days after the injury, with the result that eight weeks after the injury the patient had at least three-quarters of the motion free. Only the external rotation was somewhat more limited, and the patient was able to do her full work as caretaker of a large house.

a resistance, gradually, however, changing to the latter with increasing strength. At the same time the angle of motion is increased gradually and movements in the other directions are added, abduction and rotation.

Further increase in motion and strength will be obtained in a rather short time and then the technic of exercise does

not differ much from the common rules set for shoulder exercise. Careful handling of the arm will avoid inflammation of the subacromial bursa and prevent bursitis, which is often such a very disagreeable complication of lesions of the shoulder and more or less the whole arm.

Elbow.—No definite rules can be given for fractures of the elbow, as all depends on the mechanism of the injury, the displacement of the fragments, and the greater or less ease with which the bones can be held in good apposition. The favored position for fractures of the elbow is that in extreme flexion. Massage can easily be done with the arm in that position, also movements of the fingers and wrist and even supination and pronation as well as movements of the shoulder may be done very easily. In suitable cases where displacement is not much to be feared extension and flexion in small angles may be begun after one week, in other cases later. Thus the retraction of the flexors which is so often of a very annoying persistency may be avoided. In most of these cases simple active movements, if necessary with support and assistance, are better than passive or resistive exercises. As soon as the fragments are sufficiently united these exercises may be left to the patient, though at first they are better done under the supervision of the surgeon. At the surgical clinic in Breslau I used to collect the patients with elbow fractures, mostly children, into a class and supervised their exercises, giving support and assistance to one or another if needed. Massage of the elbow-joint itself involves a distinct danger if it is not done with great care; thus I generally advise my assistants to restrict massage to the muscles of the arm.

Lucas-Championnière[1] has for thirty years treated fractures of the olecranon with even large diastasis by massage and exercise, and has obtained good function in a short time. He points out that the fracture of the olecranon differs greatly from that of the patella, because the olecranon possesses more vitality than the patella, and interposition of soft tissues which hinders the apposition of the fragments of the patella

[1] Societé de Chirurgie, 1908; abst. in Ztschr. f. orthopaedische Chirurgie, xxiii, 654.

does not exist in the fracture of the olecranon. The diastasis of the olecranon is caused by the hematoma and the contraction of the triceps and massage is the simplest means to eliminate this contraction. Usually after two or three days of massage the pain has disappeared and the diastasis is eliminated. After two or three days more the patient may get up with a simple sling. The objections of other surgeons as Tuffier, Quènu, Delbet and others, who advise individualization in that fractures in the middle of the olecranon with considerable diastasis need suture while others will heal well under massage, are not accepted by Lucas-Championnière. The latter emphasizes that even with a large diastasis good bony union takes place under early massage and exercise.

When we compare such results with those frequently seen in our clinic we cannot hesitate in deciding which method is the better and we do not see any need for surgical interference.

Colles's Fracture.—Colles's fracture is one of the most common injuries and from our own experiences the number of patients with such fractures who suffer from a more or less handicapped wrist and hand for a long time is very considerable. We have on record quite a number who have not fully recovered after a year or more, and probably never will have a good hand.

Cotton[1] says about the results in Colles's fracture: "The important thing to remember is that bad results, 'so far as function goes,' are far more apt to be the result of bad treatment than a result of the injury. In few instances has surgery inflicted so much unnecessary damage as in the treatment of Colles's fracture and of the related lesions. If such a case is left unreduced and the patient is allowed to consider it a 'sprained' wrist, most unsightly deformities may result, but function is usually almost perfectly restored. There is, at most, some weakness, but not the stiffening of the fingers which so often resulted from the well-meant treatment so carefully carried out a generation ago."

[1] Dislocations and Joint Fractures, p. 356.

From our experience we agree with the author entirely except when he speaks of the time "a generation ago." The large number of cases resulting in stiffness makes us feel that even in this present generation there is a chance for progress, and we believe that the early functional treatment gives such a chance with only slight sacrifice of time.

The technic is rather simple and requires very little time, at least in the early stage. As I have used the Schede splint in connection with the functional treatment I shall thus describe the technic. As soon as possible after the accident the bones must be reduced under an anesthetic, then the splint is applied and an *x*-ray taken. The following day the hand is inspected and the splint reapplied. Two days later massage and movements may safely be started. Several surgeons advise to begin such treatment on the second day, but I do not see any necessity from a physiological point of view and prefer several days of complete rest. The forearm with the splint is rested on a table, and the bandage cut on the back of hand and forearm. With his left hand the operator gently steadies the wrist, avoiding direct pressure over the points of fracture. With the right hand he massages the muscles of the forearm, using gentle stroking, kneading and rolling manipulations for three or four minutes. Then a few very gentle slow passive movements of each finger individually are done in an angle of not more than 30 degrees, and the splint is bandaged on again. This treatment is repeated daily, adding every day one minute massage, up to ten minutes, and a few movements of the fingers, up to ten to fifteen. Gradually the massage is to include the tendons, wrist, hand, and fingers. Beginning on the first day of the second week the splint is carefully removed before treatment. The forearm, placed on a hard pillow with the hand hanging over its edge, is held by the operator's left hand in exactly the same position as it was on the splint—palmar and ulnar flexion—while with his right hand the operator massages, thus gaining freer access to all parts of the arm than with the splint in place.

Thus at the end of the second week, the earliest time when

in the routine of our hospital functional treatment is started, the swelling should be much reduced, motions of the fingers almost completely restored and even the mobility of the wrist and forearm improved to a certain extent. In this way I have treated six or seven cases at the surgical clinic in Breslau and have always been impressed with the speedy recovery compared with the method of immobilization which at that time was the treatment of choice in that clinic just as it is here in our hospital. I have not had the impression that the fragments were in any way in danger of becoming displaced, though I will admit that this may happen if sufficient care is lacking.

In a similar way I have treated a case of fracture of the shaft of the ulna at the border of its middle and lower third with a very gratifying result. The case is reported, not primarily for its quick cure, for the patient was a young healthy man and the displacement not very marked, thus assuring a good outcome in any case, but to show that the same principles have their place in fractures of the shaft as well. The patient was referred to me at the end of the first week with the fragments not entirely corrected and still quite loose. I proceeded in a way similar to that described above for the Colles's fracture, taking special care not to shake or move the fragments. Still more to improve the reduction I also waited somewhat longer with active movements, as unforeseen muscle contractions may cause moving of the fragments. Four weeks after the injury the fragments were solidly united and in a somewhat better position than when I first saw the case. The splint was then left off and the patient resumed his duties of a mechanic after the fifth week with a perfectly free, movable, and sufficiently strong arm and hand.

Knee.—Opportunity has come to me only once for the early functional treatment of a fracture of the knee. As the result was surprising beyond my expectations I shall report it in detail.

The patient, a woman, aged forty-four years, was admitted to the hospital for a sprain of the knee-joint. The knee was very much swollen and painful. The *x*-ray picture

showed a distinct impacted fracture of the external condyle of the tibia.

After several days of rest on a splint, I began massage, first on the thigh and upper recessus, gradually increasing the area over the whole knee-joint and the whole leg, and started with motion at an angle of about 10 degrees on the eighth day. At that time the lateral mobility caused by the severe laceration was very marked; the lower leg could be bent inward with the knee straight to an angle of at least 10 degrees. Motion was done at first by raising the knee-joint gently from the splint with the operator's hands, and after a few days with the coöperation of the patient's hip flexors. After eight to ten days more the flexor and extensor muscles of the knee-joint itself were set to work; at first with assistance, later alone and with resistance. At the end of the fourth week motion to about 90 degrees was obtained, though not with full active control. Eight weeks after the injury the patient had almost perfect function and good active control and strength with no lateral mobility. After that time we allowed her to cautiously begin with weight-bearing, though still on crutches, and told her not to go entirely without crutches earlier than ten or eleven weeks after the injury. I have not seen the patient since, but her brother reported to me that she is now perfectly well.

I realize that it is only a very small number of cases where I have had the good opportunity of applying functional principles of treatment from the beginning, but my experience has been so extremely gratifying, sometimes beyond my own expectations, that I cannot but highly recommend this method to other surgeons, and I believe that much time will be saved for the patient and much worry for the surgeon.

As conditions are at present in our hospital, all fresh fractures are sent to the surgical department, and only later, if necessary, to the medico-mechanical department. Here about 300 cases are seen during a year at a time after the injury varying from three to six weeks or even later, according to the judgment of the surgeon. We may say in general that a better understanding has taken place, but still too

many cases come into our hands where in my opinion massage and exercise could have been started much earlier with great benefit to the patient.

I admit that very many, perhaps the majority of cases, will get along satisfactorily with the routine method of immobilization, and many may not need any further treatment. But we must state that the percentage of cases which need a very much prolonged after-treatment and which never recover fully is so large, and therefore the social burden so unnecessarily great, that every effort must be made to alter the present conditions. I am sure to be in full agreement with all surgeons in this respect, although possibly our ways and means to strive for the common goal may differ to some extent. As conditions are now the after-care of fractures is very discouraging in many cases. A responsibility is placed on the surgeon who is entrusted with this care which should be borne entirely by the surgeon who has treated the case from the beginning.

The functional treatment of fractures when begun after the bones have become united under the method of immobilization does not differ much from the treatment of stiff joints in general. But on account of the great importance of this subject and on account of the fact that our principles differ in some measure from those of many other surgeons we shall go into certain details.

In a former paper on "Hand Lesions following Injuries of the Upper Extremities,"[1] I have called attention to the fact that the function of the hand may greatly and permanently suffer from an injury of any part of the upper extremity. This is, of course, evident in fractures of the hand itself as well as the wrist, but it is also seen often in fractures of the humerus, especially its upper end, and in fractures of the olecranon. Stiff hands following such injuries are very frequently seen in our department, and we would emphasize the fact that the restoration of their function very often offers a more difficult problem than the recovery of the part primarily injured. We have seen many

[1] Boston Medical and Surgical Journal, April 13, 1913.

patients who never regained full function of the hand in spite of a very long persistent and carefully carried out treatment.

Since most cases of secondary post-traumatic lesions of the hand are seen following Colles's fracture, this type shall be chiefly considered here.

The clinical picture in such cases when sent for after-care is rather typical: The forearm is somewhat flattened from the pressure of the splints. On the sides of the forearm there is noticed more or less edema and often a distinct discoloration from unabsorbed hematoma. The back of the hand and especially the fingers show, as a rule, a considerable swelling. The circulation of the hand is poor. By palpating one notices infiltration about the tendons, especially on the palmar side of the wrist and forearm and on the back of the hand and fingers. There is often noticeable an infiltration about the interphalangeal joints. In all cases the hand and fingers are very weak, and in the vast majority considerable limitation of the motion of the fingers will be noticed.

The following case may serve as an example:

A woman, aged fifty-five years, in good general health, came to the accident room on August 8, 1912, with a Colles's fracture, which was reduced under gas. Anteroposterior splints were applied and removed the next day for control. The bones were found to be in a very good position, the *x*-ray picture showing only a very slight backward bending.

On August 21 the splints were reapplied.

On August 28 the posterior splint was omitted.

On September 5 the patient was sent to the medico-mechanical department. The fingers were then found to be very stiff and swollen.

Within three months twenty-nine treatments were given with but a moderate result. When seen last the patient was not able to bend her fingers sufficiently to touch the palm. The *x*-ray picture shows a marked atrophy of all bones of the hand and a distinct thickening of the fingers, especially about the interphalangeal joints.

Under appropriate treatment these symptoms clear up more or less gradually, but in many cases the improvement

is extremely slow, and then with a decrease of the edema and infiltration the signs of atrophy become more prominent. The skin loses its normal color and turgor; it is not so movable under the palpating finger as on the normal hand. In cases of long duration the circumference of the fingers may be considerably smaller while in the earlier stages the swelling due to the poor circulation will prevent this atrophy from becoming so noticeable. Most marked is the atrophy of the bones as seen in the *x*-ray plate, to which Sudeck has first called attention. The *x*-ray picture shows a more or less marked loss of lime salts. The trabeculæ become less clear and distinct or even may disappear at some places. The degree of bone atrophy is usually greater in relation to the severity of the clinical symptoms.

With more severe clinical symptoms we notice the retraction and tightening of the fascia and tendons of the fingers, in bad cases of the whole hand. The skin is then drawn tightly around the fingers, especially on the back side; the extensor tendons on the back of the hand are firm and do not glide under the palpating finger. The flexor tendons seem to be much better protected by their tendon sheaths.

Frequently changes of the joints are noticed. In the milder cases we have only a thickening of the capsule which gradually becomes retracted and forms a firm and tough ring around the joint. In the more severe type the cartilage becomes involved too. Such joints are oftentimes very much thickened, which change becomes the more apparent, as frequently the phalangeal parts of the fingers are thin and atrophic. In many cases where the palpation seemed to suggest a distinct thickening of the phalangeal ends the *x*-ray plate indicated a normal or nearly normal size of the bones themselves, but showed a faint shadow indicating the indurated capsule. The following case represents a good example of this type:

Woman, aged fifty-four years, in fairly good general health. The patient had broken her left wrist five months previously and worn anteroposterior splints during six weeks and an anterior splint for ten days more. On admis-

sion the following note was made: Fair position of the bones, but with the usual backward tilt of the articular surface of the radius. Slight outward displacement of the radius. Slight outward displacement of the hand.

Considerable thickening of the carpus, pronation free, supination limited, marked limitation of all motions of wrist and fingers. The fingers are held in moderate contracture and cannot be flexed more than two and one-half or three inches from the palm. Also the extension of the fingers is limited. The interphalangeal joints are markedly thickened, while the tissues between the joints show a great deal of atrophy, making the thickening of the joints still more conspicuous.

The *x*-ray picture shows a marked atrophy of all bones and suggests a narrowing of the interarticular space of several interphalangeal joints. The thickening of the soft tissues around the joints is distinctly seen on the negative.

Fifty-one treatments within three and one-half months did not give a satisfactory result. When seen last the hand was still markedly crippled and stiff.

In the most severe type we find a distinct reduction of the size of the articular space, due to the atrophy of the cartilage. In cases showing actual hypertrophic spicules a certain amount of such spicules will also be noted on the other hand.

Clinically those cases show the well-known picture of hypertrophic arthritis with Heberden's nodes. The following is a typical example:

Man, aged sixty-seven years, in good general health, broke his right wrist on September 16, 1912. The fragments were set at the hospital on the same day under an anesthetic, and anteroposterior splints were applied. The splints were repadded and rebandaged on September 24 and October 1. On October 8 the patient was sent to the medico-mechanical department, where the following notes were made: Motions of wrist almost entirely limited, fingers very stiff, distance of fingers to palm in extreme flexion about two and one-half inches.

After sixty-five treatments during four months, a func-

tional improvement was obtained so far that the second and third fingers touched the palm, while the distance of the fourth and fifth fingers in full flexion was still about one-half inch. But on account of the marked limitation of the end joints the fingers touched the palm, respectively came near to it, more proximalward than normally. The wrist showed about 40 degrees of palmar and dorsal flexion, the rotation was fairly good. All fingers were much thickened, especially about the interphalangeal joints. The *x*-ray plate showed a moderate atrophy of the phalanges of the right hand and a distinct hypertrophic arthritis of most interphalangeal joints of both hands. The left hand showed a moderate amount of Heberden's nodes over the end joints, but a perfect function and absence of any other clinical symptoms.

Immediately after the removal of the splints a considerable limitation of motion is noticed, as has been mentioned above, in most cases. With the diminution of the swelling and the other acute symptoms the mobility usually shows an improvement which, however, is often very slow. In all cases where the atrophic condition becomes prominent and particularly in those showing a marked involvement of the joints, the mobility may be restricted for many months, and we have seen a considerable number which did not show a satisfactory function within even years of observation and probably may always have a crippled hand.

In one of the worst cases which came under observation four months after the injury the four fingers did not move more than about one inch forward and backward. Such stiffness may be as bad as in the worst cases of infectious arthritis, especially those of the gonorrheic type or in a septic hand. The resemblance of the traumatic hand to a hand affected by infectious arthritis is at times so great that the differential diagnosis may become rather difficult without knowledge of the history. But in these cases of severe infectious arthritis we usually find on the *x*-ray plate a more extensive destruction of cartilage and bone with a tendency to the formation of bony ankylosis, which I have not seen in any of the traumatic hands.

The end joints of the fingers are most often limited in motion. Next to them come the metacarpophalangeal and last the middle joints, although there are exceptions where all interphalangeal joints are limited in motion, while the proximal joints are practically free. The flexion is more frequently limited than the extension; though a certain limitation of the extension is very frequent. Some cases have shown a more or less marked contracture of the fingers which, however, is rarely as pronounced as in the septic hand. The hyperextension is almost always entirely limited. The thumb is usually not so much subjected to secondary traumatic lesions as the other fingers; therefore we find the limitation of motion usually not so pronounced as in the others. Nevertheless a certain amount of stiffness of the end joint of the thumb is a rather common feature.

The seriousness of the subjective symptoms is practically in accordance with the objective changes. In the severe cases the patients frequently complain of much pain and discomfort. They do not know how to hold their hand best. The hand feels cold and numb. Especially during cold weather the patients have great difficulty in keeping their fingers warm and comfortable. It is interesting to notice how much these patients become generally affected by the pain and the crippled condition of their hand; frequently they complain in a desperate manner about their constant physical and mental sufferings.

The frequency of the secondary traumatic hand varies considerably with the seat of the injury and with the age of the patient. It is obvious that the danger for the hand increases the nearer the seat of the lesion is toward it.

As to the age of the patient there can be no doubt that with advanced age the disposition to primary and secondary affections of joints, and of the hand in particular, is increased. All text-books on fractures and dislocations agree in this respect. However, the number of relatively young patients, with perfectly normal joints, aside from the injured extremity, who came under our observation suffering from most serious affections of the hand, is not small. I would say, furthermore, that in some of them the primary treatment

was applied by the best surgeons; some of those cases were treated from the first day at our hospital.

As we have mentioned before, it is a fact that patients with the typical Heberden's nodes are especially subject to traumatic complications. In many of such cases the hand of the injured side will show the thickened joints similar to, or more frequently somewhat worse than, the other hand. But almost always we will notice that the limitation of the function is much greater than on the other side if any limitation exists there at all. This, I believe, cannot be explained by an aggravation of the joint symptoms alone, but, as I have said, by the greater susceptibility of all tissues.

Conditions such as those just described may be caused (1) by the primary injury itself, including crushing of tissue, hematoma, etc.; (2) by the disposition of the patient: advanced age or hypertrophic arthritis; (3) by the treatment, or by all of these factors working together.

Considering the treatment, we may ascribe the failures to (*a*) omissions, and (*b*) actual mistakes.

(*a*) By the ordinary way of immobilization functional stimulation necessary for the quick absorption of the hematoma is omitted; the muscles are condemned to constant rest, whereas a certain amount of action would hasten their recovery and prevent atrophy to some extent.

(*b*) The forcible reduction represents a second trauma; at least in arthritic and aged persons it should be done with great care. Furthermore, an irrational application of splints may do much harm; especially is excessive pressure very dangerous. The duration of immobilization alone does not, in our opinion, play such a great role, as is frequently believed. In most cases where harm is done or not prevented this usually dates back to the first two weeks and after that it does not matter so much whether immobilization is carried on for one or two months. But as we have stated in other places, we really see no reason in carrying on immobilization over a time so long that with a more rational treatment the patient could have gone back to work.

The question is now: What can be done with such stiff hands or stiff joints in general? The answer is given in detail in the previous chapter. To repeat briefly:

In the milder cases a good functional result can be obtained by a persistent use of baking, massage, active and passive exercises, etc.; in severe cases the hand will remain more or less crippled.

It is certain that many of such hands will come out all right without any after-treatment, and in general it seems better to leave them alone, than to send them to a masseur who is not perfectly familiar with the subject. From my experience I have gained the impression that such hands are very susceptible to an inflammatory reaction, when they are handled without proper care. To frequent forcible manipulations the tissues of such hands respond with swelling and pain which at times may be very persistent. I remember cases where the pain, caused by too rough handling, prevented the patients from sleep and brought them to a terrible stage of nervousness and exhaustion.

One case of this type was especially instructive to me.

A woman, aged fifty-two years, came to my office, having sustained a Colles's fracture four months previously. The fragments were reduced to a good position and the arm and hand splinted in the typical manner for nearly seven weeks. After removal of the splints the hand, and more or less, the whole arm were much limited in motion, and a masseuse was ordered to give massage and exercise treatment. As the patient told me, these exercises had been given so forcibly that her cries from the intense pain alarmed her neighbors. I saw the patient after this form of treatment had been given for two months every day. She was very much exhausted and nervous. She did not sleep well on account of pain; she had no appetite, and had lost weight.

When first seen the whole left arm was held entirely stiff. The shoulder was limited in motion about two-thirds; the elbow one-half, and the wrist almost entirely. The fingers were so stiff that the points moved passively only about one inch forward and backward; actively even less than that. It seemed hardly possible that the masseuse had been able to bend the fingers down to touch the palm only a few days previously.

By a careful treatment with baking, massage and gentle

exercises the motion in the shoulder and elbow was almost entirely restored, while the forearm and hand showed a marked limitation of motion even after five months of treatment.

The final story of this case is not without a certain humor. The patient, who had recovered a fairly good use of her hand, although she could not bend the fingers more than to a distance of about two and a half inches from the palm, wrote me a short time after she had abandoned the treatment that she had seen a famous surgeon in another city who promised certain cure by an operation. I answered that I was anxious to learn of such an operation, as I was highly skeptical about it. I did not hear from her until nearly four years later, when I had a chance to examine her again. I found about the same condition as at the end of my treatment, only that the motions of the wrist had been somewhat, and those of the fingers slightly improved, as I would have expected anyway by a constant use throughout such a period. To my great surprise the patient told me that that famous surgeon had manipulated her stiff joints under ether nine times; certainly an enormous waste of time, energy, and money.

Fracture of the Patella.—Almost all cases of fracture of the patella which have been sent to the medico-mechanical department for after-treatment had been operated upon. The leg had been fixed on a splint for six weeks or longer, a method which in all cases had led to a considerable limitation of motion, ranging from 30 degrees to complete stiffness. In spite of the long time of immobilization we begin in these cases with very gentle active-passive motions in the following way: While the patient is lying on the table the knee is lifted up with assistance by the left hand of the operator, while his right hand presses the fragments of the patella firmly together. Then rhythmical contractions of the quadriceps are done. These motions are at first practised with the other leg, because they are usually difficult on account of the great atrophy of this muscle, and the patient is inclined to do unintended movements with the leg which may injure the patella. After a few days the knee is

placed in such a way that the lower leg projects over the edge of the table. In this position active resistive and assistive exercises are performed as described in Chapter II, p. 25. We often notice that with appropriate resistance the angle of motion is considerably greater than when the exercise is done by the patient alone. Another useful exercise is bending and extending the knee from the prone position. Here again resistance may be given. After one or two weeks exercises in sitting and standing are added; later pendulum exercise and other Zander apparatus. Massage is very useful, consisting in deep friction and effleurage of the knee; kneading, effleurage, tapotement and vibration of the muscles of the whole leg, especially the quadriceps.

Many surgeons begin the exercises much earlier and have their patients begin with weight-bearing on the tenth day. In my opinion this method has many advantages, not only in hastening function, but also in favoring nutrition of the injured patella.

Within a few years we have seen three cases which sustained a refracture, not by the treatment but outside of the hospital by very slight injuries, and we believe that the atrophy of the patella, caused by the long period of immobilization, might have favored such an incident.

The following case is cited as an example to show that early exercise treatment may be done with good result even in old cases; we believe that fresh cases would be still more suitable for such treatment.

A woman, aged fifty-four years, consulted me for an ununited fracture of the right patella of fifteen months' duration. The fragments showed a diastasis of about two inches on the *x*-ray; the patellar tendon was considerably shrunken and not longer than about one inch. No trace of active extension of the knee was possible, but flexion was almost normal. At the operation the capsule was found torn to nearly its full width. The fragments were brought together and united by sutures of kangaroo tendon. As it was feared that a diastasis would occur owing to the shrinking of the patellar tendon a bone graft was inserted into a groove of the frag-

ments. Also the capsule was firmly united with a double row of silk sutures.

After-treatment was begun one week after the operation and carried on in a similar way as in the case of arthroplasty (see p. 152), only much more cautiously. The rhythmical contractions of the quadriceps, however, were not started before the beginning of the third week. Even then what was feared happened, the fragments were separated at the first attempt of contraction of the quadriceps, a distance of about one-quarter of an inch. Owing to the presence of the bone graft, however, firm union was secured and distinct formation of callus could be seen on the *x*-ray picture, which was taken six weeks after the operation. When the patient left the hospital she had 34 degrees of motion under full control.

DISLOCATIONS.

The treatment of dislocations after successful reduction follows lines similar to that of fractures. A careful use of massage and exercise may be begun a few days after the reduction, though of course we should not recommend to attempt motion in a large angle before several weeks have passed. In 2 cases of simple coracoid dislocation of the humerus which I had reduced a few hours after the injury and where functional treatment was started on the second or third day full active motion was restored after three or four weeks. Many such cases recover without any special treatment, but the number of those which we see entering our department four weeks and more after the reduction with stiff and sensitive shoulders is large enough to feel justified in suggesting an earlier beginning of rational after-care. This is all the more important when the dislocation is complicated by another injury unless operative treatment is indicated as, for instance, in a case of rupture of the supraspinatus tendon. Other dislocations may be treated after similar principles with the exception of simple, uncomplicated posterior dislocation of the elbow. The reason for this exception lies in the fact that in these

cases ossification along the tendon of the brachial muscle occurs rather frequently (Machol), and we believe that any possible irritation should better be avoided. We recommend, therefore, in those cases rest for a few weeks followed by simple unaided active use of the arm.

CONTUSION. SPRAIN.

Cases with a contusion or sprain may generally be treated along lines similar to those with fractures, only that the whole treatment is, as a rule, easier and simpler. The effect which massage may have in such cases is at times very striking, as the following example illustrates:

A gentleman, aged about sixty years, was sent to my office by one of my colleagues. In curling on the ice the patient had sprained his left hip and buttocks a few days previously. He complained of considerable pain and walked very lame and cautiously. On examination there was found a distinct swelling and tenderness behind the trochanter and most motions of the hip caused some pain. The patient was very angry about his accident because he had intended to take part in a contest in curling within a few days, and asked me whether I could enable him to do this. He came to me on Thursday and the contest was to be on Saturday. With two treatments of massage and resistive exercise he was so very much improved that he was able to take part in the game and was the winner.

Much depends on a correct technic, as the following case shows:

A man, aged about fifty years, came to my office with the following history: Two weeks previously he slipped in the bathtub and extended his leg very suddenly. He did not feel much pain that same day, but the next morning his leg was very much swollen and painful, and he was not able to move his knee. He attributed this swelling to a rupture of a varicose vein in the back of his leg, and went to an osteopath who gave him massage and exercise treatment. Four or five treatments were given whereby the swelling of the lower leg practically disappeared while that of the knee rather increased. The

patient said that the operator had done very violent passive motions on the knee-joint which caused a great deal of pain. On examination an enormous swelling of the right knee-joint was found. Over the upper recessus the joint was about two and a half, and over the patella about two inches larger than the other knee-joint. The flexion of the knee was possible for about 60 to 70 degrees. After one week of massage the swelling was considerably reduced; then the patient had to go out of town and was treated by a reliable masseur elsewhere. When I saw him again, about ten days later, there was flexion far beyond a right angle, and the swelling had been reduced to about one-half to three-quarters of an inch. The story of the patient suggested that the traumatic synovitis had been maintained and increased if not perhaps caused by the violent manipulations.

A few remarks seem necessary on certain injuries of the knee-joint. A sprain of the knee-joint may cause one or more of the following affections: (1) Laceration of one of the lateral ligaments; (2) displacement or laceration of one or both of the semilunar cartilages; (3) laceration of one or both of the crucial ligaments.

1. The laceration of a lateral ligament takes place as a rule at or near the insertion, whereby a piece of bone or periosteum may have been torn or stripped off. A distinct amount of lateral mobility is usually seen in these cases. This being certain, any attempt to move the knee in lateral direction should be strictly avoided for at least four to six weeks. But, on the other hand, careful flexion and extension may be done after the removal of the hemarthros by massage aided by elastic compression. The joint is at first bandaged on a hamsplint, and supported on both sides by long sandbags. When the hematoma is absorbed to the greatest extent a split plaster cast is more useful. With this the patient may get up on crutches, but weight-bearing should not be attempted before six to eight weeks.

2. Displacement or laceration of one of the semilunar cartilages frequently takes place after a forcible twist of the lower leg with the knee in flexion, while the patient in an effort to hold himself up contracts his quadriceps

muscle. The diagnosis is often difficult in fresh cases. When a displacement is evident reduction may be attempted in the manner described by Cotton.[1] Graham[2] has described the advantage of massage in fresh and even in old cases. In a few suspicious early cases we have applied a split plaster cast with daily baking and massage. Some of them recovered entirely within a few weeks; in others the symptoms recurred and made operative removal necessary. We believe that such an attempt at conservative treatment is justified so long as the diagnosis is not quite certain. In later cases which are characterized by habitual obstruction or locking of the joint removal of the cartilage is the method of choice and gives, as a rule, very satisfactory results.

3. Injuries to the crucial ligaments seem to be more frequent than is commonly believed. Their diagnosis may be difficult. In early cases a similar course may be followed as just described for suspicious cases of injured semilunar cartilages, while with persistent symptoms operative repair, best through a median transpatellar incision, is indicated.

FRACTURES WITH DELAYED UNION.

From a rather wide experience it can be stated that exercise and massage represent a very efficient form of treatment in many cases of delayed union in fractures. In a paper written in 1909 I have published a report of nine cases, all of which were cured or much improved by this method.[3] Since that time the total number of cases treated at the medico-mechanical department under my supervision has increased to thirty cases, many of which have been considerably improved or cured.

In the paper mentioned I made some general remarks on the causes which were responsible for the delay of union, and explained the role which both exercise and massage play in that form of treatment. Massage acts so as to produce

[1] Dislocations and Joint Fractures, p. 496.

[2] Treatise on Massage, p. 387.

[3] Treatment of Fractures with Delayed Union. Boston Medical and Surgical Journal, July 22, 1909.

stimulation on the insufficiently nourished fragments and on the soft callus, while exercise is done with the intention of mobilizing the joints of the affected limb, which are more or less stiff, due to the long-continued treatment.

Non-operative mechanical stimulations have been used in different forms. Rubbing of the fragments against each other, striking with a small hammer and some kinds of massage have yielded good results. Walking with the injured leg in a plaster-of-Paris cast produces mechanical stimulation in cases of fracture of the lower extremity.

The method used in our cases consists in a firm rhythmical slightly vibratory pressure with the fingers on the point of the fracture. This is done with as little movement of the fragments as possible. At the first treatment we have moved the fragments and rubbed the ends of the bones once or twice to produce lacerations and hemorrhages about the callus; later during the treatment we have avoided such movement entirely, fearing that the newly formed tissue of delicate capillaries and bony spicules might become damaged, thus rather preventing than favoring bony union. For the same reasons we have strictly avoided active contraction of all muscles which originate at or near the point of the fracture.

Besides the special vibratory massage we have used massage of a general character over the rest of the extremity, especially the muscles and joints. The exercises were done mostly in a passive way except when we were sure that active motions could not produce any movement of the fragments. The combination of exercise with massage proved to be of greatest value, as usually at the same time when the union of the bones was obtained the limited function was greatly and in some cases almost fully relieved.

X-ray plates were taken in the beginning of the treatment and later on every two or three weeks. In every case there was no distinct change to be seen in the first control-picture, but in the second, four or five weeks after the beginning of the treatment, such change was evident. The shadow of the calcified part of the callus was more dense than in the first picture, and there was calcification in places where there

had previously been none. In later stages increase of the calcification was found in most pictures. These changes in the *x*-ray pictures take place while clinically the callus becomes smaller, but firmer and more compact. The changes seen in the *x*-ray picture are quite distinct on the negative plates, but the prints do not show them plainly enough. We therefore have not made any reproductions because they would not give the right idea of the real changes.

A few cases are reported as examples:

A twenty-seven-year-old healthy man came into the hospital August 18, 1908, with a fresh compound fracture of both bones of the left forearm. Open cleaning of the wound and replacement of the bones were done immediately. In the first weeks there was much discharge from the wound, and the fragments of the radius slipped out of place again and freshening and suture were performed November 9 by a new operation. January 2, 1909, the fragments of the radius showed still marked flexibility, while the ulna was only slightly elastic. The arm was completely useless and hardly any motion possible in the forearm, wrist and fingers. Then by daily stimulating treatment the fragments were united within seven or eight weeks, and in the same time wrist and fingers became readily movable; only supination and pronation were still much limited. Patient began to work in April, 1909. At the last examination in May there was found nearly perfect function of wrist and fingers and marked improvement of supination and pronation. The first *x*-ray picture showed very little callus. On the control pictures four and seven weeks afterward the shadow of the callus became more dense and new bony structure was seen.

A fifteen-year-old healthy boy with compound fracture of the lower end of the radius of both arms. He was operated upon at the hospital a few hours after the accident, September 1908. The right arm healed normally, while suppuration took place in the left. An abscess of the left wrist was opened November 27, and some sequestra removed. The edges of the fragments were curetted. On January 6, 1909, fourteen weeks after the fracture, the fragments of the left

radius were still completely flexible, the hand and fingers almost entirely useless. Stimulating treatment and massage was applied only ten times until March 25, when bony union was perfect and the function very much improved. The *x*-ray pictures showed in this case very little bony structure of the callus, and even at the time when clinically the union was perfect, a distinct separation could be seen.

A healthy man, aged fifty-one years, with simple fracture of both bones of the forearm (November 16, 1908). Ten weeks later, on January 29, 1909, the bones showed no union, the fingers were almost completely stiff, also the wrist and forearm. By daily stimulating treatment, bony union was obtained within six or seven weeks, and at the end of April the patient was able to resume work with satisfactory function of the hand. The *x*-ray pictures showed marked increase of new-formed callus. The position of the bone was improved to some extent, as seen on the *x*-ray picture and clinically.

A man, aged forty-four years, in good health, with fracture of both bones of the right leg. Eleven weeks after the accident the fragments still showed slight elasticity of the callus. The leg was much swollen, the motion in the foot limited, and marked peroneal spasm was present. Complete union and satisfactory function was obtained within four or five weeks by stimulating and functional treatment.

A man, aged twenty-five years, with a nine-month-old compound fracture of the humerus between the middle and lower one-third. The fragments were very loose and there was a sinus over the point of the fracture. All joints of the left arm and hand were greatly limited in motion. When the patient was referred to me for consultation as to the advisability of an operation I hesitated because of the sinus and because I was afraid of further delay of the functional cure by fixation after the operation. I therefore asked to refer the patient to the medico-mechanical department where he was treated by massage and exercise. After four or five weeks the fragments were practically solid and the sinus was closed. The hand and fingers and to some extent the shoulder had been very much improved in motion

and only the elbow alone did not make good progress. The patient was under treatment for a long time, and his arm became strong and useful except for the elbow which showed only about 30 degrees of motion. Had this form of treatment been started seven or eight months earlier, we might have obtained a full functional cure within a much shorter time.

We know that this form of treatment does not assure an absolute definite cure in all cases, and realize that many of them need open operations with bone plugging, etc., but wherever the function of the affected extremity is much impaired we recommend to begin with a treatment such as we have just described and improve the function of the stiffened joints as much as possible, at the same time attempting to unite the fragments. If this attempt fails, operative measures will be indicated, but for the general functional cure of the patient it will be better if such an operation is done with the joints movable. One may object here that this treatment might unnecessarily delay the final recovery, but we do not believe so; rather do we think that the joints after they have been made more mobile will not be much stiffened by the immobilization necessarily following an operative procedure; whereas, if the joints have been stiff when the extremity is subjected to an operation followed by immobilization, the prognosis in regard to freedom of motion might become much worse.

CHAPTER XIII.

ARTHRITIS.

There are not many affections of the human body where medical progress of the last decade has revolutionized our therapeutic ideas so much as in arthritis. It is not long ago that these cases were treated chiefly symptomatically with drugs or physical methods, according to the liking of the physician. Now we have learned to recognize that our first duty is to search for the etiological factor, and where it is found, to remove it if possible. The systematic following up of this idea has not only given many satisfactory results but has also helped to clear the labyrinthine paths of classification. The fact that nearly every author who has worked in the gigantic struggle to bring order out of the chaos of clinical, pathological and radiological pictures has developed a new system of classification, suggests that probably none fully satisfies all conditions.

We have here adopted the classification of Goldthwait because it is simple and clear, and is now rather generally adopted in this country.

Goldthwait distinguishes three types of arthritis:

I. Infectious arthritis.
II. Atrophic or rheumatoid arthritis.
III. Hypertrophic arthritis or osteo-arthritis.

INFECTIOUS ARTHRITIS.

It seems to be certain that many cases which heretofore were considered as rheumatic or constitutional, are of an infectious origin; therefore that class is considerably enlarged, and probably comprises more of the types of arthritis than is frequently believed. Of the infectious type we can separate those which are well characterized as to their bacterial nature —the tubercular, syphilitic, gonorrheic, pyogenic, osteomye-

litic, and perhaps a few more. The others comprise those cases which are now mostly called infectious arthritis in a narrower sense, or chronic polyarticular rheumatism, cases in which the bacterial origin seems to be certain, though the identity of the bacteria is still in doubt. We admit that in some of these cases approach to definite proof of their infectious nature has so far been unsuccessful, but we believe that further research and study will overcome more and more the obstacles still present.

With the hopeful progress in the treatment of arthritis from an etiological point of view, other remedies have not become unnecessary, but have rather been placed on a more rational basis. Therefore it seems important, before we describe the value of massage and exercise in cases of arthritis, to call attention to those recent progressive tendencies and to emphasize the fact that first of all close search must be made in every case for the source of infection; and only when this has been done or is being done may physical treatment be employed if indicated.

This book is not the place to compare the value of various physical methods; all of them may be of benefit, and hydrotherapy, balneotherapy, hot air and electricity are doubtless of value. We shall only describe the indications, technic and some results of the use of massage and exercise, although a few hints as to hot air and the congestive treatment may be permitted, as in our own and many other clinics these methods are frequently connected with massage and exercise.

The modern view that prevention is the best part of therapy calls for special consideration of the indications; not that we think that such means as massage or exercise alone would be able to prevent the inception or progress of arthritis, but that we believe they can serve to a very considerable degree in preventing such grave sequelæ as contracture, stiffness, and perhaps even ankylosis. Moreover, it is worth mentioning that in so far as arthritis is a disease of the whole body, the joint affections representing just the most conspicuous manifestations of that disease, any obvious tendency toward arthritis would call for a most

thorough general prophylactic treatment, and the application of all such means as strengthen the general health.

That a rational use of exercise is indeed able to benefit such persons cannot be doubted, but we should lay emphasis on the word rational. It is here that the family physician who sees more of such cases than we, can do most good by carefully prescribing and supervising a general régime in which exercise should have a prominent place. That also in these cases a most careful search for a possible focus and its removal, if found, ranks first of all is a matter of course, but experience constantly teaches us that the great importance of those principles is not generally recognized. When the disease has already developed it is hardly possible to distinguish between measures for treatment and measures for preventing further progress, contracture, ankylosis, etc.

Before discussing the indications for massage and exercise treatment in arthritis we have to speak of the contraindications. It is generally admitted that an acutely inflamed joint should not be touched but that it should be kept in a state of rest. Some authors recommend the use of centripetal massage of the proximal parts, as for instance, the muscles of the thigh in an affection of the knee-joint; a method which is frequently called derivative massage. We have tried this method in a few cases without being impressed with its value, but will not deny that it may do some good at times. There are usually better methods at hand to relieve severe pain in such joints as we shall see below.

Doubtless many of those cases will recover their function wholly or in part if they are left alone, and if motion and use are simply not prevented. But we have had rather frequent experience with joints which had been very acutely affected, and where very careful treatment by massage and exercise was begun at a time when the patient was not able to manage the functional problem himself. It is a matter of experience and judgment, and a difficult one at that, to decide when such functional treatment may be begun safely. In fact, the first few treatments are in a measure experimental ones.

The following case may serve as an example of how such treatment can be carried out satisfactorily.

The patient was sent to the orthopedic department on September 29, 1915, with the diagnosis of acute infectious arthritis of the right wrist, caused by an acute gonorrheal infection which he had contracted four weeks previously. The wrist and hand and the greatest part of the forearm as well as the fingers were extremely swollen and sensitive. No examination was attempted as to the function, and the patient's hand and forearm were placed in a well-padded plaster cast for three days. On his return the cast was split and a few very gentle active-passive motions of his fingers were performed in a small angle. This was repeated after four days, and beginning October 9 every week-day until November 5, when he was practically cured, at least concerning the function of all other parts except the wrist which showed only 5 to 10 degrees in every direction. This case is cited as an example that, with the correct technic, the treatment of the function can be begun at least in the neighboring parts at a time when the inflammation is very acute.

It is not to be denied that there is a danger in such management. I have seen an acute exacerbation in one case, though this may have been caused by irrational behavior of the patient himself. Furthermore, hot-air treatment had been given in that case not entirely with my consent. Bier warns against the use of active hyperemia by hot air in acute monarticular arthritis and emphasizes the application of the elastic bandage to produce passive hyperemia. Although this method does not actually belong to the subject of this book, its brief mention may be permitted not only because it is a very valuable and rather simple method, which nevertheless is not sufficiently recognized in this country, but also because its application is in many cases the most efficient and safest way to prepare the patient for a rational treatment with exercise and massage.

The passive congestive hyperemia is most indicated in the acute monarticular arthritis of the gonorrheic and allied types. A thin rubber bandage is applied on the upper arm in affections of the elbow or wrist, or on the femur in affections of the knee and foot. Constriction must be *very* slight, just enough to cause a narrowing of the superficial

veins, but not an entire obstruction. In fact, the constriction is so slight that invariably nurses or assistants, when ordered to apply the bandage, make it too snug, causing a very quick and marked constriction, discoloration of the skin and severe pain. The question of pain is of greatest importance, as it is an indication for the correct application. If pain continues or becomes increased, the bandage is too tight and must be removed at once; otherwise it may stay in place for twenty hours and be reapplied after an intermission of four hours. When, after that interval, the bandage is reapplied it usually gives much satisfaction to the patient who rejoices in the relieving effect. When I have applied the bandage myself the method has not failed in any single case of acute arthritis during the early stage, while in prolonged cases, several weeks after the beginning, the results have been less certain. This experience is in full agreement with that of Bier and others. Sometimes the results obtained by passive hyperemia have been very extraordinary and striking. Theories of explanation of the physiological effects of this method are related in detail in the books of Meyer-Schmieden, Bier, and Joseph, to which we refer our readers.

It is obvious that the methods just discussed have only a limited field of application. They are useful mainly in the gonorrheic type and similar forms of arthritis. When those cases have not had the right care in the beginning—and it is often for social reasons that not everything can be done—they often become chronic. Such a chronic condition is found especially often in those joints which are under constant strain; the feet and knees, and also the shoulders, and sometimes the wrists. Here hot air, massage and gentle resistive exercises are valuable aids to whatever other treatment may be indicated from etiological points of view, those for prostatitis, or for orthopedic defects, faulty weight-bearing or foot-strain. For a while such treatments must be test treatments; the tolerance of the joint must be carefully studied and not too much be expected in the beginning. When adhesions are present they should not be broken up all at once, but gradually loosened by friction of the capsule and its surroundings, and persistent active exercise. When

after several weeks no improvement in the angle of motion is obtained, a *gentle* manipulation under an anesthetic sometimes will be of benefit, but too much should not be expected from such measures.

What can be expected from massage of the joint depends on the changes in the capsule. Every surgeon who has had frequent experience with operations on joints knows how different the appearance of the capsule may be according to the stage of the affection. We see those capsules greatly thickened, three or four times as thick as the normal capsule, infiltrated, edematous, very rich in newly formed vessels, with a great deal of plastic material between the layers of tissues. In such cases correct massage should indeed be able to favor the conditions of healing, maintain elasticity, and mobility between the different layers, remove the stagnant edema, hasten the slow circulation in the blood and lymph capillaries and in addition supply functional stimulation to the newly formed cells.

On the other hand, we see capsules which, though much thickened, consist chiefly of firm layers of connective tissue, poor in bloodvessels, poor in tissue juice and plastic cells. In those cases massage cannot be expected to have much influence. Sometimes such capsules can be stretched by persistent exercise, but often the results are very unsatisfactory. Similar conditions are frequently seen on the dorsal aponeurosis of the fingers or on the quadriceps tendon. In several cases of that kind which we have had opportunity to examine years afterward a slight gain in motion had been made by constant use, but generally they are rather hopeless in regard to their functional recovery. The capsule has been transformed into a mass of scar-like tissue which, if conditions are favorable, should be treated in the same way as deforming or contracting scars of the skin by excision and appropriate plastic operations. The successes of Payr with the arthroplasty of joints have proved his experimental findings that a new capsule, including the ligaments, will be formed from the surrounding connective tissue when the entire capsule has been excised.

This discussion is intended to bring out the point that it

is not wise to advise massage indiscriminately in all such cases, but that individual differentiations are strictly indicated, though it must be admitted that in practice it is often very difficult to get a clear idea of the condition of the capsule, and this may be impossible in joints which are not very near to the skin.

In wrists and ankles careful attention should be given to the tendon sheaths which are often affected with the joints, and may be to a great extent responsible for limitation of function. Special attention should also be given to the muscles, particularly the extensor muscles. Generally when the patient is able to control his function to a certain extent, no treatment is necessary other than advice as to appropriate use without overdoing. We say appropriate use, because for instance, walking on a deformed foot in faulty weight-bearing will do more harm than good; likewise the elevation of the arm if it is not properly done in the humeroscapular joint, but as a scapular motion alone, may cause constant strain and irritation. In all cases where sufficient control is not obtained systematic resistive exercise is valuable if not necessary. Massage is a valuable aid, but hardly sufficient without exercise.

Septic Hand.—Cases with a septic finger or hand frequently offer very difficult problems, both to the surgeon and to the masseur. The question of what measures should be taken during the acute stage to warrant the best possible function cannot be discussed in this book. Generally we see these cases after the wounds have been healed, the scars become solid and the fingers stiff and contracted. A number of cases, however, which have been treated at our hospital were sent to the medico-mechanical department before the wounds had closed, sometimes with rubber drains still in place and large granulating surfaces still present. This procedure is extremely wise and has enabled us to present much better end-results. We have seen hardly any complications resulting from such early functional treatment, though in a few cases the treatment had to be interrupted for a few days on account of a slight increase of the inflammation. In one case of severe sepsis of the left arm and

hand, which was sent to us only a few days after the onset with numerous discharging wounds, the patient had a chill and temperature of 104° F. on the evening following the first very light treatment. The temperature fell to the normal in two days and treatment was continued uninterruptedly with a very satisfactory end-result. The fever had obviously been caused by pressing toxic matters into the general circulation by the massage given on the first day. Since this experience we omit massage for the first week or two, and apply simply exercise treatment.

This consists at first in very cautiously given, slow passive and soon afterward active movements of each single joint, not more than two or three times. The whole treatment at first should not last longer than five to ten minutes. In a later stage, however, it will consume much more time, up to an hour and even longer. A detailed description of this treatment is not necessary, as it follows the rules laid down in Chapter XI.

By a persistent treatment function may be restored to a very large degree, provided the septic process has not been too extensive and the case is not too old and neglected. Of course with defects of tendons and severe infection of joints nothing can be expected from conservative methods.

The indications for massage and exercise discussed for secondary chronic infectious arthritis apply to a certain extent to the primary form, though here still greater care should be taken and the etiological indications should always be considered first. I wish to emphasize this point because not infrequently I have been asked by patients, masseurs and even physicians about the value of massage. The control of these cases is perhaps still more difficult than in the former type, and the old medical law that the first rule is to do no harm should constantly be borne in mind in handling chronic polyarticular arthritis. In one large hospital patients with arthritis receive a slip of paper at their discharge, where in addition to other rules and regulations in regard to habits, diet, etc., the remark is added: "Rub your joints twice daily as hard as you can." From our personal experience we cannot recommend such advice and

feel that much harm may be done. Moreover, when in such cases steps have been taken to fight the disease by the removal of carious roots of teeth, or infected tonsils, etc., any local treatment would seem to interfere with observations of the reactions to these other steps, which are necessary for clear ideas of the situations. Therefore it would seem indicated to allow at least a certain length of time for the reactions to appear and to apply massage or exercise or both later, as may then seem advisable.

Besides the indications already discussed we should mention the relief of pain in chronic arthritis. Hot air and massage are sometimes excellent means to soothe irritated nerves and spastic muscles. Massage should be done with sufficient ease and preferably toward the proximal sides of the affected joints. Massage of the joints directly is ordinarily too irritative and should be omitted if pain is present.

Massage and exercise can also be of great value in relieving contractures and stiffness, though their effect naturally depends on the real damage done to the joints, muscles, tendons, tendon sheaths and bursæ, and often much more effective means are needed than simple exercises. In several cases of chronic infectious polyarthritis which had led to severe crippling of the hands we have restored a good deal of the usefulness of this important part of the human body by a persistent use of massage and exercise.

A young woman, aged thirty years, came to me, having had "rheumatism" four years ago which started in the right fifth finger and came on slowly. Within six months many joints of the arms, hands and legs had been affected. She had to stay in bed almost six months and suffered a great deal of pain. Under no other treatment but medicine and liniments the disease had come to a standstill, but had left her with both feet and both hands crippled. Her general health had been very poor all that time, but now was much better. When she was seen first there was no pain in the joints. Without going into details it may just be said that the left shoulder and elbow were somewhat limited and all other joints below the elbow very much restricted in motion. The right arm, shoulder and elbow were free; the

other joints all somewhat restricted in motion, but not quite as much as on the left arm. Many of the finger-joints were contracted in flexed position; some of the middle joints were hyperextended. Although the case looked rather hopeless, treatment of baking, massage and exercise, especially resistive exercise, was given for three months almost constantly three times a week for one hour at a time, with the result that the patient at the end was able to do a great many things which she had not done during the last four years, such as writing, sewing, knitting, and a number of the lighter household occupations. The treatment had been done intentionally without causing pain to the patient, who was rather afraid of the treatment in the beginning and had to be educated to confidence and endurance. In regard to the technic it may be mentioned that at least in the beginning each single joint was taken up individually, and only after a certain amount of control and strength had been obtained, motions were done in more than one joint and in more than one finger at a time. After a while the patient had to practise how to grasp and hold a penholder, a needle, or similar things between the fingers and had to do more complicated combination exercises with either one hand or with both hands together.

Finally, general indications should be considered. The benefit derived from massage and exercise in cases of convalescence and debility may also be available for arthritic patients. We have therefore frequently applied general massage to hospital patients who were being studied and treated from an etiological point of view without having any definite reaction, and have usually seen a pleasant stimulative effect, which in the end must have been of value to the affected joints themselves, though no quick change was seen and could hardly be expected.

From the work of Lane, Goldthwait, Strangeways, and others, we know that in many cases infectious arthritis is caused by chronic disorders of the intestinal tract. Those patients are very often severely constipated, and the evident effect of abdominal massage on chronic constipation suggests its wide applications to those unfortunate sufferers.

Painter and Brown, at the Robert Brigham Hospital in Boston, have in recent years applied in cases of chronic arthritis methods of postural correction practically identical with many of those described in Chapters III and XVI. The special indication for such treatment has been given by the observation that in about all their cases of severe chronic infectious arthritis the posture was very defective and the function of the internal organs much impaired. In many cases the results have been extremely encouraging, and it has been a great pleasure and satisfaction to the writer while on a visit to that hospital to see patients perform postural exercises in excellent poise and with fine vigor, who had entered the hospital as hopeless cripples, after being bed-ridden for years and considered as incurable by their physicians, their relatives, and themselves. While it was emphasized that in those patients every other rational method of etiological, dietetic, and general hygienic treatment has been used, the particular value of the exercise treatment in addition to massage and hydrotherapy could not be doubted. The experiences we have had in that hospital have only helped to increase my conviction that nothing is more wrong in the management of these unfortunate sufferers than to leave them alone to their fate. And to repeat it once more, it is the duty of the family physician in the early stages of arthritis, not only to exhaust all possible means in the way of tests and examinations for a rational care from the etiological point of view, but also to consider carefully to what extent physical methods can be made use of to stimulate general and local conditions of his patients. Moreover, in applying such methods in early stages, the physician will soon recognize that their value is much greater in preventing than in curing atrophy of muscles, contractures, and adhesions of joints.

ATROPHIC OR RHEUMATOID ARTHRITIS.

The second type is that commonly known as rheumatoid or atrophic arthritis, an affection which is most frequently seen among women of middle age who belong to the poorer

classes, people who have felt a good deal of the "wear and tear of life and the exigencies of poverty." "Such factors as grief, accident and its attendant nervous shock, play an important part in the etiology."[1] The disease which is generally believed not to be of an infectious nature involves all structures of the joint and in its final stages may lead to very destructive lesions.

Experiments on patients suffering from this disease have shown a great disturbance of the calcium metabolism. "Calcium is excreted in more than twice the amount in which it was injected," and histological as well as *x*-ray examinations leave no doubt that the abundance of excreted calcium is derived from the bones. This disturbance of the metabolism has been found only during the acute stage. Whether a nervous element, in the line of a neurotrophic disturbance plays a definite part in the pathogenesis of this disease is not yet definitely known, but is suspected to exist.

Atrophic arthritis is a polyarticular affection, attacking, as a rule, the peripheral joints first, while the spine is less frequently affected than in other types. The joints become swollen by capsular infiltration and show in later stages typical deformities: flexion or subluxation. At times true ankylosis takes place in some of the joints.

Marked constitutional disturbances are usually seen, such as muscular atrophy, poor circulation, parchment-like, anemic skin, and general lassitude. The most important form of treatment is orthopedic prevention and correction of deformity, and it is evident that here exercise and massage have a large field, though often only secondary to more radical procedures, forcible reduction of contractures, operations, etc. But massage and proper exercise would be of greater advantage if they could be employed at the right moment. Most of the patients who have been seen by the writer were in such an advanced, hopeless stage that nothing could be expected from these or perhaps any other form of treatment. The general character and the clinical course of atrophic arthritis, however, make it evident that much can

[1] Goldthwait, Painter, Osgood: Diseases of the Joints and Bones.

be expected from a stimulative treatment such as massage and also to some extent exercise provided the disease has not gone too far. "Massage can be practised directly upon these joints as well as upon muscles in the neighborhood without risk of stirring up any active process and with very great benefit to the local condition."

It is evident that during the acute stage any stimulative treatment should be abolished, but when the acute symptoms have subsided a certain amount of massage and exercise, that out of doors being best, is advisable and preferable to long-continued rest, as is often forced upon such patients by well-meaning physicians.

HYPERTROPHIC ARTHRITIS OR OSTEO-ARTHRITIS.

Hypertrophic arthritis, or osteo-arthritis has been the subject of frequent discussion as to its etiology in recent years. The role which infectious and constitutional disturbances play in such cases as primary or secondary factors is not certain. Radiologists and clinicians not rarely call cases of typical infectious arthritis hypertrophic because of the findings of proliferations in the *x*-ray picture. These types, however, can be well separated in most cases. Hypertrophic arthritis is poly- or monarticular, though in cases where one joint is the seat of the trouble close search will usually reveal changes in some other additional joints. The fingers, knees, spine, hips, elbow and feet are the parts most frequently involved. It is generally seen in elderly people and in men more often than in women.

Goldthwait, Painter and Osgood state that traumatism and exposure play an important part in the etiology. "The traumatism need not necessarily be a direct and violent one from the outside, but may be a mild and oftentimes unrecognized injury which results from the ordinary occupational use to which the affected joints are put." "Among men the greater number of instances of hypertrophic lesions occur in those whose occupation subjects them to slight but oft-repeated injuries." Firemen, teamsters, freight handlers and men with similar occupations represent a large contin-

gent among the people suffering from hypertrophic arthritis. "Among women the disease is more common in the finger and knee-joint. It is more frequently seen in those who do their own housework and are constantly subjecting their fingers to the slight but oft-repeated traumatisms of household duties." Affections of the knees are very often seen in stout women with faulty poise.

Schanz[1] believes that hypertrophic arthritis or "arthritis deformans" is nothing but the reaction of the joint structures against abuse with advancing age. Like any machine a joint will be worn off, and the various typical signs are all easily explained from such a point of view; the degeneration and the defects of cartilage, which result from the inflammatory symptoms, represent reactions against traumatic insults; and the hypertrophic proliferations are products of a natural tendency to self-repair, though frequently they do not seem to be very appropriate.

We feel that the comparison of a joint with a machine is excellent, and as a machine serves the better and longer the better the care that is taken of it, so likewise a joint will be better preserved the better care we take of our health in general and of our joints in particular. This is especially true in regard to weight-bearing, a point which plays a prominent role in Preiser's[2] theory. This author goes so far as to say that faulty weight-bearing is the chief or frequently even the sole cause of hypertrophic arthritis or arthritis deformans, and has developed his ideas in a very elaborate way. Although Preiser's theory has not been generally accepted it has drawn greater attention to the certainly important connection between faulty weight-bearing and hypertrophic arthritis.

Finally we shall mention Wollenberg's industrious studies which have led him to the conclusion that hypertrophic arthritis is caused by sclerotic changes of the arteries supplying the joints. Wollenberg's theory is not generally accepted, or rather his findings have been frequently interpreted to

[1] Ztschr. f. orthopaedische Chirurgie, vol. xxxiv, p. 258.

[2] Statische Gelenkenkrankungen, Stuttgart, 1911, and many other publications.

mean that both processes, the sclerotic change of the vessels and the hypertrophic arthritis are signs of one and the same pathological process.

The chances for a rational prophylaxis are, as a rule, not very favorable. Usually patients do not seek the physician's advice until pain, aches and soreness occur, or until the affected limbs begin to refuse service. Frequently these symptoms appear before the changes have progressed very far. They come in waves, with intermissions; during the quiet stage the patient's mind is satisfied, until perhaps after a more strenuous effort the symptoms begin again. In these cases a rational application of physical therapeutics used for a sufficiently long time is in our opinion of very great value, although by the very nature of these processes definite conclusions as to the effect of the treatment are often impossible. At least such conclusions must not be based upon subjective relief because, as we have just mentioned, pains or aches come and go so often without any obvious cause. On the other hand, when objective changes exist the disease has usually passed those limits where we can expect much of any prophylactic treatment.

The more advanced the stage is in which we see the disease, the less we can expect from a rather conservative treatment such as massage and exercise represent, but even here we have been able in a considerable number of cases to add largely to the comfort of the patient, to improve the arc of motion, and perhaps even to act retardingly upon the degenerative process. The first law is here, as always, not to do harm. We have to handle those cases with great care and remember that hypertrophic joints are particularly vulnerable. It is absolutely contraindicated to produce stimulating effects upon such tissues which are in overirritated condition, and particularly on bony proliferations, because we know from frequent experience in the treatment of fractures with delayed union that mechanical stimulation favors the growth of callus and bony proliferations.

We have, therefore, generally restricted massage treatment to the muscular parts and treated the joints themselves either not at all or only very lightly. A certain indication

for direct joint massage is given frequently by the steady ache. Light effleurage and kneading are the manipulations preferred, while firm friction and vibration are not advisable. Baking has often been found of great value in producing alleviating effects, but even this method should be used with care and not be exaggerated. Light hyperemia by an application of hot air of not over 200° F. and not over fifteen to twenty minutes' duration, would seem to us preferable to any very stimulative treatment.

The question of how much exercise should be used depends largely on the condition of the joints. The joints of the lower extremity must be considered quite differently from those of the arm. In the latter we desire motion as free as possible; in the former the weight-bearing question is just as, or perhaps more, important than the mobility. We would not advise the giving of passive or active exercise to a hip-joint which is fairly quiescent and allows comfortable weight-bearing. On the other hand, a stiff shoulder limits the function of the whole arm to a very large extent, and we feel justified in making comparatively greater efforts to regain motion. But here also we advise strictly against too great efforts, and especially against forcible manipulations under an anesthetic. Often a great deal of the limitation of motion is caused by a simultaneous affection of the subacromial bursa. It should be treated according to the principles stated in Chapter XIV.

In prescribing exercise treatment to hypertrophic joints we lay special emphasis on the manner in which the resistive exercise is used. It is here more important than perhaps under any other conditions to restrict the amount of motion. As long as any irritation exists in the joint, the operator should not go beyond that amount which the patient is able to control himself. This at the same time would preclude his looking for a gain in motion which would be evident at the time of the treatment. If he does so, he will be tempted to use passive manipulations instead of active-resistive exercise. Therefore the routine methods of treatment of stiff joints as prescribed in Chapter XI do not apply to hypertrophic arthritis.

We have seen in the general part of the book that one of the features of resistive exercise is that intra-articular pressure will be reduced to a minimum. It would seem, therefore, as if systematic resistive exercise would serve as an excellent means to keep the joints limber without doing that harm which irregular movement does. The joints are the least "abused" by the systematic application of resistive exercise, as Schanz observes.

The following case is cited as an example how, by a rational and long-continued use of massage and exercise treatment in addition to other appropriate methods, a definite improvement can be seen.

A woman, aged fifty-five years, complained for several years of aching and dragging sensations in both knees and hips, and had increasing trouble in walking, so much so that finally she had to give it up. A surgeon who saw her advised rest. After following this advice for several months no improvement was noticed; walking was just as bad as before, or even worse, and the patient became very much discouraged. On clinical and *x*-ray examinations both knees showed very marked hypertrophic changes. I advised relief from weight-bearing by temporary use of crutches, and started her on a treatment of massage, chiefly applied to the muscles of the legs and thigh. Exercise was done without weight-bearing, and consisted in resistive movements of the hips and knee, and also of the arms and the trunk. These exercises were done on a simple gymnastic apparatus which was constructed in her own home. The very great weakness of the muscles of the thigh which was one of the most conspicuous symptoms, has been considerably improved, and the patient walks with distinctly greater ease than before. This case should serve as an example mainly against a certain pessimism of physicians in treating or rather not treating the cases before they are at the worst stages. Rest is necessary where inflammatory and irritative symptoms exist, but it should not be prescribed in a general way, but freely mixed with exercise of such a character that no harm can be done to the affected joints.

Aside from the local treatment of the affected joints general indications exist, such as favoring free elimination, accompanying adipositas which is liable to aggravate symptoms, a general poor circulation, and others. Under all such conditions exercise and massage may be indicated, though in applying them great care should be taken not to injure the affected joints which are so susceptible to traumatism.

CHAPTER XIV.

SUBACROMIAL BURSITIS.

Affections of the shoulder are so common and its mechanism is so peculiar that it would seem justifiable to discuss them in a special chapter. Furthermore, the particular characteristics of the shoulder mechanism have only recently been fully understood; hence as practice shows they are not yet so commonly known by physicians and masseurs. A few anatomical and physiological remarks are necessary for a clear understanding of the problems and clinical pictures.

The normal motions of the shoulder depend on the coöperation of the humeroscapular joint, the subacromial semijoint mechanism, the clavicular joints, and the mechanism of motion of the scapula.

The humeroscapular joint allows a very large amount of motion, but the humerus is checked upward and sideward by the acromion. In abduction and elevation of the humerus the greater tuberosity slides underneath the acromion. This mechanism is made possible by the presence of the subacromial bursa which may be considered as a semijoint.

The motions of the humeroscapular joint which, as we have stated, are checked to some extent by the scapula are further supplemented by the mobility of the scapula. The coöperation of these three factors permits a very great amount of mobility, more than in any other joint of the body, united with great firmness and strength under very unfavorable leverage conditions.

The joints of the clavicle are of minor importance, as they are less frequently subject to pathological changes than the others, and as with even one of them considerably damaged the function of the shoulder may not necessarily be reduced to a very great extent.

The muscular mechanism of the shoulder motions is made up of not less than seventeen muscles, of which six go from the trunk to the scapula, two from the trunk to the humerus, and nine from the scapula to the humerus. Two of the last group, biceps and triceps, also serve the elbow-joint. This multitude of muscles which receive their nerve supply from various parts of the cervicobrachial plexus, from the second to the seventh cervical segment, requires an extremely complicated and delicate coöperation, and it is easily understood that any affection will at once bring about a greater or lesser disturbance of this coöperation. This would explain why spastic contractions of the muscles are more frequently seen here than in any other part of the body with the exception of the lumbosacral and sacro-iliac and perhaps the cervical regions. We shall come back to this point later because its thorough consideration is one of the most important requirements for rational treatment of many lesions of the shoulder.

The number of such lesions is legion and it is impossible to discuss all of them within the limits of this book. Furthermore, a number of them have found sufficient consideration in other chapters and do not need to be repeated here.

The most important clinical significance is attached to lesions of the shoulder by the frequent involvement, primary or secondary, of the subacromial bursa and the disturbance of its function as a semijoint. It is due to this fact that the greatest number of shoulder cases enter our clinic with the diagnosis subacromial bursitis. While we cannot accept this as a diagnosis in all cases and should try to specify the nature of the pathological process more clearly, if this is at all possible, the frequent use of this term shows that the symptoms of an involvement of the subacromial bursa very often stands in the foreground.

Dr. E. A. Codman deserves much credit for being the first in this country, by careful anatomical studies and clinical observations, to throw light upon that region after Küster and others had previously called attention to its important role in the pathology and therapy of shoulder lesions.

Codman divides the cases of subacromial bursitis into three types.

1. Acute or spasmodic type.
2. Subacute or adherent type.
3. Chronic or non-adherent type.

In looking over our large number of cases we have found no better classification, although in any given case a definite distinction between the types A and B is not always quite easy.

Codman[1] in his excellent monograph has elaborately defined the symptoms of these three types of subacromial bursitis and discussed the differential diagnosis. We refer to his articles as to details, and shall here just mention the most frequent conditions with which subacromial bursitis is confused. These are, according to Codman: Tuberculosis of the shoulder-joint, fractures of the tuberosity, fractures of the anatomical or surgical neck of the humerus, deep axillary abscess, and neuritis.

In a very large number of cases the subacromial bursitis is secondary to a lesion of the neighboring structures. Such lesions are in the majority of cases traumatic in the widest sense of the word. We find here another point of analogy to the lesions of the lumbosacral regions which are also very frequently of traumatic origin. When we speak of traumatic origin we mean not only actual injuries but also want to include frequently repeated strains and sprains as they are caused by many occupations, as well as minor injuries such as heavy lifting, a sudden forced elevation of the arm in reaching up quickly, and other small accidents, often not recognized as such by patients or physicians but nevertheless sometimes leading to severe damage. From the abundant material of our hospital Risley[2] has enumerated the most common shoulder injuries which, as he claims, can be diagnosed in most of the cases. An analysis of 450 cases which Risley has seen in the out-patient department during the

[1] Bursitis Subacromialis, or Periarthritis of the Shoulder-joint, Boston.

[2] The Common Shoulder Injuries, Boston Medical and Surgical Journal, September 16, 1915.

years 1913 and 1914 has shown the order of frequency to be about as follows:

1. Simple contusion or sprain of the shoulder without fracture or other complication.
2. Subacromial bursitis.
   (*a*) Occupational.
   (*b*) Traumatic.
   (*c*) Secondary to some other injury or infection.
3. Fracture, insertion fracture or contusion of the greater tuberosity of the humerus or acromion.
4. Dislocation of the joint.
5. Ruptured supraspinatus tendon with or without separation of the greater tuberosity.
6. Fracture of the upper end of the humerus.
7. Chronic arthritis of the acromioclavicular joint.
8. Occupational neuroses.
9. Arthritis of the shoulder-joint.
   (*a*) Traumatic in origin.
   (*b*) Old infectious joints.
10. Injuries to the brachial plexus.

Turning our attention next to the treatment we shall not attempt to give a detailed description of the various kinds of therapeutic measures, but will merely describe the value of massage and exercise with brief references to other methods as far as they do not follow general principles.

We do not see any clearer way than to follow again Codman's description, with which we agree in principle.

1. In the first, the acute or spasmodic type, the main indications are: "the patient's comfort and the avoidance of adhesions." "Rest is best obtained by keeping the arm in abducted position;" "the patient may be seated with a table at his side and the abducted arm laid on a pillow on the table." During the night "the arm is supported on a pillow placed with its long axis at right angles with the patient's body as he lies on his back." When the patient is up he may wear the arm in a sling, but should be advised to let the arm occasionally swing by his side or rest it on a table (Fig. 50). Massage applied to adjacent muscles and subcutaneous tissue may be of value, but it should not be applied

to the region of the bursa directly. As in all such acute cases, joints, bursæ or other structures being affected, too extensive and heroic treatment is contraindicated and will

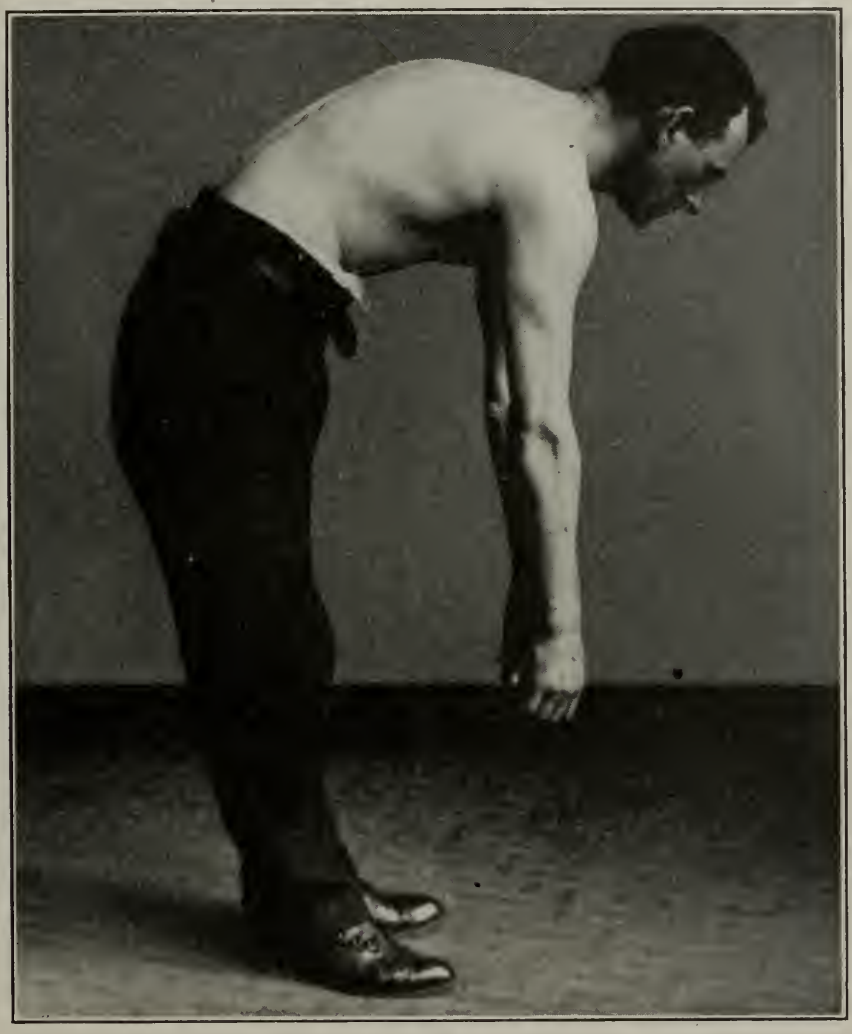


Fig. 50.—An active-passive exercise devised by Codman. The patient leans forward and has his arm drop passively. This movement is often possible in subacromial bursitis where an active motion at the same angle is not possible.

do more harm than good. When the acute stage has passed gentle exercise may be done. For such cases the pendulum and other Zander apparatus are of decided value, though not necessary.

2. In the subacute or adherent type the treatment outlined under No. 1 will suffice as long as the adhesions are plastic. Even then the limitation may be of a chiefly spastic nature. But here a somewhat more active course is indicated. These are the cases where much benefit can be derived from a rational treatment which is given under full

Fig. 51.—Position for active and passive exercises of the shoulder; the forefinger of the left hand rests over the tuberosity; the middle finger over the acromion, while the other fingers steady the scapula. The right hand elevates the arm or gives resistance against drawing it downward, etc.

consideration of the peculiar anatomical conditions (Fig. 51), whereas a neglect of these conditions will almost certainly do much harm. As these cases are quite frequent I shall give a detailed description of the treatment in the three following cases which may be considered as typical.

Case I.—A woman of middle age, who complained of trouble in her right shoulder since June, 1915, from an

unknown cause. She has not had any real injury but admits that she has strained her arm a great deal. In trying to keep on using the arm conditions became worse until in October the arm bothered her a great deal and the shoulder became entirely stiff. No treatment but rest had been given. The pain was relieved to a great extent but the stiffness persisted. The patient, who is a piano-player, was not able to play for over three months.

When I first saw the patient, January 10, 1916, the right shoulder was found to be almost stiff in all directions. Any attempt to move the shoulder caused considerable pain. There was no local tenderness but a moderate atrophy of the muscles, especially the anterior part of the deltoid. After thirty minutes of moderate baking motion returned in part. The rotation was then free about 30 degrees; abduction 25 to 30 degrees and anteroposterior motions even more. The arm could be raised forward about 40 to 45 degrees; backward about 5 to 10 degrees.

A very mild treatment of massage and resistive exercise was applied on the first day according to the principles laid down in Chapter XI, page 157. Two days later the motion gained at the first treatment was entirely lost again, but the patient had not had any discomfort after the treatment. Under baking, gentle massage and resistive exercise motion was restored as on the first day and perhaps slightly more. The improvement went on at first very slowly, but after a few weeks the patient began to improve more rapidly, and after three months had nearly completely recovered except for very slight limitation of motion in an extreme outward and inward rotation while in full abduction. The treatment was given at first in the lying position only, and only after several weeks' treatment were movements in upright position and cane exercises added. The number of treatments given from January 10 to the end of April was twenty-four.

The importance of baking of moderate duration and intensity in many affections of the shoulder cases has been demonstrated several times in this particular case. One day the baking machine was out of order and baking could not be given in the usual way; the relaxation of the muscles that day was

very much less conspicuous than when baking had been given previous to the massage and exercise. On another day the baking had been extended longer than usual and longer than should have been done, and after that treatment the patient complained of lasting pain and soreness which she almost never did after the ordinary kind of treatment.

Case II.—The patient, a healthy man of middle age, fell on June 1 and hurt his left shoulder. He had considerable pain for a few days and was not able to use his arm. There were no blue spots seen and no swelling. The pain stopped soon but stiffness has persisted ever since. I saw the patient on September 21 and made the following record: There was a slight thickening over the subcoracoid bursa and this spot was somewhat tender. The patient complained of pain at any effort to force abduction. There was no pronounced atrophy of muscles. Abduction was only about 30 to 40 degrees or with added scapula motion about 60 degrees. The forward elevation was 70 degrees; with the scapula about 100 degrees. The rotation was only slightly limited and the patient was able to bring his hand around on the back, though not quite so far as normal. Massage and gentle passive manipulations were applied on the first day, care being taken not to force motion; then the patient was advised to rest his arm for several days. At the second visit very slight resistive exercises in the lying position were added to the massage and gentle manipulations, and the treatment increased in duration, intensity and frequency. After six to eight treatments I succeeded for the first time in bringing the tuberosity underneath the acromion. This was done while the arm was elevated in adduction and outward rotation. On that day we succeeded only once, and for the next two visits it was again impossible but after that it became gradually easier, also the angle, in which the arm was elevated so as to place the tuberosity underneath the acromion, became wider. Finally it became possible in full sideward abduction. As usual it took a comparatively long time to obtain the last 25 to 30 degrees of motion, but after ten weeks of treatment the patient had practically recovered.

Case III.—Another case of a very similar type was seen the year before. The conditions resembled those encountered in the previous case except for the angle in which gliding of the tuberosity underneath the acromion was accomplished for the first time and during a few weeks afterward. The patient had complained about his shoulder some six months, following a slight strain, before he was first seen by me. His right arm was very much limited in motion, except for the rotation which was fairly free. Six weeks before a manipulation under an anesthetic had been performed which, however, did not accomplish any lasting result. For about five months the patient had not been able to bring the tuberosity of the humerus underneath the acromion and any attempts caused pain. After treatments with baking, massage and resistive exercise for two or three weeks I succeeded in elevating the arm in the following way: abduction with the arm three-quarters inwardly rotated, bringing the elbow forward and finally elevating it with simultaneous outward rotation of about 30 degrees. Then the humerus went under the acromion with a very loud click which was slightly painful. For about two weeks the patient was not able to accomplish this himself, while I could do it easily, but only in the described manner. Then he learned to do it during the evening and after only a few weeks it could be done easily and at any time of the day and in an increasingly wider angle. After three months of treatment the patient was practically cured except for a slight and unimportant amount of restricted motion. The treatment was given at first in the lying position only, later also in the upright position and with the use of a cane.

To obtain the last 25 to 30 degrees of motion which often require a comparatively long time, the following cane exercises are recommended besides those described in Chapter IV, pages 46–48:

1. The operator stands behind the patient who holds the cane on his back with the arms straightened out. Then the patient moves the cane backward as much as possible, the operator giving resistance, and when the farthest limit is reached the patient moves it back again toward his body, the

operator again giving resistance. At the same time the beginning of the second half of this exercise is used for a vigorous stretching in the manner of an eccentric resistance exer-

Fig. 52.—Cane exercise for backward motion of arms.

cise, the operator holding the cane with his right hand and with his left hand steadying the scapula (Fig. 52).

2. The patient bends his elbows, thereby raising the cane horizontally as much as possible. Now the operator grasps

the elbows and gives resistance, concentric and eccentric, while the patient moves his elbows forward and backward. This exercise may be done symmetrically or asymmetrically. (Fig. 53.)

In order to apply greater force the operator pushes his right arm under the patient's arm (in an affection of the

FIG. 53.—Cane exercise for rotation of arm.

right shoulder) and steadies the scapula with both hands. The patient moves his elbow forward and backward. A very great and at the same time well-measured force may thus be applied.

Similar exercises may be done, as illustrated by Figs. 54 and 55.

In cases where firm cicatricial adhesions have formed one of the following methods of treatment must be adopted.

(*a*) Gradual stretching.

(*b*) Rupture under an anesthetic.

(*c*) Operation.

Fig. 54.—Cane exercise for rotation of arms.

For the choice of these various forms of treatment there must be considered not only the local conditions in and about the bursa but also, as Codman emphasizes, the causes, the nervous and physical conditions of the patient, and, as we may add, the social conditions and the competency of the surgeon or the masseur.

(*a*) From our experience we believe that the conservative treatment by gradual stretching, passive and active exercise with massage and hot air will give good results in very many cases. The general rules are about the same as in the spastic cases only that we should proceed with greater force and energy. Massage if applied correctly as deep friction over

FIG. 55.—Cane exercise for elevation and rotation of arms. This exercise is also of use in postural treatment.

the bursa is of great value, though we cannot reach the deeper subacromial portion. We apply the treatment best in the lying position as described above. The operator's left hand steadies the scapula while his right hand conducts the motions of the arm. After a short treatment with baking and massage we begin generally with rotary motions.

Resistive exercise is, as almost always, of greatest importance even when the motion is entirely restricted. Its value lies in the proper functioning of the contracted muscles which in time will exert a decided influence on the stretching, loosening, and final absorption of the adhesions.

The order of motions is generally as follows: (1) Rotation, outward and inward; (2) anteroposterior motion; (3) abduction; (4) combinations of these three motions.

When a certain amount of mobility and control has been obtained, exercises with a cane or pulley may be added and may be done by the patient himself at home. The most important point is that the operator as well as the patient distinguishes properly between motions in the humeroscapular joint and the subacromial semijoint on the one hand and motions which are done by the scapula alone on the other. Neglect of this rule is seen very frequently and tends to lead to irritation and soreness, delaying rather than hastening the functional recovery. All these motions must be done very slowly. Quick motions in these cases are invariably carried out by the scapula alone with the humerus held rigid, even when a certain amount of mobility exists in the shoulder-joint. The use of Zander or similar apparatus is rather problematic. We advise against it before a definite amount of control of the humeroscapular and subacromial motion is obtained. We have frequently observed patients with such stiff shoulders while performing exercises on Zander and pendulum apparatus and have almost constantly found that the motion was done by the scapula alone. They are not necessarily harmful, but rather useless. When a certain amount of control is obtained, however, apparatus is quite useful, although we can in no sense expect them to be specifically curable.

(*b*) In many cases, though probably not the majority, the adhesions are too firm to be loosened up by simple exercise. Then the manipulation under an anesthetic with or without fixation in the abducted position or an open operation is often advisable.

(*c*) Codman has raised objections against the too frequent application of manipulation under ether in a similar way as we have done in Chapter XI, p. 161. These objec-

tions are: The danger of injuring normal tissues and of speedy reformation of adhesions. He has emphasized, therefore, the preference of an open incision with dissection of the bursa and breaking up of adhesions under the direct guidance of the eye or finger. We are in full agreement with Codman, and give in the following the description of a case where this course was taken with a surprisingly good and quick result.

A rather slender and delicate woman, aged thirty-six years, who works in a box factory at a machine which requires great strain on the right arm. The arms frequently became tired but the patient never had any pain until one month ago; then pain started in the right biceps. After two weeks she had to stop work as the shoulder began to trouble her more and became stiff. The patient was admitted to the orthopedic ward March 23, 1915.

General examination was negative. The right shoulder showed very marked atrophy of the muscles. The upper arm was seven-eighths of an inch smaller than the left. The motions in the humeroscapular joint were almost entirely restricted except a slight amount of abduction. Rotation was absolutely limited. Any attempts to force motion or any active motion by the patient herself caused very severe pain. The *x*-ray picture showed very marked atrophy of the upper end of the humerus and glenoid, but nowhere any destructive processes or proliferations.

On account of the very severe symptoms which suggested a lesion of the joint itself, an exploratory arthrotomy was done on March 30 through a posterior incision. Both the capsule as well as the interior of the joint were found absolutely normal and the wound was closed again. Then from an anterior lateral incision the subacromial bursa was exposed. There was found a rather small subacromial bursa which did not pass beyond the limits of the subacromial space. There was no trace of a subdeltoid bursa. The wall of the subacromial bursa as far as it was seen seemed to be thickened and inflamed. With a blunt instrument the deltoid was lifted from its base on the humerus about as far as the subdeltoid bursa usually reaches. After this was done

the amount of stiffness was still the same as before. Then the arm was moved slowly in all directions, taking particular care to preserve the insertions of the rotator muscles and of the supraspinatus. A great many adhesions were broken with the characteristic crepitation which was localized in front of the head of the humerus. After the operation the arm was placed on an abduction splint and gentle passive and active motions were begun about the seventh day after the operation.

On April 11 the splint was removed and the arm allowed to be gradually adducted. About six or seven weeks after the operation, after the patient had been treated every day at the medico-mechanical department by massage and exercise she had perfectly free motion without any pain.

3. In the third type, the chronic or non-adherent type, pain or even temporary spasmodic restriction of certain motions is caused by "thickened folds, fringes, small osteophytes, calcareous deposits in the base of the bursa, etc." An open operation will probably bring about the quickest cure in such cases, though as the prognosis is almost always good it is not absolutely necessary. "Excepting operation, we know of no more effective treatment than massage." We agree entirely with this statement of Codman's. A deep, firm friction over the bursa with lifting up of the overlying soft tissues is of greatest value and will be further supplemented by deep kneading of the deltoid and the other shoulder muscles.

Exercises are of no particular value in this type and may even be contraindicated when the patient shows symptoms of spasm in certain motions. We generally advise against any special exercise treatment, leaving to the patient a moderate use for daily occupation and merely advising to avoid such movements as cause pain and spasm.

As was stated beforehand the shoulder is subject to a great variety of affections which may lead to pain and stiffness. In many such cases the subacromial and subcoracoid bursæ may also be affected. The treatment of those conditions does not require any detailed description as it generally follows the rules laid down in this chapter and in the chapters on injuries, arthritis, and neuralgia.

Two affections closely related to each other, however, would need special consideration on account of their particular interest, both from a pathological and a clinical point of view. These are the rupture of the supraspinatus tendon and the lime-salt deposits in the base of the subacromial bursa.

In the rupture of the supraspinatus tendon the pathological interest is centered in the fact that when the tear is of certain size the conditions of spontaneous repair are very unfavorable. The process of healing in a severed tendon takes place chiefly by an action of its tendon sheaths. The tendon of the supraspinatus runs between the capsule of the shoulder-joint and the floor of the subacromial bursa. In cases of extensive rupture of the tendon the floor of the bursa and even the capsule are equally ruptured. Then the chances of spontaneous healing are rather poor, and an operation is indicated for the restoration of function. The diagnosis of such rupture is often difficult when the shoulder is much restricted in motion; when the passive mobility is free the symptoms are rather typical. As soon as the diagnosis is made the tendon should be sutured and the arm placed on an abduction splint. Even suspicious cases ought to be operated. In the after-treatment exercise and massage are of great value, as the description of the following case will show:

A healthy man, aged fifty-eight years, injured his shoulder three months ago in the following way: He was lifting a heavy harness to a rack above his head and had his arms fully extended upward when his foot slipped and he felt something crack in his left shoulder. He managed to get the harness in place but could not raise the arm again. He came to the out-patient department where the diagnosis of a sprain of the shoulder was made, and the patient was sent to the medico-mechanical department. His left shoulder was very sensitive and showed almost complete absence of active and passive motion. As the function did not improve he was advised to have the shoulder operated upon.

The patient was operated upon March 19, and after full exposure of the joint had been obtained by temporarily dividing and turning back the acromion process it was found that the supraspinatus tendon was entirely torn loose from its insertion for about two-thirds of its breadth. There was also

an extensive laceration in the capsule so that the subacromial bursa and the shoulder-joint connected through a hole the size of a quarter. The capsule and tendon were sewed together with silk and the arm put up in abduction for about five weeks. Motion of the arm was begun about two weeks after the operation, and about six months later the patient's shoulder was perfectly restored as to motion and strength.

The technic of exercise treatment in such cases as well as in others where an abduction splint has been used after operation on the bursa is as follows: In simple cases three or four days, in cases with ruptured supraspinatus ten or twelve days after the operation or earlier the elbow with the forearm is lifted up an inch or two from the splint by the operator, who describes a few very slow and gentle passive exercises forward-backward and upward-downward. This is repeated on the following days and the patient encouraged to take part actively. Then rotary motions are added and the angle of motion is increased. Three weeks after the operation, in simpler cases much earlier, the splint is temporarily removed during the exercise and adduction is practised. If this is done by gentle resistive exercises no harm will be done, whereas passive movements to increase the angle of motion forcibly may tear and stretch the newly formed tendon and its insertion. Five weeks after the operation the abduction splint is removed, but if adduction is not quite free a splint with reduced angle or a pillow is applied for some time, in order to avoid strain.

Another interesting condition frequently seen in affections of the shoulder-joint is the lime-salt deposit. Codman's opinion that these deposits are located underneath the floor of the bursa and that they are usually found after a tear of the supraspinatus tendon, has been corroborated by the findings in two cases in which we have had the chance to operate. The fact that the functional improvement in these two cases has not been very satisfactory, and my experience with another case which we shall report below have led us on a more conservative track in this type of cases.

Brickner[1] in a recent article considers operative treatment

[1] Am. Jour. Med. Sc., vol. clxxvi, p. 351.

to be indicated in almost all severe cases where it affords a speedy recovery, but advises rest in abducted position to be "given a fair trial" in less severe acute cases. Brickner, Dunlop,[1] and others have seen these deposits disappear without any treatment, which we do not doubt they do sometimes. Although our personal experience in this kind of cases is still rather limited, we feel justified in advising conservative treatment by baking, massage and exercise, and if necessary with rest in abducted position, at least for several weeks before an operation is performed.

The following case may serve as an example: A stout woman, aged forty-seven years, came to the out-patient department complaining about pain and stiffness in her left shoulder. This had been present a year and a half without any known cause. The pain was increased by any attempt to move the arm and the patient was entirely unable to use the arm actively.

On examination the muscles of the left shoulder showed a marked atrophy and there was some tenderness over the acromion in front of the shoulder. All motions were very much limited and all shoulder muscles showed a marked spasm at any attempt to move the arm. The abduction and elevation forward and backward was not possible for more than 40 to 50 degrees; rotation about 90 degrees. With coöperation of the scapula elevation was possible to about 90 degrees. The patient could with difficulty place the left hand upon the right shoulder, but could not be made to touch the left buttock. The *x*-ray picture taken on November 9 showed a marked shadow about the size of a five-cent piece in the region of the supraspinatus tendon.

From November 9 to January 5, 1915, the patient had nineteen treatments, most of them given by the writer personally; baking, massage and resistive and passive exercise in the manner described. The improvement was steady and rapid. On December 22 the function was almost restored; the tuberosity was gliding underneath the acromion and back again with no difficulty or pain. An *x*-ray picture taken on that day showed only slight traces of the shadow.

[1] Am. Jour. Orthop. Surg., February, 1916, p. 102.

CHAPTER XV.

LUMBOSACRAL AND SACRO-ILIAC AFFECTIONS.

Our knowledge of the lesions of the lumbosacral and sacro-iliac junctions has been greatly enriched during the last ten years, especially by the excellent contributions of Goldthwait. We know now that many painful affections which heretofore have been classified as neuralgia or neuritis of the lumbosacral nerves are really due to lesions of this part of the spine. Therefore it seems appropriate to devote a special chapter to these lesions which are so frequently seen in our clinics, and which deserve the greatest interest on the part of the orthopedic surgeon as well as the student of physical therapy. For the reason that the investigations of the region mentioned and their various affections are of rather recent date and therefore are not so well understood and generally known as most others with which we have to deal in this book, we find it necessary to give some short notes about the anatomy, the clinical pathology, causes and general principles of treatment. For details we must refer to the papers and books of Goldthwait, Painter, Osgood, Meisenbach, Fitch, Peckham, Bucholz, and others.

The lumbosacral junction, formed by the intervertebral disk between the last lumbar and the first sacral vertebræ and by the two posterior joints, is of special interest and importance, chiefly for the following reasons:

1. It is the junction of a flexible with a fixed part.

2. The physiological inclination of the pelvis makes the lumbosacral junction more subject to strain than any other part of the spine.

3. Close to the last lumbar and the first sacral vertebræ is the insertion of the large muscles of the back, generally known as erectors of the spine.

4. The lumbosacral junction is the seat of anatomical variations more frequently than any other junction of different sections of the spine. This is so much so that only with a certain difficulty can we speak of normal and abnormal.

These anatomical variations consist in the higher or lower seat of the lumbosacral junction in regard to the height of the iliac bones; in the great variety of shapes of the articular processes where we see the flat or the crescent shape either on one or on both sides, and a difference in the direction from the frontal to the sagittal plane; in the abundant variety of the shapes and sizes of the transverse processes of the last lumbar vertebra; and in the partial or total sacralization of the last lumbar, respectively the lumbarization of the first sacral vertebra or the presence of a supernumerary transitional vertebra.

It is obvious that traumatic or infectious lesions to which the lumbosacral junction is subject as any other joint of the body, will cause a great variety of clinical pictures as well as peculiar difficulties in the understanding and treatment of such lesions. Those difficulties are still further increased by the neighborhood and often intimate connection of the lumbosacral with the sacro-iliac junctions, to which we must now turn our attention.

The sacro-iliac articulations are formed partly by strong masses of ligaments, partly by a true joint with all its attributes: cartilage, synovial membrane, and joint cavity. These joints combine great firmness with a small but distinct amount of mobility. The ligaments serve to hold the ilia to the sacrum, and are thus subject to greatest strain in weight-bearing on one leg as it is alternatingly required in locomotion. The slight but definite mobility of the joint aids in the elasticity of motion of the trunk and legs, especially in walking, running and jumping. The interior surfaces of the sacro-iliac joint are not as even as in many other joints, but have a number of convexities on one side which fit into concavities on the other.

As the pelvis in general so the sacro-iliac articulations in particular show marked differences in shape, size and directions in the two sexes; those of men are higher, deeper, more

curved and more oblique, than those of women; differences which correspond to the physical function of the female pelvis.

A further variety in shape of the sacro-iliac articulation in both sexes, though in our experience more frequently in men, is caused by the anatomical variations of the lumbosacral junction. Asymmetrical and symmetrical sacralization may cause one or both sacro-iliac articulations to be much higher than in the average in that the enlarged transverse process of the last lumbar vertebra may articulate with the ilium either in the form of a true joint or a ligamentous junction.

As we have stated above great varieties exist as to a deeper or higher seat of the sacrum and the lumbar vertebræ in relation to the pelvis. It is obvious, therefore, that affections in the sacro-iliac articulations must find widely differing mechanical conditions in the one or the other type. There must further be mentioned the close anatomical relationship of the lumbosacral nerves to these joints which is largely responsible for the fact that the affections of the joints and their neighboring structures, such as ligaments, bones, insertions of muscles, bursæ, etc., have been so long considered as true affections of the nerves themselves.

The lumbosacral and sacro-iliac junctions are subject to any lesion to which joints and bones are subject in general, and the joints of the weight-bearing static mechanism of the body in particular; such as fractures, dislocations, sprains, occupational and postural strains, infectious arthritis, hypertrophic osteo-arthritis, bursitis, periostitis, diseases of the bones and joints, etc.

It is, however, the particular anatomical and physiological character of those parts of the body which lends peculiar color to the clinical picture, which makes those cases often so very persistent and renders their treatment sometimes an exceedingly difficult matter.

While our knowledge of the pathology of those lesions has been greatly enriched, there are still great difficulties in ascertaining definitely the nature of the alteration in the individual case. This fact cannot be surprising for we meet often enough considerable difficulties even in such an exposed

region as the knee-joint, and here we have to deal with the very deeply seated structures hidden by thick masses of bones and muscles. Certain methods of examination such as palpation and inspection are of hardly any avail, osteopaths to the contrary, and we have to depend for the diagnosis more than in any other lesion on the reactive symptoms, such as pain and muscle spasm, stiffness and deformity.

Pain.—The pain is often but not always an indicator for the seat of the lesion. It is frequently believed that pain in the distribution of the peroneal nerve on the outside of the leg, associated with pain in the back of the thigh and below the iliac crest, is typical for sacro-iliac affections. From a number of experiences, however, we believe that this should not be generalized, and a diagnosis of an inflammatory condition of one of the sacro-iliac joints should not be made from the distribution of pain alone unless other symptoms are found in addition. The distribution of pain in the anterior femoral nerve and on the outside of the thigh is generally suggestive of lesions in the lumbar region, often with exclusion of the sacro-iliac joints.

Muscle Spasm.—Hand in hand with pain goes spasm of muscles. The muscle groups most frequently affected are the long muscles of the back, the erectors of the spine and the hamstring muscles on one or both sides; less often the lateral lumbar muscles and the iliopsoas are contracted on one or both sides. This spastic contraction represents an involuntary protection caused by the irritation within and about the affected joints, as we see it so frequently in other joints.

For the understanding of this spastic rigidity of the muscle another fact must be considered. In any upright position a constant muscular action is required to maintain the balance of the body. This action is mainly of a static nature in sitting and standing, while in locomotion positive, negative and static actions of many muscle groups are freely mixed in the various stages. All these muscular actions require an extremely complex nervous regulation which may become greatly disturbed if the action of one or

several groups has been interfered with by an inflammatory condition of any of the joints necessary for the mechanism of balance. An analogue to the physiological coöperation of these muscle groups is seen in the mechanism of the shoulder, and it has been a matter of great interest to us in applying functional treatment to a considerable number of cases with painful affections of the shoulder-joint as well as such of the lumbosacral and sacro-iliac junctions, to study the ways in which that physiological coöperation of the involved muscle groups is gradually restored when the underlying affection has been cured.

Stiffness.—Stiffness results in most cases from the muscle spasm and is thus in direct proportion to it. Therefore we frequently see the joints entirely free in anesthesia. There are other cases, however, which show an actual stiffness due to an affection of one or more joints or to an actual retraction of muscles. These cases are usually of a grave character and respond to treatment more slowly. This distinction between spastic and actual stiffness is often difficult and at times cannot be made except by having the patient entirely relaxed under an anesthetic.

Deviation.—The most conspicuous symptom which is present in a very large percentage of cases is the deviation of the trunk. This deviation consists usually in a list of the trunk forward and to one side, which may appear in all degrees from one noticeable only by careful inspection up to a very considerable deformity. In the latter case we speak of a sciatic scoliosis, a term which is rightly disputed, because we have not to deal with a real scoliosis, and furthermore, the underlying cause is in the majority of cases not true sciatica, but in our opinion an affection of the lumbosacral or sacro-iliac joints. The deviation is usually away from the affected side. In a smaller number of cases it is toward the painful side, and in a few exceptional cases the deviation may be alternating to the one and the other side. The lateral deviation is usually combined with an anteroposterior deviation of the spine. In the majority of cases the lumbar spine is flattened; in some it is even more or less kyphotic. In such cases the patient holds his trunk considerably bent

forward. In exceptional cases the lumbar lordosis is increased.

The lumbosacral and sacro-iliac affections may arise from very different causes, as we have stated. In a very large number of cases with this affection our personal experience shows the majority can be traced to traumatism. This may be a single definite trauma, often of a rather slight nature, such as stooping down, lifting a heavy load, misstepping, etc., or it may be a repeated injury or what we call an occupational traumatism, a frequently repeated strain or sprain or jarring of the spine. In a great number of cases, though probably the minority, the symptoms come without any definite traumatism. The examination of such cases will often reveal an arthritic process, most frequently a typical hypertrophic osteo-arthritis of the spine or the sacro-iliac joints; an affection which may be found, of course, also in those cases which are traceable to traumatism. In many cases a definite faulty posture is noticed which may be an aggravating factor, if not the chief cause, although we should emphasize that the pathological deviation as described above should not be confused with a typical faulty posture. The manner in which a stooped position may lead to a strain in the lumbosacral and sacro-iliac joints has been described in detail in Goldthwait's papers, to which we refer our readers.

X-ray Examination.—The *x*-ray examination shows in many cases anatomical variations or very large transverse processes of the last lumbar vertebra. In a given case it is often very difficult to determine exactly the role which such findings play. Those patients have had their peculiar vertebræ all their life, and we cannot from the outset look upon this as the cause of the present trouble. But it seems probable that in persons with such anatomical variations a mechanical disposition exists on the basis of which injuries, strain or inflammatory processes may develop into peculiar and typical lesions. For instance, a large transverse process of the last lumbar vertebra may sustain by its presence an irritative process to such an extent that only by its removal can a cure be obtained.

With this in mind it is not surprising that the explanation of these clinical pictures is sometimes of a rather hypothetical or at least theoretical nature, and that it is often extremely difficult to outline definite rules for the treatment.

Treatment.—Before we describe the principles of the therapy which are followed in our clinic we have to say a few words about an incident which occurs in some of these cases, though its frequency and importance are, at least in our opinion, often overestimated. This is the subluxation of joints and the locking or spastic fixation in such a position. The history and development of certain cases makes such a condition very suggestive, though this is probably all that can be said. When we see a man who from simple sneezing or a false step over a pebble is suddenly thrown into an extremely painful and cramped position, from which he may be relieved by a simple manipulation, if need be under an anesthetic, the explanation of a slipping or subluxation is very suggestive, but as we have said, this explanation should not be generalized too much.

The principles of treatment are: protection in order to give nature a chance to heal the underlying affection, and restoration of function. When we keep these principles in mind our therapy will be raised beyond a simply symptomatic treatment, though we admit that in many cases we have to be satisfied with complying to the symptomatic indication.

Protection is secured by orthopedic appliances such as adhesive plaster strapping, belts, braces, and plaster casts; furthermore, by rest in bed or in an otherwise comfortable position. The spastic deviation which we see so frequently is generally considered to be a means of protection of nature in order to relieve the affected parts from strain and pressure. Hence it would seem wise to follow nature's lead and choose a position which rather imitates than corrects such a deviation.

The protection alone is often sufficient to secure prompt relief, though in many cases other methods of treatment must be added, among which massage and thermo- and hydrotherapeutic applications rank very highly.

As we have found exercise an excellent method to relieve

persistent spastic muscular contraction under many conditions its application in these cases would seem perfectly rational, and we have cases on record which have well responded to this form of treatment after others had failed. The attempts to state definitely indications and contraindications for exercise treatment meets the same difficulties which we have stated for making a correct diagnosis in general. Wherever we find or suspect any active inflammation of joints, tuberculosis, infectious arthritis, etc., exercise is contraindicated. With evidence of hypertrophic osteo-arthritis at least great care should be taken to avoid irritation. Furthermore, the presence of acute pain contraindicates any active treatment. Massage may help to relieve pain, though this is usually much more thoroughly accomplished by orthopedic appliances.

The point to attack is first of all the muscle spasm, and the most useful method is, as elsewhere, the resistive exercise. The question of localization is an interesting and often difficult problem and requires a careful study of the case. Here again we must be led by the deviation. Usually it is not rational to make movements opposite to the direction which the protective deviation indicates. Therefore we do not begin with corrective movements, but let those muscles work which are antagonistic to the muscles contracted. The position again from which the exercise is done must be chosen according to the individual needs. Simple prescriptions such as "lying prone" or "supine" are not sufficient. Many of these patients have great difficulty in lying prone because of the spastic contraction of the flexor muscles of one or both hips. Then we have to place them on pillows in order to prevent undue stretching of those muscles. In case No. II at least four thick pillows were necessary to bring the patient into a comfortable position. Lying supine usually requires a pillow under the knees for the same mechanical reason. The knee-elbow or knee-hand position has been found of great value. One will often find that in these positions certain motions are possible which cannot be accomplished with weight-bearing, a fact which is of value both for diagnosis and treatment. The localiza-

tion of resistive exercise, gentle passive stretching, the eccentric movements frequently required in these cases, may all well be done in knee-elbow position.

Only when a certain amount of muscular control exists or after it has been accomplished by treatment may we proceed to exercises in weight-bearing. These are first done in sitting and only later in standing. In fact the standing position is of rather slight value for these exercises compared with the other positions. For sitting we use a fairly high and firm stool. The movements used are described on pages 34–36. In those exercises which are shown in Figs. 6 and 7 a certain amount of lifting and suspending of the body can be accomplished by placing the operator's right hand under the patient's left arm. Thus the weight-bearing strain may be materially relieved.

The selection of the various forms of movements depends on the case. When any pronounced spasm exists we begin with very gentle and slow concentric movements within a small angle. For instance, in a case of spastic contraction of the flexors of the hip we have the patient lie in the prone position with pillows under his trunk to secure perfect comfort. The operator, grasping the knee, lifts the whole leg up somewhat from the table, not more than can be accomplished without pain, and has the patient pull his leg down against resistance. As soon as the spasm is relieved the patient has to do the lifting himself, at first with assistance by the operator, later alone, and finally with increasing resistance. Then eccentric movements may be added; this is done by lifting the leg slowly up while the patient contracts his flexor muscles. When this is possible a certain amount of passive stretching may also be done, a movement which is not rational in the beginning.

Massage is a valuable adjunct to resistive exercise, though in our experience of secondary importance only. Deep though gentle kneading is the most important manipulation which, however, cannot be accomplished in certain muscle groups such as the ileopsoas. Tapotement and vibration have not been found very effective in our experience; but other observers have found them quite useful.

Thermo- and hydrotherapeutic applications may greatly assist the treatment by their hyperemic and pain-lessening effect. But all these procedures will only develop their full value when used in preparation for and in connection with rational exercise treatment.

From the foregoing conclusions it is evident that schematic prescriptions cannot be given. The operator must study his case and try to get a clear idea of the mechanical condition. This is usually not accomplished on the first day, but requires careful observation. Very often the first treatments have a somewhat experimental character. In cases of a certain duration we advise the patient not to look for immediate relief, and ask him to report his sensations as exactly as possible.

In all severe cases it is of decided advantage to admit the patient to the hospital for a few weeks or to treat him at his home. Unfortunately the conditions of our clinic are such that only a very small percentage of patients can be admitted to the ward, and usually the treatment must be ambulatory. It is evident that much of the benefit of each treatment will be lost by going to and from the clinic, especially when the patient lives at some distance and has to ride on a train or street car.

We have pointed out above that it is not our idea to contrast exercise with other forms of orthopedic treatment, although we have seen cases where that method has shown results which could not be accomplished by other means. In most cases orthopedic appliances are indicated besides, such as belts, removable casts or braces. The indications and technic of such means, however, cannot be discussed in this book.

In the following we shall report a few cases which have been preferably treated by exercise, although orthopedic appliances have also been used to some extent.

Case I.[1]—Engineer college student of twenty-two years, who had grown rapidly at the age of thirteen to eighteen and often had pain which was considered to be growing

[1] A Study of the Conditions Frequently called "Sciatic Scoliosis," C. Hermann Bucholz, Am. Jour. Orthop. Surg., May, 1913.

pain. In spite of all that he has done much athletic work, as football, hockey, rowing, and has walked a great deal in his profession.

In April, 1910, he was feeling more tired than usual; the winter before he had played much hockey and had done much walking. He noticed that he had to straighten out his back after writing for a while. He had some pain in the right iliac crest and lower back, but kept on walking and massaged himself. After getting up from sitting he noticed that he held himself somewhat inclined toward the *right* side. Treatment prescribed by a physician and consisting of aspirin and soaking with hot water gave no relief.

During the summer he did much rowing, camping out of doors, and was often wet through. In the fall, 1910, he entered college and was advised by the football coach to join the team. For two or three weeks he felt better, then the pain became more severe and more extended over the right hip, crest and sacro-iliac region. In spite of that he managed to pass through the football season.

In the winter 1910–11, he consulted an orthopedic surgeon who made the diagnosis sacro-iliac strain and strapped the back for a few days. After a short time of rest and baking he at first felt better, but became much worse, when he had to walk one-quarter of a mile.

After that a manipulation under ether was done which made him very stiff and increased his pain very much. He also had indigestion and constipation during that time and tonsillitis. After the manipulation he was so much worse that he could not walk more than 100 feet and had to use crutches for nearly three months. Baking or heat in any other form made him much worse.

In April, 1911, he consulted a medical authority who gave him a certain relief by general dietetic prescriptions and aspirin.

In the summer, 1911, he went to an osteopath who manipulated his back and legs and massaged and stretched his sciatic nerve. Six treatments were followed by a certain improvement, but pain in walking and the deformity persisted.

In September, 1911, he had the tonsils removed and was at a hospital for seventeen days. After that time he was not able to work for several days on account of severe pain. A few weeks later he was sent to the medico-mechanical department of the Massachusetts General Hospital, where the following examination was made:

Tall, well-built, healthy, though somewhat tired-looking young man with healthy internal organs.

Seen on standing from front one notices that he holds his body markedly drawn forward and to the *left;* the middle line shows a marked sharp bend at the level of the umbilicus. The pelvis looks tilted toward the front and to the right side. From back the list toward the left side is also very marked. The spine describes a total left curve, most marked at height of the third lumbar vertebra. The right trochanter is markedly prominent; the left shoulder is somewhat higher than the right one. The whole back is very flat, but shows a slight dorsolumbar lordosis. The patient holds his right knee and hip slightly flexed. Any attempt to straighten them causes much pain along the right sciatic nerve and increases the deviation of the back markedly.

He stands on either leg alone without difficulty. In walking he seems to protect his right hip; he does not allow the leg to swing forward, but brings it forward with the whole right side, somewhat resembling the gait of a patient with hip disease.

The motions of his back are markedly limited. In bending forward the deformity is increased. Bending to the right side is easier than to the left. Bending to the left is not possible so far as to straighten or overcorrect the total curve.

The deformity is the same in lying. The right leg and buttocks are somewhat atrophic. Straight leg raising is markedly limited and any attempt very painful on the right side, while it is almost free on the left. Flexion of the right hip is free, abduction and rotation somewhat limited. Full extension of either hip is not quite possible. Hyperextension of the lumbar spine in lying is impossible. In lifting the legs up backward the spine is lifted like a stiff rod.

Tenderness is noticed over the right sacro-iliac joint, the sciatic notch and above and downward along the sciatic nerve. No paralytic signs, no disturbance of the sensory nerves, reflexes normal.

Both feet are markedly flat and pronated. In trying to supinate his feet in standing a motion which is decidedly difficult the patient has to rotate his whole legs much outward, else he cannot raise the inner border of the foot. This symptom is more evident on the right side.

The *x*-ray picture shows a very large right transverse process of the fifth lumbar vertebra. The point of this process is somewhat thickened and darker. There is a distinct shadow between that point and the ilium.

Treatment with a number of Zander apparatus for his back and legs had only a slight if any effect. In January, 1912, he was sent to the orthopedic ward and a plaster jacket was put on after a few days of rest. The jacket and rest again, as before, increased his symptoms. Then in March, 1912, I started a treatment consisting of massage of his back and buttocks and a number of exercises in lying, sitting and in knee-elbow position. After a short time the patient reported a slight relief, which increased gradually.

I also raised his left heel one-half inch and had him wear a half-inch thick felt pad under his left buttocks to raise his left side in sitting, and strapped his feet with adhesive plaster.

Within two months a marked improvement was obtained; the pain had gone for most of the time, the deformity was easily correctable and the stiffness of the back and right hip was diminished. The patient continued the treatment, though with intermissions, for about six months longer.

In the fall of 1912 he had a perfectly flexible back, his right hip was nearly normal in motion, the straight-leg raising of both legs was possible beyond the right angle. The lumbar lordosis had in part returned. The patient walked rather normally. The deformity was not fully corrected, though it was much less evident. There was off and on a slight pain along the right sciatic nerve after a long walk. The patient enjoyed life as never before, but was

advised against too vigorous sports and exercises. Now he is in a perfect condition and has never had any more trouble.

Case II.—A rather frail, poorly nourished young man of twenty-nine years, who had complained of pain in his right hip and thigh for about four months. The pain came on within a few weeks and had evidently to do with his occupation. The patient was a boiler-maker and had to work for many hours a day in a greatly stooped position, straining his back and hips constantly; though he remembered that friends told him in his youth that he was not entirely straight he said that this was never of any consequence to him.

The examination showed an extremely severe left sciatic scoliosis which could be transformed by the patient into the right-sided deviation, though the latter was not entirely symmetrical to the former, and could not be maintained for more than a few minutes as it caused pain after a certain time.

The *x*-ray picture showed a typical complete sacralization of the last lumbar vertebra with large transverse processes. The stereoscopic *x*-ray picture was suggestive of the close nearness of the ilia and those transverse processes. Probably inflammatory changes had taken place by the grinding of these bones and had caused the severe spastic deviation.

The patient was advised to spend as much time as possible in the most comfortable position, which was sitting somewhat bent over to the left side. A plaster cast was tried but failed to relieve him, also crutches gave no comfort, but rather increased the pain.

The patient came to the medico-mechanical department for several months almost daily and was treated with massage, exercise and manipulations which were worked out after careful observation of the effect of each single manipulation. The tendency was, as has been said before, not to oppose the contracted muscles but at first to work with them, thus increasing rather than correcting the deviation. The resistive exercises were selected in such a way that the exercise tried as much as possible to relax the spastically contracted muscles. In order not to complicate the condi-

tion more than necessary the right-sided deviation was treated only after a distinct improvement had taken place.

The exercises given in this case consisted in resistive straight-leg raising, resistive hyperextension, knee-elbow movements, exercises in sitting: flexion of the spine, moving of the spine to the right side, and twisting of the spine with the right side forward, both against strong resistance. Improvement became noticeable after about one month of treatment and went on fairly rapidly so that the patient was practically cured after six months.

We believe that the time of recovery would have been materially shortened if the patient had been treated in the hospital instead of going to and from his home.

Case III.—A woman, aged sixty-four years, who had suffered from severe pain in her right hip and thigh for eight months. Various forms of treatment did not cure the affection, though she had relief now and then. She never had pain in any other joints, and was generally in fair health except for a weak stomach and a moderate constipation.

When first seen, October, 1914, she presented the picture of a typical heterologous sciatic scoliosis with a deviation of the spine more severe than I had ever seen before in a woman. The motions of the spine were restricted in bending to the right and backward, but not much restricted to the other side. Straight-leg raising was somewhat limited. The right calf was three-quarters of an inch thinner than the left. Reflexes normal. In knee-chest position the spine was a good deal freer and the deviation seemed to almost disappear.

The *x*-ray picture showed a definite but not very marked hypertrophic arthritis of the sacro-iliac joints.

The patient, whose condition had been slightly improved under partial rest and support by a corset fitted with steels, was given regular massage and special exercises in the following way:

First, lying prone over several pillows the whole back was thoroughly massaged, then gentle resistive exercises were done at first in knee-elbow position; anteroposterior and lateral motions of the spine, hyperextension of the hips, and at the end another back massage was given. After

several treatments exercises in the sitting position were added, such as described on pp. 34–36. A distinct improvement was seen after two or three weeks. At that time the patient slipped on the ground and felt a little pain in the back. After that she sat for one hour at a church meeting, and when she got up she felt her back deviate again and had a great deal of pain. This was relieved by Dr. R. B. Osgood on the following day by a forced hyperextention of the right hip, which was followed by a distinct click and considerable relief from pain.

The clinical picture following this incident was very suggestive of a slipping of the right sacro-iliac joint. From this acute attack, however, the patient recovered very quickly, and ten days later she could stand entirely straight. About one year later after a slight attack of grippe and a slight fall she noticed some pain in her right hip and a slight deviation of the spine, this time to the right side. Again a short treatment of manipulations and massage, added to a belt, relieved her in a very short time.

Case IV.—In November, 1913, the patient, a slender, tall man, aged forty-five years, began to have pain in the region of the right trochanter which started after he had cranked his automobile very forcibly. During the first period of the disease the pain was not constant, but in the summer, 1914, it became very persistent. A pelvic belt relieved the condition somewhat, but not entirely, and in February, 1915, the patient still complained of pain in the back of the right leg which was especially felt at certain quick motions or jars, scuffing, etc. Several months ago the patient began to play squash, but had to stop it because the pain became worse again. For the same reason the patient avoided playing tennis. He was usually comfortable in the morning, though sitting on a chair soon began to cause pain in back of the right leg where the pressure came. The pain started as a rule in the afternoon.

The examination showed a fairly flat back which was slightly listed to the left side away from the painful spot. The list was increased in forward bending, which was considerably limited. The other motions were fairly free.

Straight-leg raising was restricted at the right side to about an angle of 50 degrees. The joints and reflexes were normal. A distinct tenderness was noted along the course of the sciatic nerve on the back of the right thigh, especially near the tuber ischii. The muscles of the back of the right thigh and over the lumbar spine, particularly the right side, were distinctly tighter and more contracted than on the other side.

Diagnosis of this case was evidently a sprain of the right sacro-iliac junction with inflammatory signs about the sciatic nerve.

The present trouble was suspected to be caused by some irritation in or about the sacro-iliac joint, producing muscular spasm, and this again by inappropriate action of the statics sustaining a condition of strain and irritation. The indication to treatment seemed to be given in the necessity to break that vicious circle and eliminate the muscular spasm. This had not been done to the full extent by any support. During the first days of treatment before the condition was sufficiently clear, I applied massage to the back of the thigh and to the region of the sacro-iliac joint with no relief. In fact, it rather increased the irritation somewhat. Then I began to stretch the muscles, at first rather gently, later with increasing force until the force was made so much that the patient could not stand any more.

From that time on the improvement was very marked, as not only the patient himself reported, but could be seen by the rapid improvement of the forward bending of the spine and the improvement of the straight-leg raising motion. Gradually the patient also became straighter in standing, though even after several months of treatment a very slight list was still to be seen when the pain had almost entirely disappeared.

The exercises used in this case were done in the following way:

1. Patient in the lying position flexes his leg as high up as possible and tries to extend it as near to the vertical line as possible against the resistance of the operator.
2. Straight-leg raising active-passive.

3. Patient sits on a table, the body flexed forward, holding himself on the edge of the table; then the operator takes one leg after the other and straightens it out at the knee-joint.

Besides these exercises some others of a more general character were done, and freely mixed with massage of the contracted muscles. Direct massage of the nerve was not employed any more after it had shown unfavorable results.

CHAPTER XVI.

FAULTY POSTURE—ROUND SHOULDERS—KYPHOSIS.

The question of posture is one of great consequence, not only from an esthetic, but also to a very large extent from a general hygienic and social point of view. The stooped and round-shouldered posture which we see so often among young people gives a decidedly ugly appearance, and it is usually this factor which induces parents and teachers to send the children to the clinic or to a gymnasium for correction. But it cannot be too strongly emphasized that a persistent faulty poise frequently involves the general health and interferes with a proper physical and mental development. It is a fact though not sufficiently well recognized until recently that a great many pathological conditions can be directly or indirectly traced to faulty posture, and thus the corrective postural training is practical hygiene and preventive medicine in the best sense. For all details we refer to Goldthwait's inspiring publications on this subject; at this place only a few important points may be mentioned.

The treatment of faulty posture is essentially a muscle problem, though in severe cases it may develop into a bone problem. The upright posture is maintained by a constant static muscular action. The muscles of the body are arranged in such a way as to balance each other in groups. Gravity draws the weight of the body downward and the muscles have to act to keep it up. If they do not work properly and if bad habits develop and are allowed to exert their noxious influence faulty posture will develop. Then certain muscle groups will work under unfavorable physiological conditions which in turn will interfere with their action, favoring fatigue and insufficient tonus, and faulty posture will increase. Thus a vicious circle develops, the breaking of which is the province for postural training.

Constant faulty and insufficient action of the muscles will show its effect on the skeleton after a certain time, not only on the inserting points, as is so constantly seen in the scapula, but the joints may also develop a change in their structure, and if the nutrition of the bones is at all disturbed actual deformity may result, such as increased kyphosis and lordosis, curved scapulæ, deformation of the thorax and pelvis, flat feet, and others.

Furthermore, the stooped attitude of the thorax will interfere more or less with the anatomical relations and with the function of the internal organs, as the comparison of the normal sagittal cross-section of the thorax and abdomen with that seen in people with faulty posture, as well as numerous clinical observations, clearly demonstrate. The persistent interference with the correct function of the internal organs will exert a certain deleterious influence upon the general metabolism and show its marks upon the whole physical and mental development. These conditions are undoubtedly favored in many cases by a certain congenital habitus and anatomical variations from the normal, such as have been stated for the development of the colic mesentery and other parts. In such cases the noxious influence of poor physical and particularly poor muscular development will be all the more effective, leading to a more serious prognosis and rendering the therapeutic problem more difficult.

Before we discuss the treatment of faulty posture we shall describe the normal well-balanced posture. For this we have chosen the classical description of Goldthwait:[1]

"In the upright position, the poise or attitude in which there is the least strain, and consequently the correct attitude, is with the body held so that it is made as tall as is possible without raising onto the toes. In this position the head is erect, the shoulders are thrown back so that their centre is distinctly posterior to the centre of gravity, the chest is high, the abdomen is flat and the spinal curves are slightly convex backward in the dorsal region and convex

[1] The Relation of Posture to Human Efficiency and the Influence of Poise upon the Support and Function of the Viscera. Am. Jour. Orthop. Surg., vol. vii, 1909, p. 372.

forward in the lumbar region. The pelvis is inclined forward so that the axis from the promontory of the sacrum to the top of the pubic bones is downward and forward 30 degrees from the horizontal, the inclination of the sacrum being downward and backward so that the axis of the pelvis is at right angles with the plane of the brim of the pelvis, or about 60 degrees from the horizontal. In this position the anterior portion of the upper part of the sacrum, together with the last lumbar vertebra, is almost directly over the top of the great trochanter, or a little posterior to the centre of the hip-joint. In this position the Y ligament is made tense as well as the iliopsoas muscle, these two structures serving to prevent the pelvis from lessening its forward inclination. In this position the hamstring muscles are tight, giving support to the knees as well as preventing an increase in the forward inclination of the pelvis. The knees are straight and the weight is received at the foot upon the astragalus with the posterior calf muscles tight, so that the heel rests lightly, and the chief strain is thrown upon the ball of the feet. The posterior calf muscles are tense, the result being that the posterior tibial and the peroneus longus by their contraction hold the tarsal bones in place, the foot thus being in the position of greatest strength, while the flexor muscles of the toes hold them in contact with the floor, giving a stable base and rendering the forward propulsion of the body possible with the least effort."

"The muscles of the trunk in this position are in such balance that while the anterior and posterior groups are in slight contraction, neither group is strained and but few of the ligaments are under tension. The shoulder is slightly back of the lateral median line of the body so that the weight is received largely upon the thorax, none of the muscles being in more than slight contraction, and the strain upon the posterior muscles which must occur when the shoulder is held forward is absent. The head is held erect and so balanced that while all of the muscles, the anterior, posterior and lateral, are in slight contraction, each group is properly balanced by the others and none are subjected to more work than they can easily perform. With the body so poised, not

only is there the least possible expenditure of energy required for the maintenance of the position, but it is from this position that action is made most easily. All of the parts are in balance, so that whatever the movement, whether it concern chiefly one part or another, the start is made with no waste of energy in correcting the poise or 'gathering oneself' preparatory to the action."

The ideal posture as described above is not as frequently seen as one would wish. A large proportion of the civilized people show a certain droop and stoop, most frequently indicated in the shift of the centre of gravity, the upper part of the trunk leaning somewhat backward. While in the great majority of healthy people this stoop can easily be corrected by a simple effort of the muscles, there are still a great many individuals who cannot do so without a very considerable effort, if at all. In these cases we may speak of a pathological posture, though it must be admitted that in drawing a strict border-line between the normal and the abnormal we sometimes meet with a certain difficulty.

The correction of faulty posture is a social problem as well as a medical one. It is a work far beyond the limits of the physician, and the big bulk of it is concerned with the school. But in this matter the physician should be the instructor not only of teachers of gymnastics but of teachers in general. He must make them realize how much depends on the pupils acquiring and maintaining a good posture. He must teach them also how far they may go and when the physician should be consulted.

Furthermore, it must be emphasized that in almost all of these cases two indications exist, one from an orthopedic and one from a medical point of view. Orthopedic treatment is indicated as soon as the maintenance of proper poise begins to involve an effort for the child great enough to interfere with the economy of its whole system, and it becomes still more evident when correct balance is impossible, whether from lack of muscle tone or from actual deformity.

This leads us to distinguish *two* main groups which again are not very sharply separated: (1) Faulty posture from deficient muscle tone or muscle development, and (2) faulty

posture with more or less prominent deformities of bones and joints. Both groups have a close relationship with each other in that patients of the first type may in an advanced stage develop actual deformities, though we believe that such deformities often begin at a very early age. Distinguishing between these groups is of greater importance in regard to prognosis than in regard to therapy itself, though patients of the second type generally need more care and more prolonged treatment and observation than the former.

In both types the most prominent means of treatment is, as has generally been recognized, developmental and educational exercise, although we must very strongly emphasize that a one-sided preference of exercise with neglect of the general medical indications may do more harm than good. Experience teaches us that it is of great importance to raise a warning hand against the overenthusiasm of gymnasts in that respect, and this is particularly so where the general health is affected, as it is to a certain extent in many of these patients.

The treatment should be preceded by a careful examination whereby the condition of the nose and throat, lungs, heart and kidneys receive special consideration. Furthermore, it is of the greatest importance to decide whether that condition exists which is frequently spoken of as weak back, or insufficientia dorsi (Schanz). In such cases to begin with exercises in weight-bearing posture would be likely to involve a grave danger. As we have stated above, the whole problem is a social as well as a medical one. Therefore, in any case where we find a pronounced weak back, especially where it is associated with a weakness of the lungs or an inherited tendency to tuberculosis, anemia, weakness of the heart, etc., we have the child stay out of school for some time, perhaps for the rest of the school season, or even for a whole year. We should prescribe prolonged rest, if possible in the open air. We regulate the diet and take regular records of the weight. But a simple prescription of rest is not sufficient. We must be more exact in prescribing how much the child must rest, and in what position.

It will depend on the findings of the examination whether

the rest should be permanent for a few weeks, or whether one hour after meals and ten to twelve hours at night would be sufficient for a beginning. In a position propped up with plenty of pillows under the head and shoulders, the ribs will depress the upper part of the abdomen, thus interfering with the function of the stomach, liver, etc. The lungs will be deprived of their proper function and cannot be ventilated to the full extent, which will have its effect again on the action of the heart and the circulation in general. The restricted ventilation of the lungs must be detrimental to the anemia which is so prevalent among this class of patients. All these factors should be carefully considered in teaching the proper position in which to rest. Children get easily accustomed to any position, but it is wise not to proceed too quickly and not to attempt too much at once; thus we let the child sleep with only a flat pillow under the head, later taking this away, and still later putting a pillow under the shoulder blades.

Now for the very start of the treatment, breathing exercises should be made at regular intervals every day. It is not necessary to repeat in detail the prescriptions as given in the general part. The thoracic as well as the abdominal breathing should be practised. It is well to combine deep breathing with raising of the arms. After the first or second week has been spent in doing this, simple exercises from a lying position may be added. In selecting the proper methods we have no better instructor than Nature herself.

Let us turn our attention to the baby, who is slowly learning to sit up and stand up. Following a primitive instinct the infant strengthens his muscles in a very rational manner. The first thing is to kick with the legs and to raise the head, later the shoulders and more and more of the body, until one day the baby is sitting up straight. Then he turns over on his belly. This turning itself is a valuable exercise. Lying in the prone position he practises raising his head and shoulders, and it will not be long before he is moving along. He has learned to creep. About the same time his muscles have been sufficiently strengthened to hold

him on his feet and walking will result from further practice in balance.

Relatively speaking, our patient has to some extent lost the art of standing and walking correctly; the ability to bear the weight properly has not been sufficiently developed with increasing weight. In a measure he has become an infant again, and it is rational to treat him as an infant. After sufficient rest, a few exercises are prescribed in analogy to those done by the child.

1. From supine position:

(*a*) Raising and lowering the legs alternately.

(*b*) Raising the head.

(*c*) Raising the arms over the head in connection with deep breathing.

2. Rolling over on the side and on the stomach.

3. From prone position:

(*a*) Raising the head.

(*b*) Raising the arms.

(*c*) Raising the head, arms and shoulders, arms being stretched sideward. (During exercises *b* and *c* it is wise to hold the legs of the child down on the bed.)

(*d*) Raising the legs alternately—hyperextension of the hip.

These exercises should be done three or four times a day, beginning with about five minutes and adding more time with increasing strength. They should never tire out the child. A few minutes of gentle back massage after the exercise is of advantage, and if it is not possible to secure an expert for that purpose it will do to have the mother gently rub the back with sweet oil.

In the majority of our out-patient cases we have the children treated two or three times weekly under the direction of a special teacher. The form of treatment we prefer and which to our knowledge is most generally used in orthopedic clinics is the individual instruction and training. Our foremost aim is to try to impress the patients with the fact that it is first of all necessary for them to realize the importance of growing up straight; that in their case this cannot be accomplished without a willing coöperation of their whole

energy; that it is not enough for them to put in an appearance for an hour occasionally at the clinic and to forget all about their condition in the meantime; and that we can only show the way and lead them to see that the natural faculty of acquiring strength and getting cured lies in themselves, in their own body and mind.

We shall now describe the treatment of postural cases as it has been carried on in our clinics for the last six years, though we have to admit that the particular difficulties of an out-patient clinic often prevent us from handling the cases in a way which we consider important and helpful. The patients are examined—and during this examination it is determined whether they are able to bring their body into a good or fair posture and about how long this can be maintained. If they are at all able to correct themselves for a short time we begin with the postural drill at once. They are taught how to stand properly, both in a relaxed and in a somewhat forced posture. For the relaxed posture we allow them to set the left foot slightly forward, thus alleviating the balance and relieving the work of the muscles required for forced standing. We emphasize the importance that the standing in "rest" should never be a standing in poor posture.

At the command "attention" or "position" the left foot is drawn back in line with the right, and the entire muscular mechanism needed for the correct balance is set to work. Any failures must be corrected at once; the most frequent mistake in the beginning is to lean the trunk backward, hollow the lumbar spine, and push the abdomen forward. After this is corrected by instructive assistance the position "rest" is taken, and the whole maneuvre started anew. Again in taking the position "rest" the same mistake is done, and must be corrected. No other exercise should be done until the patient is able to bring his body into proper poise.

After this "postural drill" has been practised for about five to ten minutes the patient is allowed to rest lying. If there is sufficient assistance available the time of resting is best spent with massage of the back, for which it is wise to have the patient lie down in such a way as to have the thorax

fully expanded and the abdominal organs free from pressure. Then some of the exercises from the lying position are done and the "postural drill" is repeated once more.

Fig. 56.—Head-stretching.

As soon as the patient has learned how to keep a proper position simple exercises are done. We generally begin with "head-stretching" and "hip-stretching."

1. Head-stretching (Fig. 56). At "one" the hands are clasped on top of the head; at "two" the patient tries to flex his elbows, thereby stretching his spine; at "three" the arms are relaxed; and at "four" they are placed in position at the side. During the forcible flexion the shoulders must

Fig. 57.—Hip-stretching.

not be raised and care should be taken that the balance of the trunk is not altered. In the beginning the hands of the assistant have hardly time to leave the patient's body because there is always something to correct.

When the exercise is finished, the position "rest" is taken and the patient allowed to relax for ten to fifteen seconds.

When a certain training is reached the exercise may be repeated twice or oftener before the patient is allowed to go

FIG. 58.—Upward stretching of arms.

into "rest," and in a more advanced stage the commands "two" and "three" may be repeated twice or oftener before

the arms are lowered. But no exercise should be repeated unless a good posture is maintained throughout the whole exercise.

These general rules apply to all exercises and will not be repeated.

2. Hip-stretching (Fig. 57). At "one" the hands are placed on the crests of the pelvis; at "two" the arms try to extend, and to stretch the spine; at "three" the arms relax; and at "four" they are placed in position. For the description of the following exercises the "commands" are omitted

Fig. 59.—Sideward stretching of arms.

for simplicity. They are not absolutely necessary and in a large clinic may be impractical, but it cannot be denied that they are very helpful, and when giving personal attention to the patient I make constant use of them.

The stretching exercises may be combined with deep thoracic breathing. Other stretching exercises are done in the following ways:

3. The arms are elevated and the patient tries to reach up as high as possible with the fingers, thus stretching the body. The average adult may reach two or three inches higher without raising the heels. Fig. 58 shows the

patient doing this exercise in sitting, a position in which many postural exercises may also be done.

4. The arms are raised sideward and the patient tries to reach sideward as far as possible (Fig. 59).

Fig. 60.—Leaning forward with hands on neck.

5. The hands are clasped behind the neck, or somewhat easier, put on the back of the head. In this exercise the tendency exists to bend the head forward; that must not be permitted but properly corrected. In doing this exercise

correctly a powerful stretching effect is exerted upon the dorsal spine and thorax.

6. The work for the scapular and back muscles done by this exercise can be still increased and modified by having the elbows do circular movements.

7. Or by having the hands clasped behind the neck while the head is bent forward and then erecting the head, not simply bending it backward; a resistance may be given to the neck muscles by the hands. The elbows which are at first held forward are drawn to the side with the erecting of the head. In the early stage of the training the teacher should guide these motions, applying resistance or corrective assistance whenever necessary.

In the next group of exercises a new element is introduced, that is, the shifting of the centre of gravity without altering the position of the feet.

8. Leaning forward (Fig. 60). With the hands on the crest of the pelvis, or somewhat more difficult, with the hands in a position as in Exercise No. 5, the body is inclined forward as much as possible without flexing the spine. An angle of 15 to 20 degrees should suffice for the beginning. As this exercise is intended to cause the glutei and posterior leg muscles to work for maintaining the balance, the exercise may be done in the following way: The patient is to stand with the heels two or three inches in front of the wall; now he should lean forward as far as he can without touching the wall with his buttocks. This exercise should also be done with the arms stretching up—and sideward as in Exercises Nos. 3 and 4. The difficulty is increased in the following order: (*a*) Hands on crest; (*b*) hands on neck; (*c*) arms stretched sideward; (*d*) arms stretched upward.

9. A similar exercise is done backward. Here care must be taken not to simply bend the trunk backward, thus increasing the lumbar lordosis which is anyway exaggerated in most of these cases. Also it should not become anything resembling the relaxed posture. This will be best avoided by a simultaneous effort to flatten the lumbar curve.

In the next group similar exercises as described under Nos. 8 and 9 are done with one foot forward. This may be carried out in two variations.

10. The patient places one leg forward, a distance of about two or three feet, with the knee slightly flexed; then raises his

Fig. 61.—Falling-out exercise from standing position.

arms upward or sideward, stretches, and relaxes, and repeats the exercise once or oftener; finally he returns to the original position (Figs. 61 and 62).

11. The patient returns to position each time when he has finished the stretching exercise. This exercise may also be done with any of the other arm exercises; furthermore, it

Fig. 62.—Spring sitting position.

may be done half or full sideward with corresponding twist of the whole trunk. It is important that the trunk is held in a straight line with the backward leg.

12. From the position attained in Exercises Nos. 10 and

11, the body may be flexed forward to have the fingers touch the floor; here again both variations of Nos. 10 and 11 may be practised, the latter being somewhat more difficult.

13. Hyperextension of either leg: One foot is set backward with the toes on the floor and the heel up; then it returns to position. Care must be taken not to increase the lumbar curve but rather to flatten it. This exercise may be combined with any of the arm exercises already described. Frequently the following arm exercise is combined with hyperextension of the leg: The arms are raised forward to a horizontal line and while the foot is set backward they are carried sideward backward, somewhat beyond the frontal plane. Some children are so flexible that they can bring the hands to nearly or actually touching each other behind the back. Such a test is not intended with that exercise, and should be advised against. It should be, as all these exercises are, muscle training, but not joint-stretching. Those patients are, as a rule, too flexible; we do not need to limber them up any more, but we want to have them learn and acquire proper muscular control.

These exercises which may be further modified have a general character attempting to correct the posture and train those muscles most needed for a proper poise in standing. In cases where a noticeable difficulty exists to maintain a correct posture, and especially in all cases where a localized, well-defined postural deformity is noticed, such as a markedly exaggerated lumbar lordosis, or a dorsal kyphosis, or an irregular anteroposterior outline, or a postural scoliosis, special exercises must be done. In these cases and preferably in such which show signs of the "insufficientia dorsi" or "weak back" we let the training begin with exercises in lying, later in sitting position, and do not take up exercises in standing until a definite effect is accomplished, and until the soreness has disappeared. Besides the exercises in lying which have been mentioned on page 258 a number of resistive exercises are of particular value. They are to be done from lying, knee-elbow and sitting position, as follows:

14. Raising head and shoulders from lying prone (Fig. 63). The feet are held by a second assistant, or if such is not

available, by a strap. The operator, standing on the left side of the patient, applies with one hand a corrective

Fig. 63.—Raising head and shoulders from prone position.

Fig. 64.—Raising head and shoulders from prone position with the trunk protruding over the edge of the table.

resistance on the point where it is most necessary, while the other hand, placed under the upper chest, may support and guide the trunk. In the beginning we have this exercise

done in three steps: At "one" the arms and shoulders are drawn backward; at "two" the head is raised; and at "three" the chest is raised a few inches. Raising up to full height is not desirable as it will increase the lumbar lordosis.

15. In a more advanced stage this exercise may be done with the patient's trunk projecting over the edge of the table (Fig. 64).

16. Knee-elbow position: The patient is taught to curve the spine forward and backward while the teacher applies

Fig. 65.—Knee-elbow position: Raising against resistance.

corrective resistance or assistance. For the raising (Fig. 65) —kyphosis—the resisting right hand rests on the spine and the assisting left hand on the lower thorax. For the lowering (Fig. 66)—lordosis—the teacher embraces the body of the patient, having his right arm rest on the sacrum and the left arm press gently against the lower ribs.

17. Sitting: The most convenient way is to have the patient sit near the edge of the table, with the knees flexed and the legs hanging down. The patient sits in an erect

position; the assistant places the right arm over the upper part of the sternum and the left hand over the upper part of the lumbar spine, and advises the patient to curve the spine pressing against both hands (Fig. 67). This exercise is not to be done as the usual forward bending with simultaneous action of the hip flexors, but only as a curving of the spine. Furthermore, it should not be done to the extreme possible flexion, but only enough to obtain a good contraction of the forward muscles.

Fig. 66.—Knee-elbow position: Lowering against resistance.

18. After this is done the spine has to be erected again, for which the operator may give a corrective assistance (Fig. 68). The hand which works on the back may be placed higher up or lower down, thus changing in a way the localization of the resistance or assistance movement.

19. This exercise is similar to No. 18. The patient bends the spine way forward and brings it into an erect position against the resistance of the operator which is to be applied higher up or lower down as the individual indications require. To do this exercise with sufficient strength it is necessary to fix the patient's pelvis. This may be done by

a second assistant or by a strap. A simple and very effective way, especially in working on adults where much strength is needed, has been the following: A sufficiently long strap is bound over the pelvis of the patient and goes also around the operator's waist. This fixation allows the operator to have both hands at his disposal and to apply a

Fig. 67.—Flexion of the spine against resistance.

very much greater force because he has not to hold himself so much by his own muscle power.

20. Another modification of this exercise may be done with the patient standing against and leaning over a table of moderate height. As he erects himself resistance is given by the operator whenever necessary.

These last exercises are especially suitable in cases of

marked kyphosis. With such patients two other exercises have been found of great value.

21. The patient is sitting on a low stool; the operator places his right foot on the stool and his knee against the kyphotic part. Then he draws the patient's shoulders backward, applying a certain amount of pressure against the

Fig. 68.—Extension of the spine with assistance.

hump with the knee. This exercise may be combined with resistive movements (Fig. 69).

22. The patient is standing, or better sitting on a low stool. A cane is placed on his back and held there by the flexed arms, while a small but firm pillow is put between the cane and the spine. By pulling the arms forward a corrective pressure is

applied against the hump, an effect which may still be much increased by the operator giving a resistance to the arms pulling the cane, and adding pressure with his hand or fist on the hump.

Fig. 69.—Bracing of back with knee against dorsal spine; also for resistive exercise.

Many of these exercises may be combined with breathing exercises, but in cases where it is difficult for the patient to control movements of the chest, breathing in its different

forms of thoracic and abdominal breathing, and a combination of both should be practised in addition.

23. A kind of "reversed" breathing which has been found of special value in such cases is done in the following way: The patient takes a deep abdominal inspiration, holding his hands against the abdomen and applying a gentle resistance. During this movement the ribs should not be raised, but rather somewhat lowered. Then during the expiration the ribs must be forcibly raised, for which the hands may give assistance from the abdomen. We have found this exercise of particular value in cases of marked atonia of the abdominal wall. During the inspiration the patient will show a certain tendency to lean backward, which should not be permitted, and if necessary, prevented by the operator. If the patient is unable to do this exercise standing, it should be practised first in the lying position. This exercise may be increased in difficulty by having the patient count slowly with a loud voice during the expiratory movement. The number to which the patient is able to count may serve as a record for his respiratory strength and control.

Special exercises for the correction of exaggerated lordosis:

24. The patient, lying perfectly flat, tries to press his lumbar spine down as near to the table as possible. This is accomplished by an active tilt of the pelvis backward.

25. When this exercise is well understood it is practised in standing. The patient tries to straighten his lumbar spine as much as possible and to tilt his pelvis backward.

26. At the suggestion of Dr. Kidner we make frequent use of the following exercise: The patient stands with the back against the wall or a door post, touching it with the head, shoulders, buttocks, and heels. A person with a flexible or a flat spine will in this position easily bring the lumbar spine in touch with the wall. The average person will have some difficulty to do so, while a person with a lordotic and not very flexible spine cannot accomplish this unless the feet are set forward a certain distance, and in severe cases not even then. The patient has now to place his feet forward so much that the lumbar spine comes in close touch with the wall and then slowly step by step bring his feet nearer to the wall,

constantly trying to keep his lumbar spine in touch with it by a strong action of his muscles. As soon as he feels that he cannot hold the spine any longer at the wall the position of the feet is marked and the exercise repeated. A decrease of this distance is to be striven for and should be carefully measured. Other exercises for the correction of lordosis may be done in knee-elbow or knee-hand position as active or resistive movements in the manner described above.

CHAPTER XVII.

LATERAL CURVATURE.

The history of the treatment of lateral curvature represents one of the most interesting chapters in the development of orthopedic surgery. An immense amount of work has been done by surgeons of many countries and among them many of the best men, and still we are far from possessing generally recognized principles of treatment. The methods employed have been, and to some extent are still, very different from each other, and very different values are placed on massage and exercise. We shall at first attempt to find a way out of this labyrinth and define the value of massage and exercise according to the opinion of leading orthopedic surgeons.

The treatment of lateral curvature has two main indications: (1) The removal of the causative factor, and (2) the correction of the deformity.

REMOVAL OF THE CAUSATIVE FACTOR.

The problem of removal of the cause is in the majority of cases an impossible one because in many the cause is not definitely known and in many others the pathological process responsible for the deformity has been arrested a long time ago (as in many cases of infantile paralysis or empyema). The fact that in many text-books on mechanotherapy weakness of the muscles in combination with faulty attitude has been held responsible entirely or in large measure for the onset and development of habitual scoliosis, the most frequent type of lateral curvature, and that exercise treatment therefore has been considered as the rational procedure, meeting directly the etiological indication, makes it necessary for us to say a few words on the modern theories of the

etiology of lateral curvature. These may be divided into constitutional and mechanistic theories. The followers of the constitutional origin believe an abnormal condition to exist in the bones of scoliotic children while the shape of the deformity is determined by habitual causes. The followers of the mechanistic theories believe that the scoliotic deformation results from asymmetries of the base of the spine (Boehm, Adams). None of these theories have been sufficiently proved to be generally accepted, and probably none will ever be accepted for all cases. There are great differences among the scoliotics, not only in regard to the deformity itself but also in regard to the general constitution and, as Schanz emphasizes very strongly, in regard to the prognosis. In his excellent report before the International Congress in London this author states that the scoliotic cases may be divided into two fairly well distinguished types; a malignant and a benign type. In his experience, which comprises to a large extent private patients, the malignant cases form only 10 per cent. Chlumsky and others have made similar statements on the basis of statistics made in schools and clinics.

Although from our personal experience which is largely drawn from the out-patient clinic, the percentage of the malignant cases seems to be considerably larger and although we confess that the distinction between the benign and malignant types does not seem to us quite so easy as Schanz states, we believe that his distinction is nevertheless of considerable value. It is not the time yet to divide these cases in regard to the etiology, though we are strongly inclined to believe that in these malignant progressive cases constitutional weakness associated with marked plasticity of the bones plays the prominent role while the mechanistic element if found at all—and it has been found in many of them—has merely a shaping and modeling influence. Without following these deductions any further we come to the conclusion that we should definitely give up the attempts of any routine treatment in lateral curvature and should strictly follow individual indications.

Greatest attention should be paid to those severe malignant cases which show a progressive tendency, and although we

have as yet no definite knowledge of the morbid process we shall probably come near to the causative indication when we consider the constitutional element as of foremost importance. In this respect, however, exercise plays only a secondary role. Making it the treatment of choice, it is likely to do more harm than good. Fortunately these cases are in the minority and there are many left to which we can apply exercise and massage to great advantage.

This leads us to the second indication, the correction of the deformity.

CORRECTION OF THE DEFORMITY.

The salient point in this important and difficult problem cannot be expressed more exactly than in Lovett's words:[1] "Structural scoliosis is a bone problem; a glance at the deformed column indicates that, but it has been too largely considered and treated as a muscle problem." "The history of the treatment of moderate and severe structural scoliosis as a muscle problem is a history largely of failure or of extravagant and unwarranted claims."

But nevertheless exercise has a very definite place in the treatment of lateral curvature. Its effect consists in (*a*) loosening of contractures; (*b*) muscle building; (*c*) postural correction; (*d*) hygienic uplifting; and (*e*) if done with proper technic, in actual correction.

Loosening of Contractures.—It cannot be doubted that exercise will do this to a certain extent, though it is accomplished much more thoroughly by corrective jackets. But it must be considered that a certain effect of free exercise treatment may be to render the spine often flexible more quickly than the muscles learn to hold it. Any efforts in this direction, therefore, should be accompanied by strengthening of the muscles in proper relation to the loosening of the stiffened spine. We know from personal experience that here great harm can be done by improper treatment. But this applies not only to exercise, but to other methods as well. When a stiff scoliotic spine has been stretched and corrected

[1] Lateral Curvature of the Spine, Philadelphia, 1912, 2d ed., p. 127.

by a series of plaster jackets danger exists that the muscles will not hold the spine and relapse may take place. Therefore, hand in hand with loosening of the spine should go muscle building.

Muscle Building.—The effect of exercise in this direction cannot be doubted and certain systems of gymnastics for lateral curvature have been built up on this principle. As example may be mentioned Teschner's system, which has been largely adopted by Whitman and described in his text-book.

Correction of Posture.—The correction of posture has been much disputed as a factor of importance in the treatment of lateral curvature. We personally believe that it is of very great importance and are convinced that many of the results claimed in regard to actual correction find their chief or perhaps sole explanation in a correction of the general posture. Both muscle building and postural correction are intimately connected with each other.

Hygienic Uplifting.—Under this heading would fall the influence of exercise upon the internal organs, the circulatory and nervous systems, and the general metabolism. What is of importance for the health of every child is of exceedingly great importance for the scoliotic child. The general problem is the same, but the application of exercise treatment must be carefully guided by the individual indications.

Correction of the Deformity.—The question whether and to what extent an actual correction of the deformity can be accomplished and maintained by exercise alone has been answered in different ways. Zander, one of the most enthusiastic advocates of exercise and massage, a man who has treated hundreds of cases and has constructed a number of practical and useful apparatus for the treatment of lateral curvature, makes a very modest claim when he says: "We cannot directly correct these children, but we can make them grow straighter." Lange is more optimistic about the chances to actually correct the deformity. He has developed a system of treatment for active and passive correction and overcorrection by simple and practical apparatus. His chief object is to make sure that the correcting force attacks

the height of the convexity. Details will be discussed later on. Also Schulthess advocates exercise treatment for correction of the deformity. He uses many pieces of apparatus which have the great value of exact localization of the correcting force. Unfortunately his apparatus is so complicated and expensive that it will hardly ever find common application.

All that has been said above concerns chiefly the habitual scoliosis, which, however, deserves most consideration as it is more frequent than all the other forms put together. A few remarks will suffice about the other types.

Rachitic Scoliosis.—Rachitic scoliosis is not so frequently seen in this country as in Europe. When we consider what has been said about the danger from constitutional weakness we shall restrict the use of exercise in these cases until by proper medical care the disease itself is healed, while at the same time rational orthopedic treatment should prevent deformity or its progress. Massage has been advised in the treatment of rickets, but we do not feel that it is of more than a secondary subordinate value. Mitchell advises the use of cod-liver oil as a lubricant in such cases.

Empyema.—Empyema not infrequently leads to lateral curvature which may become very severe if great care is not taken in time. We shall hear more about the prevention of this affection in the chapter on the Respiratory Organs. The cases we usually see of that type belong to the most severe deformities of the spine, which most violently resist all efforts of correction. But in our experience these patients can be much benefited by a persistent rational exercise treatment, though the use of supporting braces is often necessary.

The following case will serve as an example: A young man, aged twenty-one years, had noticed a curvature of the back following empyema about three years ago. On account of pain below the left shoulder he went to a physician who applied a brace. This stopped the pain for one year, and then it started again. Now the patient could not wear the brace any longer, though he had practically worn it all the time until recently. He said that it took his breath away.

The patient is poorly developed and nourished, and shows a very marked left cervicodorsal and right dorsolumbar curve. The spine is fairly rigid and cannot be controlled by active motions, while very little passive correction is possible. The left shoulder is much higher than the right one; the thorax on the left side is much compressed.

The patient was advised to give up his brace, which evidently crowded the spine and thorax together. As the patient lived some distance from town he could come only once a week for a lesson, but he carried out a number of exercises at home very faithfully, and arranged a little home gymnasium in the attic which served the purpose exceedingly well. By faithful exercising he gained in four months ten pounds in weight and three or four inches in height. When first seen his height was five feet six and a quarter inches, and in a forcibly erected position five feet seven and a quarter inches was measured. Four months later he showed a height of five feet ten and a quarter inches without great difficulty. The exercises given to him consisted in breathing, postural, light dumb-bell exercises, resistive exercises as described below, the resistance given by weight and pulley, and self-corrective exercises. The general health of the patient had been improved in the meantime so much that he was able to take up his former occupation as a clerk in a store.

Infantile Paralysis.—The problem of preventing lateral curvature in infantile paralysis affecting important muscle groups of the trunk is one of the most difficult in orthopedic surgery. Lateral curvature may develop in recumbency, and may increase in spite of braces or casts. The question of what is to be gained by exercise finds an answer similar to the prognosis of these cases in general. Where there is a complete paralysis of many muscle groups we cannot expect very much, but, as we have emphasized in the chapter on Infantile Paralysis, in most cases many muscles are only partially paralyzed, and are capable of considerable training by systematic exercise. In giving such exercise treatment the principles laid down for the treatment of infantile paralysis cases should be considered and thus the corrective exercises be modified. These cases

must be watched very closely, as we know from experience that considerable harm can be done by overexertion.

Congenital Scoliosis.—As the cases of congenital scoliosis are comparatively rare discussion may be omitted. Generally these cases are not good subjects for exercise treatment, and, as a rule, do not need it, except for indications such as poor general posture, or general health. The treatment should not strive to attempt too much in regard to the correction of the deformity, because as long as we are not able to remove the deforming cause the result of any correction possibly obtained will be rather questionable, at least before the skeleton has reached its final growth.

Before we discuss the technic of massage and exercise in lateral curvature we must make it clear that we do not consider this form of treatment as the treatment of choice, but that we must demand in each case that there be very careful individual indications. Scoliosis should be treated by or under the supervision of a competent orthopedic surgeon who will apply braces, plaster casts or physical therapeutics as indicated in the individual case.

We begin with a brief description of massage as applied in lateral curvature.

The patient is lying prone and if considerable lordosis exists one or more pillows are placed under his abdomen so as to straighten his spine and relax his muscles. After introductory effleurage of the back as described on p. 94 the individual muscle groups are thoroughly kneaded. As we do not accept the old theory of a primary one-sided pathological change of muscles as the actual cause of lateral curvature we believe that all muscle groups should be treated and not only those on the convex side.

Moreover, corrective manipulations should be combined with the massage. In a case of right dorsal and left lumbar curvature this is done in the following way: The operator, who stands on the left side of the patient places his left hand underneath the left side of the thorax and his right hand upon the right dorsal hump, and while kneading and stroking over the hump tries to reshape the deformity, and to untwist the spine and thorax. In sufficiently flexible

cases this is often possible to a very considerable extent. Afterward similar manipulations are applied to the lumbar segment, the hands being reversed.

EXERCISE TREATMENT OF LATERAL CURVATURE.

The exercises for the treatment of lateral curvature may be divided into:

1. Simple muscle-building exercises.
2. Postural exercises.
3. Special corrective and self-corrective exercises with and without apparatus.

The exercises under Nos. 1 and 2 have been sufficiently described in the chapters on Active and Passive and Free Exercise as well as in the chapter on Faulty Posture. The method described by Teschner and reproduced by Whitman is almost identical with the form of exercise described in Chapter III, except for the work with heavy dumb-bells. We believe that such "heavy work" is excellent in the later stages of the treatment, but warn against its use before a sufficient amount of control has been obtained. The direct corrective influence of all these exercises, as well as those mentioned under No. 2, postural exercise, is at least problematic. Their general hygienic effect and their effect on the posture, however, cannot be denied and, if applied under careful supervision of the physician or his competent assistant they may be very beneficial. A prominent part in all these exercises as well as in many considered under No. 3 is played by the cultivation of correct breathing. This must be done both symmetrically and asymmetrically as has been outlined in Chapter III. Lacquet makes a strong point of exercising the shoulder-joints and training their muscles.

Before passing on to the description of the exercises especially devised for lateral curvature we wish to consider a few points which we think are of great importance.

(*a*) It cannot be doubted that the best chances are given by hospital treatment, especially in severe cases, and in the so-called malignant type we should insist on hospital care. Unfortunately in our clinic and in many others this is not

possible on account of an insufficient number of beds. We must therefore treat our patients in the out-patient department. This is done in two sections which are separated but in close touch with each other. In one section corrective plaster work is done and in the other exercise treatment is given. The selection of cases is generally left to the orthopedic surgeon in charge of the former section. For the exercise treatment the children are collected in classes, though each child is treated individually under the direction of a special teacher and under the supervision of the writer.

(*b*) The general health is the subject of special attention. Consultations with the medical and other departments are held if necessary. Regular tests of weight and height are taken once a month or oftener and if either one shows a constant tendency to decrease, special precautions are taken or the treatment is interrupted. The social conditions are studied and amply considered with the assistance of the social service department.

(*c*) The girls are requested to wear bloomers during the exercises. The back is exposed to allow constant inspection of the effect of the posture and movements.

(*d*) Of importance is the question whether or not children should have exercise treatment who complain of pain and tenderness in the back. In general this is not a contraindication to exercise, though we take special precautions. In such cases weight-bearing and suspension exercises are entirely omitted. If pain and tenderness do not disappear within a few weeks or if they increase, exercise treatment is suspended.

(*e*) As we have outlined in Chapter XVI (see page 258) an important part of all exercise treatment consists in education. It is not enough that the children come two or three times weekly and exercise for an hour or two, but they must be impressed with the necessity of learning to accomplish with ease and almost automatically what will be at first difficult for them. They must learn to cultivate their will-power and must be taught to regain the sense of correct balance which has become gradually disturbed during years of going about with a deformed and poorly balanced spine.

3. Besides the exercises of a general muscle building and postural character there have been devised a great many special exercises for correction and overcorrection. The chief postulate in all these exercises is, as Lange emphasizes, that the correction or overcorrection is really applied where it is needed. Hence care must be taken that another deformity does not result in the effort to correct one, and that an increase of a secondary curve does not take place while the primary curve is subject to corrective treatment. This seems so perfectly natural and self-evident that it should not need any further remarks, but experience in the clinic as well as a study of illustrations in a number of text-books have convinced us that this requirement is not always sufficiently considered. Thus, for instance, when the correction of a marked dorsal hump is attempted by bringing the patient either actively or passively into a position of extreme lumbar lordosis we consider such an exercise as entirely irrational, because it merely tends to increase the already unfavorable compensatory hyperflexibility of the lumbar spine, aside from the consideration of the modern mechanical theory of lateral curvature, according to which an increase of the lumbar lordosis would not seem to be desirable.

The exercises for special correction may be done (*a*) with the assistance of another person; (*b*) by the patient himself; and (*c*) by an apparatus with or without the help of another person.

In discussing the corrective exercise done by another person we proceed from the passive manipulations described in connection with and as a part of massage of the back for lateral curvature. The same position as described for the passive manipulations may be used also for active and resistive exercise, as well as combinations of passive and active movements, according to the same rules which have been laid down above for the mobilization of stiff joints. Although the principles are not exactly the same they are similar to a certain extent at least, and here as there the mobilization by active muscle action and especially by well-localized resistive exercise is undoubtedly far superior than that by passive manipulations.

The resistive exercises are done from lying, knee-elbow,

knee-hand position, and sitting. Standing and suspension are not particularly useful except standing leaning over a table.

In the following paragraphs a number of resistive exercises are described as examples, though it must be emphasized again that the operator has to individualize strictly.

These exercises have been worked out on a girl, aged sixteen years, with severe right dorsal curvature, marked hump of the right ribs and marked twist and deformation of the thorax.

1. The patient sits on a high stool; the operator fastens the pelvis with a strap which goes around his own waist. The patient, from a position bent way forward is to raise the head, then the shoulders, and finally the body against resistance applied by pressing over the hump with the operator's right hand, while his left hand assists in lifting the thorax. When the patient has raised the body half-way she begins a deep inspiration which reaches its full height when the body has been raised to a vertical position.

2. The patient assumes a position bent forward and to the left with a simultaneous twist to the left. The arms may be left relaxed, or better still, may be elevated to a horizontal position. The operator in the same way as before applies resistance over the right hump and assistance to the left lower thorax while the patient bends backward and to the right, and twists to the right. A deep inspiration is made as in No. 1.

3. The patient, sitting with the thorax somewhat listed, but not flexed to the right, and somewhat twisted to the right, is to push toward the left against a resistance applied over the left upper thorax at the same time raising the left shoulder upward and bringing the right shoulder somewhat backward. When the exercise is nearly completed the operator changes from resisting to assisting and passive stretching, thus lifting up the left thorax.

4. The patient lies prone over moderate-sized pillows with the arms hanging downward relaxed. The operator grasps the right scapula and the region of the hump with the right hand while his left hand grasps the right shoulder from front

and back. The patient raises the right shoulder and arm backward, whereby the operator's right hand gives resistance and the left hand guides the motion. After raising the right shoulder somewhat the motion should be combined with a twist to the right side, which the left arm and head must follow. The patient should try to look over the right shoulder toward the operator. Care should be taken not to hyperextend the lumbar spine to any considerable extent which is somewhat counteracted by the pillows.

5. In a case of right dorsal curve a simple resistive exercise consists in raising the right arm backward upward while lying prone, preferably over pillows. If the spine is not too rigid the correcting effect of the exercise can be noted immediately. This exercise may be further modified by resistance which can be given by having the patient lift up a weight.

These exercises may be learned by the patient himself, although the corrective effect can never be the same as when resistance is applied. A certain danger in doing them alone lies in the fact that it is not easy for the patient to control the localization. Hence in the effort to correct a right dorsal curve he may simply increase the existing left lumbar curve, or in trying to erect his dorsal spine he may increase his already exaggerated lumbar lordosis.

The exercise in suspension is based on entirely different principles. It is practised by suspension on the head, or on the hands, or both. As most cases of lateral curvature become more or less stretched out in suspension this position has for a long time been considered as especially valuable. It cannot be denied that suspension produces a very marked mobilizing effect upon the contracted spine, but the question is: Is this form of mobilization of value? We believe that it is often not, because the muscles are not strengthened in proportion to the speed of mobilization. But unless this is done no good effect can be expected from the mobilization. We have seen girls in orthopedic clinics whose height could be increased four or five inches by suspension. After being released from the headsling they collapsed like an accordion. For many years we have given up the suspension with the head alone and use it only in selected cases in

combination with hand suspension for rather short periods (Fig. 70).

We entirely agree with Mencière when he says that scoliotic spines which can be materially corrected by sus-

Fig. 70.—Suspension by hands and head. The patient is shown hanging on one of Zander's apparatus; by pulling one or both handles down the seat is raised on one side.

pension are not suitable for exercise treatment in suspension or in weight-bearing, but only such cases which show ability to strengthen and correct the spine by muscle action.

Of great value, however, is the hand suspension on the Swedish ladder or on rings or a trapeze in combination with active exercises of the arms, legs, and trunk. Such exercises may be done in various ways, subject to modifications according to the character of the deformities (Figs. 71 and 72).

Fig. 71.—Hip and knee flexion in suspension.

The most valuable exercise which is done by the patient alone without help of another person or apparatus is the creeping exercise which has been developed by Klapp. Proceeding from the observation that four-footed animals

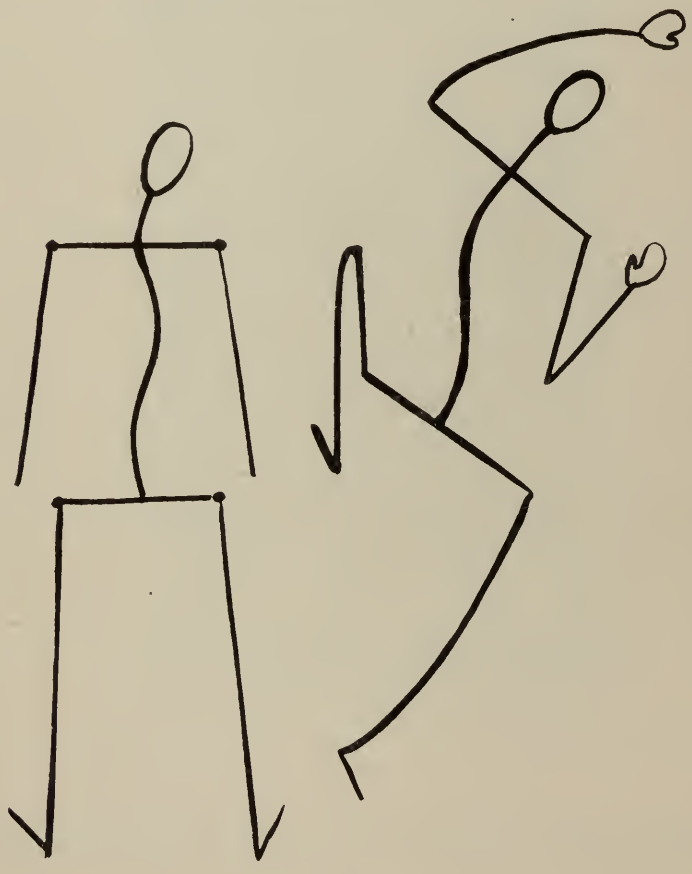
almost never have scoliosis, Klapp made a perfectly logical step in advising the knee-hand position as a rational way to perform exercises in the treatment of lateral curvature. While we cannot quite share the enthusiastic claims of Klapp and his pupils about the immense value of his method,

FIG. 72.—Suspension on Swedish ladder. By flexion of hip and knee a certain correction of the spine may be obtained.

we consider it an excellent exercise which favors mobilization and muscle-building in a harmless position.

Simple Creeping Exercise.—The patient goes down on his knees and hands and creeps forward in a fairly rapid tempo,

FIG. 73 —Creeping.



a *b*

FIG. 74.—*a*, scoliosis standing; *b*, simultaneous correction of both curves during the ambling gait. (Klapp.)

making the steps as long as possible and swinging the shoulder girdle and pelvis as far as possible. Thus, the spine is forced to make wide lateral motions which in the end may have a mobilizing effect (Fig. 73).

FIG. 75.—Creeping with active self-correction.

Hyperextension.—When considerable kyphosis exists, the patient must learn to extend or even hyperextend his spine. In cases with kyphosis in the upper dorsal segment this is best accomplished by the so-called "deep creeping." The arms are flexed at the elbows in an acute angle, thus bringing the shoulder girdle near to the floor, in the manner of

the dachshund, which animal has a marked dorsal lordosis. The head is carried up high, though avoiding hyperextension

Fig. 76.—Corrective exercise for left total scoliosis.

of the cervical spine. This exercise has also been used by Klapp for cases of old Pott's disease with the idea of mobi-

lizing the parts of the spine above and below the affected area.

Ambling Gait.—This exercise is intended for double curves, as Fig. 74 illustrates. At first the left arm and left leg are

FIG. 77.—Self-correction in standing.

put forward as far as possible; by that movement the right dorsal curve is increased and the left lumbar curve corrected or overcorrected; then the right arm and right leg are put

forward, causing the opposite effect. A certain difficulty exists here as in almost all other free exercises, namely, that while we correct one curve the other curve may be increased. This difficulty is best overcome by simultaneous efforts to hyperextend the spine as much as possible. These ideas are based on the studies of Lovett and Schulthess who have shown that in hyperextension the intervertebral joints have the greatest mobility.

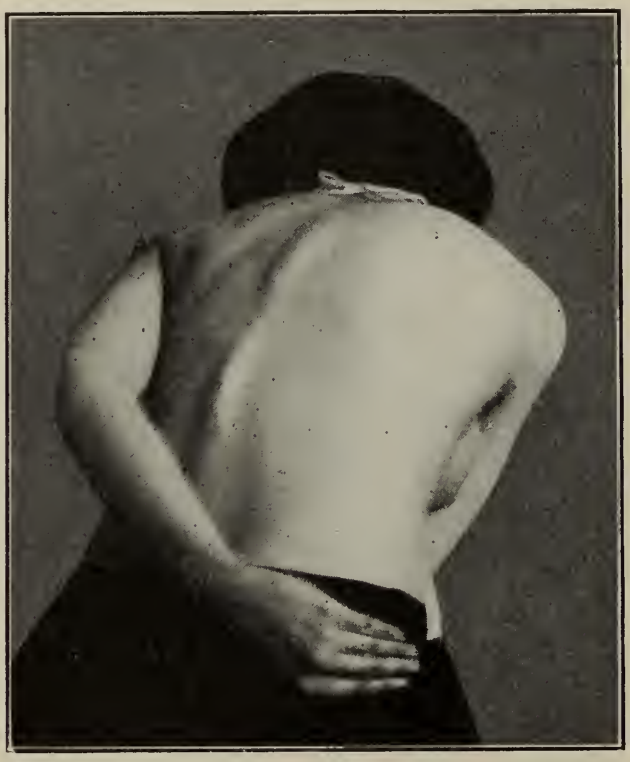


Fig. 78.—Self-correction in forward flexed position.

It may be of interest to mention in this connection that Abbott claims hyperflexion to be best suitable for correction and overcorrection. Furthermore, Adams's ideas may be recalled that increased lumbar lordosis and increased forward inclination of the pelvis may favor slipping of any of the lower lumbar vertebræ, thus further damaging the irregular base of the scoliotic spine.

When Klapp compares the great flexibility of the tiger or

the cat, which animals have a very straight or almost lordotic spine with the increase in mobility of the scoliotic spine in hyperextension, it may be objected that such comparison should not be based on the external anatomy, but only on the structure of the articular processes which differ very widely in the various classes of animals.

Fig. 79.—Self-correction in kneeling.

Further exercises in creeping or from the creeping position may be done by raising one arm and shoulder with twisting the body, in a way similar to that described for the resistive exercise No. 2, p. 287 (see also Fig. 75).

The standing position is in our opinion the least favorable

for special corrective exercises, though its value for postural correction cannot be doubted. We will describe a few exercises in standing but wish it to be understood that we do not rely upon them alone.

1. In a case of left total scoliosis correction or even overcorrection may be obtained by stretching the right arm upward and the left arm downward or sideward (Fig. 76). A slight bending of the trunk toward the left side and a slight twist toward the left side may be combined with the stretching of the arms.

Fig. 80.—Patient hanging over Zander apparatus K–1 for correction of lateral curvature.

2. Inclination of the body to the left side. When the body is listed toward the right side the patient should learn to force it over toward the left side by his own muscle power. As usually in these cases the left shoulder hangs downward and backward, it should be forced upward and forward. The hands may be placed on the neck or the right hand may press

on the right dorsal hump and the left placed on the neck and stretched out sideward.

3. Self-corrective exercise: In a case of left dorsal and right lumbar scoliosis the right hand is placed over the lum-

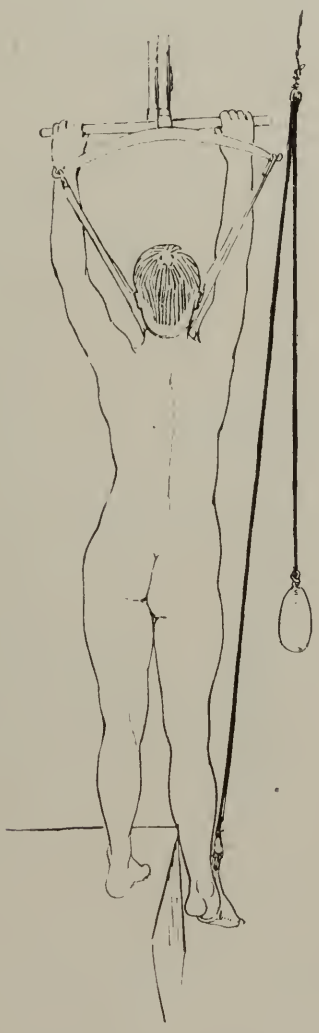


Fig. 81.—Overcorrection of a left lumbar curve. (Lange.)

bar curve and the left hand over the dorsal curve. Both hands press and try to correct the spinal curves (Fig. 77). When the trunk is listed toward one side this exercise should be combined with the last mentioned.

These exercises may be combined with falling out of one

leg in the manner described under Nos. 10 and 11 of the postural exercises, though this should not be practised before sufficient control is obtained.

4. The following exercise has been developed according to the principles of correction as devised by Mackenzie Forbes: In a left dorsal scoliosis the patient bends the body forward, places the left hand on the back, the right hand in front of

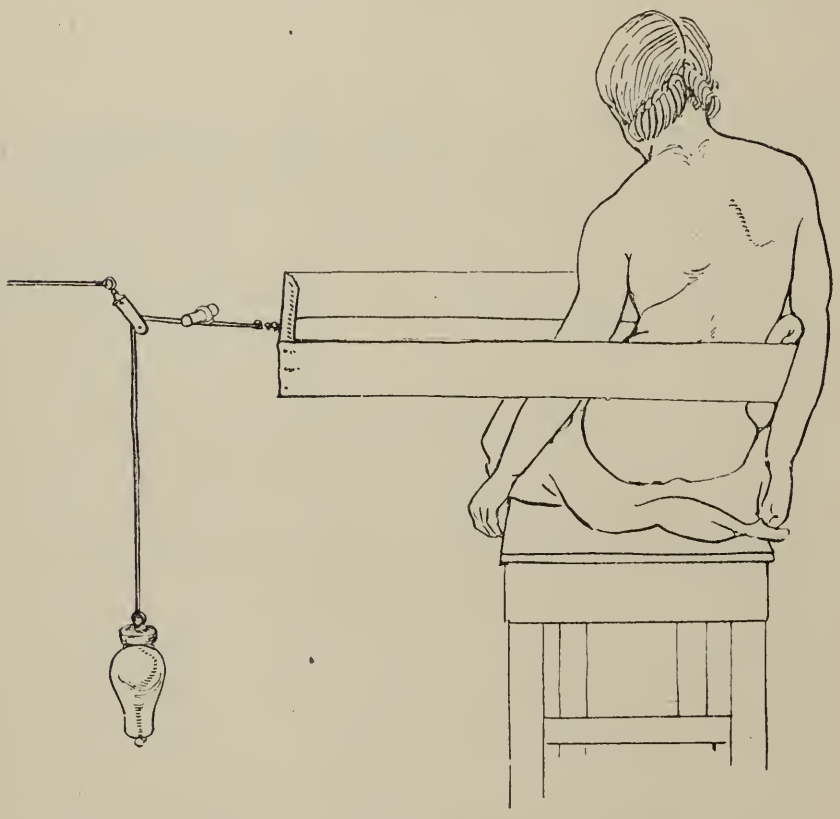


Fig. 82.—Correction of left lumbar or left total scoliosis. (Lange.)

the head on the left shoulder and twists the spine and head toward the left side (Fig. 78). In order to secure easier balance the right foot may be placed forward. As in all asymmetrical exercises in standing the control of the pelvis is difficult if not impossible, it is advisable to use a pelvic clamp (Lovett).

There are many different ways in which self-corrective

exercise may be done. Fig. 79 illustrates a method often employed.

A great number of apparatus have been constructed for the correction of scoliosis, from the simplest up to the most complicated and ingenious machines (Fig. 80). We agree with Lange in that apparatus for this purpose must be (1) simple to manage; (2) fairly inexpensive; and (3) exact in

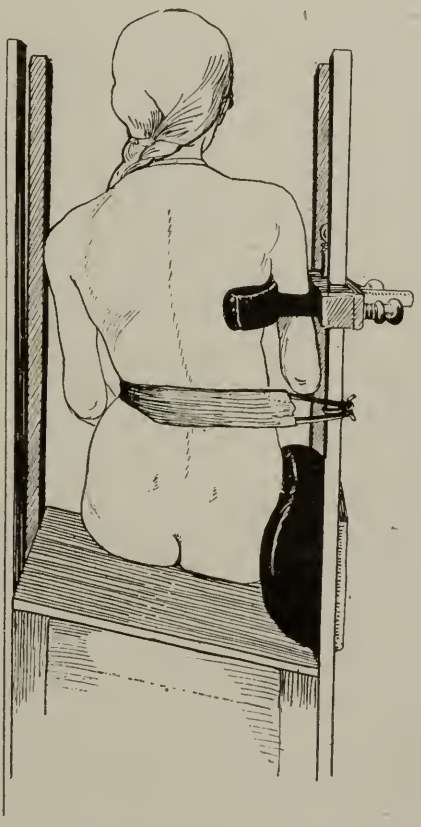


FIG. 83.—Correction of right dorsal and left lumbar scoliosis. (Lange.)

their work, *i. e.*, we must be sure that correction or, if such is possible, overcorrection must be well localized.

Of all apparatus which we know these requirements have been best fulfilled by Lange's[1] apparatus. For details his well-illustrated paper should be studied. We shall merely

[1] Die Behandlung der habituellen Skoliose durch active und passive Oberkorrectur, Ztschr. f. Orthopaedische Chirurgie, 1907, vol. xviii.

reproduce a few pictures. Lange's idea is to accomplish active and passive correction or overcorrection with the simplest kind of apparatus. This is fairly simple in single curves. For instance a loose left lumbar curve may be overcorrected by a simple pulley apparatus as shown in Figs. 81 and 82. Fig. 83 shows a case in which the left

Fig. 84.—Correction of forward stoop of left shoulder in left total scoliosis. (Lange.)

lumbar scoliosis is well overcorrected by a strap, while a pad pressing over the right side of the thorax corrects the right dorsal curve. The apparatus in the illustration shows a passive correction, but it may be used for active exercise as well. In these examples the corrective pressure has been applied in a lateral direction only while other apparat strive to obtain correction of the torsion.

In Fig. 84 a strap is fastened around the left shoulder of a case with left total scoliosis. The patient is to lift a weight by drawing the shoulder backward. The tendency of this exercise is the same as that described on page 288, raising the arm and shoulder backward while lying prone.

Fig. 85.—Apparatus for passive correction in lying. (Lange.)

Besides this and similar apparatus for active and active-passive correction Lange has constructed very practical and useful apparatus for passive correction in lying. Fig. 85 shows such an apparatus as an example. One or two belts furnish the correction while the padded boards support the neck and pelvis and prevent these parts from slipping.

CHAPTER XVIII.

AFFECTIONS OF THE FOOT.

The feet are the most faithful servants of our body but, as a rule, are treated worst of all. They have to carry us through life in millions of steps and years of standing, and with little appreciation of these duties we squeeze them into more or less irrational shoes and conduct them in improper positions. The wonderful machine of the foot is one-half unused and the other half is used in a inappropriate manner. It is not surprising, therefore, that affections of the feet represent a very large part of orthopedic work, and the problems offered in their treatment are quite numerous. Exercise and massage have a very prominent place among the therapeutic measures, although in practice, especially in the routine work of large clinics they are much overshadowed by other methods, not always to the advantage of the patient.

The opinion of orthopedic men as to the value of exercise treatment of weak and flat feet differs very widely. While there are a few who claim that they can cure most cases by exercise treatment alone and do not need supports, there are others who consider exercise treatment of no practical value, and we may add, a great many neglect it too much in comparison with other methods.

An orthopedic surgeon gave me in a personal interview the following reasons for his neglect of exercise treatment. He said: "A person walks ten thousand steps on the average during a day. If he has pronated feet he will keep his feet in that deformed position during all these many steps, and I do not see that it will help him to practise corrective exercises every morning for fifteen to twenty minutes." This conclusion, however logical it is, shows that the most

important point has been overlooked, and that is the educational element. Besides that it is perfectly possible to train certain muscle groups, as frequent experience proves.

Before we describe indications and technic we shall give a few brief remarks on the anatomy and normal function of the foot.

The foot serves chiefly two purposes: it is a static support and a propelling machine.[1] In standing in proper position the joints and ligaments of the foot and the whole static column are arranged in such a way that a minimum of work is required by the muscles. As everywhere in the body the muscles are arranged in groups balancing each other in a certain relation. It is particularly the proportional strength of the adductors and abductors of the foot which is of importance for a correct balance and proper function. Osgood[2] has made exact measurements on a large number of feet in order to study this relationship. The result of his experiments which have been made on an apparatus especially devised for this purpose are given in detail on account of the great importance which the question of balance has for the problems discussed in this chapter.

Groups.	Number of feet.	Average numbers. Adductors.	Abductors.
1. Normal feet	22	10	8.2
2. Pronated feet without symptoms	23	10	10.5
3. Weak or strained, though flexible pronated feet	46	10	10.8
4. Acute, flat foot; fairly flexible, but with signs of acute strain, swollen, congested, tender and very painful	32	10	12.2

These numbers are average numbers; we have found at times the relation as much changed as 1 to 2 in favor of the abductors in weak and strained pronated feet.

The arch of the foot has not a permanent character, but it is maintained by the ligaments and the adductor muscles which are further assisted by the long flexors of the toes. The ligaments have no distinct elasticity; while the muscles have. When the latter fail to accomplish their work properly

[1] Whitman: Orthopedic Surgery.

[2] Amer. Jour. of Orth. Surg., January, 1908.

the full strain of maintaining the arch rests upon the ligaments. Then the foot gives way. This takes place at first as a physiological movement in the subastragaloid and the mediotarsal joints; the os calcis tilts inward, the foot becomes pronated and the arch apparently lowered. Without weight-bearing the arch will be restored again.

In walking the purpose of the muscles of the foot is to propel it. In the normally shaped and balanced foot the median line of the knee should fall about over the second toe. In the pronated foot this line falls more or less to the inside in which position the propelling function is disturbed. The muscles which ought to propel by active contraction perform a merely static if not a negative action. Hence the gait becomes unelastic and clumsy.

If this abnormal condition persists for a certain time, the ligaments on the inner side of the foot, especially the deltoid and the calcaneoscaphoid ligaments, may give way under the constant strain and an increasing deformity may result, which then persists also in position without weight-bearing. The foot becomes flat. The problem which had at first been a muscle problem becomes a bone problem.

These deductions will make clear the great importance of the preventive treatment, and will also illustrate the part which exercise is to play. If we are able to reëducate the weakened and stretched muscles to perform their function correctly in standing and walking we may succeed in preventing deformity. The difficulty in doing this lies chiefly in the fact that, as a rule, the patients do not come for treatment until after the faulty weight-bearing condition has become inveterate or actual deformity has resulted. It would be ideal if the initial stages during the growing age could always be attacked and in this regard, just as we have outlined for the problem of faulty posture, of which faulty weight-bearing and improper function of the foot is frequently a part, an important part of the preventive problem rests with the teachers and parents.

In every child with faulty posture the care of the feet should be considered as a very important part of the treatment, even when there is no local complaint. We should

prescribe proper shoes and try to restore correct balance by systematic training of the weakened adductor muscles. Under otherwise favorable conditions, and with the intelligent and helpful coöperation of the patient this is usually accomplished in a fairly short time. But with this we must not be satisfied; in the same way that we cannot speak of a final result of the postural treatment of the back before correct posture and function has become easy and almost automatic, so with the foot the treatment is not really finished before the patient has learned to carry his feet in a proper weight-bearing line with a minimum of muscular effort and before he has learned to propel the foot in walking automatically in a correct way. This, however, cannot be accomplished except by a long-continued systematic training for which very frequently there is no time, energy or understanding of the important question.

The more neglected the foot is and the longer the deformity has persisted, the more difficult correction will be. This is the problem which we have generally to deal with in the clinic. The patient comes usually on account of pain which is caused by the long-continued strain and deficiency of muscle power to maintain proper poise and permit correct function. Very often pain occurs after the patient has been off the feet on account of illness or when increase of weight has taken place without proportionate increase of muscle strength. Only in the light form of these cases may exercise together with the prescription of proper shoes be sufficient to accomplish a satisfactory result. In the great majority of cases orthopedic appliances—strapping, Thomas heel, plates—are indicated, but the treatment will not be complete unless the patient learns to make proper use of the feet. In practice this part of the treatment is most neglected, either because with the great number of patients in clinics time is lacking for careful instruction or because the patient is satisfied when the pain and weakness are relieved. We must admit, however, that the problem of correction as outlined above is too difficult to be accomplished satisfactorily unless the patient has a great deal of patience and energy. In most of these advanced cases attempts to restore

proper balance and function by exercise alone without other orthopedic treatment will fail.

This will be all the more the case if bony deformity or actual flat-foot is to be treated. The claims found here and there in the medical literature that flat-foot can be recovered by exercise seem to be at least greatly exaggerated. What may have been accomplished in such cases and so fostered the belief in the power of this treatment is probably the correction of a pronated foot which has been wrongly considered as an actually deformed flat foot. In the type of cases spoken of previously massage is of secondary importance only, and if done alone without other orthopedic treatment including muscle training and education it will be merely a waste of time and money. In addition to such other treatment it may be quite helpful in relieving pain and ache though, as a rule, this is accomplished much more thoroughly by proper strapping with adhesive plaster.

The technic of the exercise treatment of weak, pronated feet is done in our clinic in the following way:

At first the patient is made familiar with the idea of the treatment. He is shown how by a proper use of the adductor muscles the weight-bearing outline of the foot is restored. This is practised without weight-bearing and a number of simple resistive exercises are done to increase tonus and strength of these muscles. During the last year we have used an exercise which has been found very valuable, combining simplicity with great efficiency.

The forefoot is placed upon one end of a turkish towel, and in adducting, the foot is to grasp the towel, pulling it toward the inside. By repeating these motions a number of times the whole length of the towel is moved under the foot, the knee and heel being at the same time not removed from the spot. In placing weights of increasing size on the outer end of the towel the resistance can be increased to any amount desired. After this exercise has been thoroughly practised in sitting without weight-bearing it should be taken up in standing. It is advisable to practise it at first with one foot only, resting on the other and bearing part of the weight on the arms of two chairs or leaning

against a table. The chief aim is to localize the adduction of the foot and not have the leg rotate in the hip. When this is sufficiently learned without weight-bearing, weight should be put on the foot increasingly, and when each foot has learned the exercise alone it might be done with both feet together. How quickly it is possible to progress from one exercise to the next will depend on the ease with which the exercise is done. In any case of distinct weakness and strain very slow progress should be attempted. If the foot is somewhat strained that point must be found out where a certain amount of exercise causes no pain.

Another useful exercise is done with a simple pulley arrangement or a spring scale such as used on Osgood's apparatus. An important point is always to have the patient understand that the adduction must be done underneath the astragalus. There is always a tendency to help with the adductors and inward rotators of the hip which is entirely wrong. In fact we urge the patient to learn rather to twist the leg slightly outward while the foot pulls inward with the same tendency as described for the combined action of the flexors of the hand and the extensors of the carpus.

There are many other exercises devised for the treatment of weak, pronated feet; but we believe that these few will suffice as they, better than any others of which we know, will strengthen the adductors and the long flexors of the toes, and thus enable them to restore proper balance.

When the exercises are learned in sitting and standing, and when the patient has gained sufficient control so as to hold his feet in proper position, then, but not before, walking exercises must be done. I think it is a waste of time to demonstrate once or twice to the patients with weak, pronated feet in the out-patient clinic how they should walk properly. Either they may strain their feet in an effort to do so, or, and this most commonly, they will soon give up any attempts. But when they have been sufficiently trained walking exercises are quite useful. We show them where the weight-bearing line must fall and how to propel the foot, and we impress them with the importance of using their foot and leg muscles properly.

There are three types of feet which require special consideration because massage and exercise are really of great value and at times almost indispensable in bringing about relief and cure. These are: (1) The contracted, weak or flat foot; (2) the traumatic flat foot; and (3) the arthritic foot.

1. The typical contracted, weak or flat foot is characterized by a spasmodic contraction of the peroneal muscles. This contraction may be relieved by simple rest with or without wet poultices or similar means. In light cases spiral strapping followed by a correct support will be sufficient. But very often the contraction is most persistent, requiring manipulations. The simplest way to relieve it is manipulation under an anesthetic followed by a plaster-of-Paris cast in an overcorrected position. The experience of our clinic has shown that rather frequently the correction has been insufficient after the cast is removed, or that recurrence soon takes place. In a number of such cases persistent treatment by manual resistive exercise with passive manipulations has led to a satisfactory result. This has induced us to try this treatment in several cases, and we believe that when it is carried out with the correct understanding of the anatomical and mechanical conditions it is at least as good and perhaps in a way superior to the forcible manipulation followed by weeks of immobilization. This treatment is applied in the following way:

The patient is advised to use crutches and avoid weight-bearing for a certain time. The foot is heated in the baker and thoroughly massaged. The manipulations employed are effleurage and kneading of the muscles of the leg and foot, effleurage and friction of the joints and tendon sheaths of the foot, in which tender spots should be avoided. Then resistive exercise is done as follows: The patient lies on his back, the knee is held in semiflexion supported by a firm pillow. The operator holds the forefoot with the right hand and steadies the knee with the left. Then he orders the patient to adduct his foot while he applies at first a moderate, later a very strong resistance. Thereby it will be noticed that the adductor muscles can actually draw the foot inward to a certain extent, though this may be very little in the

beginning, sometimes not more than 5 to 10 degrees. The idea of the resistance is, as has been described (p. 25), to exclude the action of the antagonists, here the contracted peroneals. If this is done correctly the treatment will not cause pain. This is a very important point to be observed. The way I have frequently seen the conservative treatment carried out is by passive stretching. This, however, causes pain and increases the existing irritation; furthermore, it is usually futile as the contraction of the peroneal muscles is so powerful that it cannot be overcome without a general or local anesthetic. After the treatment the foot is bandaged and the patient advised to rest at home. As soon as a marked improvement is obtained, say 20 to 30 degrees of active adduction, the result is fixed by a spiral strapping. Of course this treatment will not succeed in all cases, and a manipulation under an anesthetic may become necessary, but even then I believe that a preparatory conservative treatment for a few weeks will not mean lost time but will be quite valuable for the final outcome. When a forcible manipulation under an anesthetic has been done and a plaster-of-Paris cast applied, it should be followed by proper exercise treatment to be done in the same careful way, only with a slightly changed technic. Usually I have the cast split after one week and begin with resistive exercise. In such cases the foot is held in full adduction and supination. The operator grasps the foot, abducts it about 10 to 20 degrees and has the patient adduct it against a moderate resistance. Gradually the angle of motion and the amount of resistance are increased. After each treatment the cast is reapplied. Often a spiral strapping is applied in addition.

TRAUMATIC, WEAK OR FLAT FOOT.

In consequence of a fracture or a severe sprain of the foot, the ankle, or the leg, the weight-bearing and propelling functions of the foot are often very much impaired. The supporting ligaments are primarily or secondarily stretched, the muscles are weakened; often inflammatory changes of the joints and tendon sheaths are seen. These cases require

a very careful and persistent treatment, the result of which will, of course, depend a great deal upon the actual damage to the injured joints and bones.

The worst type of these cases, and a quite frequent one, too, is the compression fracture of the os calcis with involvement and often partial or total ankylosis of the subastragaloid joint. In all these cases the first indication is the restoration of a proper weight-bearing line. Sometimes this may be accomplished by active and passive exercise only, but often needs more strenuous methods, such as forcible reduction, or osteotomy, or osteoplastic operations. Such procedures are wisely followed by a persistent and long-continued use of proper exercise and massage and application of a good support of the arch. Massage in such cases must be very thorough, consisting chiefly in deep friction and effleurage over the tendon sheaths, the tarsal and ankle-joints, and the soft tissues of the foot, and furthermore, effleurage and deep kneading of the muscles of the leg.

ARTHRITIC FOOT.

The arthritic foot often presents a very difficult problem requiring a good deal of patience and energy on the part of the patient as well as the operator. In these cases the general care and etiological treatment are necessary as outlined in Chapter XIII. Besides these indications proper alignment of the foot is necessary but its accomplishment often meets with very great and sometimes almost unsurmountable difficulties. A long-continued appropriate treatment by baking, massage and exercise is indispensable in these cases and will often lead to very satisfactory results. A mistake is commonly made in that the operator tries to accomplish too much at a time. Considering the severe pathological changes in most of these cases, we cannot expect a functional restoration in a short time. It cannot be accomplished except by a slow metamorphosis and regeneration of the pathologically altered structures, and its final success depends largely on the actual changes of the tissues. The treatment is similar to

that in traumatic feet, only that it must be carried out more cautiously.

In all these cases we make a special point that the treatment is not strictly local concerning the foot alone, but that we must also treat the whole leg. In our clinic we frequently carry out this form of treatment on Zander apparatus, although it may also be done without them.

CHAPTER XIX.

PARALYSIS: FLACCID TYPE: INFANTILE PARALYSIS. NEURITIS. PERIPHERAL PARALYSIS. OBSTETRICAL PALSY.

The value of exercise and massage in the treatment of the various forms of paralysis is recognized by many authorities in neurology and orthopedics. Frequent experience, however, in our clinics shows that at least exercise in its widest sense is not used as much as necessary, and if it is used, that its application is not always in the most appropriate and rational manner.

Very many patients have been treated for years with "electricity and massage," or more accurately with a faradic battery which they are advised to play over the paralyzed muscles, and with some indiscriminate rubbing. Moreover, in a considerable number of cases no treatment has been given and the patient has been told that nothing could be done for him. Such a statement would seem to be inexcusable considering the fact that by rational treatment, of which appropriate exercise and massage form an important part, considerable and lasting improvement can be obtained in very many cases, and we believe that the results will be much more satisfactory if the treatment is started at the earliest moment possible, and continued as long as necessary. For practical purposes the various forms of paralyses may be classified in two groups or types; the flaccid type in which the peripheral neurons, and the spastic type in which the central neurons are affected.

As the methods of exercise differ in both these groups they will be discussed in separate chapters; but first a few words must be said about indications which are, to a great extent, identical for both types.

In discussing methods and results a neurologist made the following remark to me: "It is merely a matter of fashion what treatment you want to apply, massage, electricity, drugs, or exercise; the last seems to be most fashionable now, though we must not forget that the effect of any treatment depends on the condition of the nerve cell; if it is destroyed no treatment will help." While this explanation is probably true, such a statement does not, in our opinion, do justice to the situation. The indications for exercise treatment are much wider than attempting the restoration of affected ganglion cells.[1]

Analyzing the various indications, we have to consider the effect of the treatment on:

1. The primarily affected neurons.
2. Those neurons.
   - (*a*) Which are in a functional connection with the former.
   - (*b*) Those which furnish possibilities of substitution for the destroyed parts.
3. The musculature.
4. (*a*) The joints; (*b*) the bones.
5. The internal organs and general health.
6. The mind of the patient.

Indications.—1. The first question, that of the influence of the treatment on the primarily affected neuron, is the most difficult one to explain. It is almost certain that a completely destroyed neuron will never regenerate, but in practice it is frequently very difficult to decide to what extent the neurons are affected. This is especially true soon after the onset, as is so well illustrated by the course of infantile spinal paralysis. While in many cases no further regeneration takes place after six to twelve months, in others this period of regeneration may be much longer. There are indeed patients who finally show power in muscles which have been apparently completely paralyzed for more than twelve months.

[1] The section on indications is taken in part from an earlier paper entitled "The Exercise Treatment of Paralysis," American Journal of Orthopedic Surgery, May, 1912.

Clinical observations suggest that carefully treated cases make better progress than those which are not treated, so that we may fairly suppose that this treatment has an actual influence on the regenerative process, though this has not yet been definitely proved.

2. In the treatment of paralysis, however, as well as in some other disturbances of the nervous system (as tabes), it is not only the primarily affected neuron which is to be treated, but also all those neurons which are in a functional connection with it.

A voluntary motion is a very complicated process and needs the coöperation of many different neurons: the motor neurons which lead stimuli from the cortical motor centers to the peripheral nerves, the associative neurons, which furnish the connection of the various cerebral centres, and also the sensory neurons of muscles and joints, which by their action enable the brain to control the correct performance of the movement. All of these suffer from lack of activity when one of them is injured; they suffer in a different degree in the different diseases, but to a certain extent in all of them.

To Leyden and his pupils Goldscheider, Jacob, Lazarus, and others, who have greatly improved the exercise therapy of paralysis and other disturbances of the nervous system, we are indebted for the inauguration of rational theories on the influence of functional stimulation of the neurons. Goldscheider's ideas on this subject in his classical book, *On the Importance of Stimuli in the Light of the Neuron Theory,* and the ideas in Jacob's article in the *Handbuch f. physikalische Therapie* are briefly as follows:

The stimulated condition of a neuron which is produced by any adequate stimulus, provided this is above the stimulus threshold, acts in turn as a stimulus on the contact neuron, provided the neuron is sufficiently stimulated, or as Goldscheider says, the stimulus is above the neuron threshold. Furthermore, a stimulus which is not able to bring a stimulated condition so far that it is above the neuron threshold or that it has no actual effect prepares the way for the following stimulus, so that the latter may

overcome the resistances given by passing through the neuron and passing over to the next neuron. In this way may be explained the greater effect of cumulation of stimuli. These resistances are not of equal value, but are subject to a considerable change, according to the amount and character of stimuli which pass along the neurons. Goldscheider speaks of a lowering of the neuron threshold and says that in like manner as we notice at times a very marked lowering of the peripheral stimulus threshold so we have reason to suppose that similar conditions are present in the relation of the various neurons in the neuron threshold. On the other hand, by the lack of appropriate stimuli the neuron threshold is raised and the resistances are increased, but by furnishing appropriate stimuli a lowering of the threshold may take place again, provided the anatomical lesion is not too severe. If we consider those theories to be true we know of no way in which the neuron threshold can be so well lowered as by a rational exercise treatment.

The theories above enunciated help us further in understanding the recovery in cases of cerebral paralysis where, as is supposed, substitution of other neurons for the destroyed ones takes place. The clinical and experimental observation of Lazarus,[1] Foerster,[2] Faure,[3] and others lead to the conclusion that when the pyramidal tracks are destroyed on one side the subcortical centres and the associative neurons of the same hemisphere, as well as parts of the other hemisphere, may to some extent take their places. These new paths are rough, their neuron thresholds are high. Nature has on hand certain resources for preparing the new tracks, but this natural power is usually too small. A real education, a supply of repeated adequate stimuli by exercise treatment, is necessary to take full advantage of these unused storehouses of nervous energy.

3. The third point to be considered is the training of the muscles. As we have seen in Chapter V, the influence of exercise on the muscle is important in two different ways:

[1] Lazarus: Zeitschrift für klin. Mediz., vol. xlv, p. 314.
[2] Foerster: Centralbl. f. Nervenheilk., 1903, p. 56, and 1904, p. 1014.
[3] Faure: Gaz. des hôpitaux, 1909, p. 681.

(1) It builds up the muscular tissue, as is so well shown in the hypertrophy of muscles in athletes. (2) It increases the power and the endurance of the muscle along with the increase of the muscular tissue, although not in constant relation to it.

It must, however, be constantly borne in mind that with the increase of muscular tissue and of muscle power which these exercises provoke, there is also necessarily a favorable influence exerted on the nerves supplying their muscles.

Special indications for muscle training are given in such cases of anterior poliomyelitis or peripheral paralysis where we have to deal with a partial paralysis, for the following reason. In most parts of the body the muscles are arranged in such a way that if one muscle is paralyzed, another may take its function to some extent and this substitution is at times surprisingly good. Thus, we often find in cases with paralysis of the deltoid, that the scapular muscles enable the patient to elevate the arm sufficiently to reach up with the hand to the face, if the long head of the triceps is active in securing proper leverage of the humerus; or the long extensors of the carpus and the brachioradialis may substitute for a paralyzed biceps, making flexion of the elbow possible. Also the glutei and hamstring muscles together with the gastrocnemius may control the knee in the case of a paralyzed quadriceps; or the absence of the anterior tibial may be somewhat compensated by the extensors of the toes together with the posterior tibial, etc. We must therefore study each case carefully and try to find out how great the possibilities of restoration are from this point of view, striving to strengthen those muscles which can be substituted for the paralyzed ones.

4. The next point to mention is the influence of exercise therapy on the condition of the joints. One of the prominent features in many cases of paralysis is the disturbance of the equilibrium of muscle action aided by the influence of gravity, the weight of bed covers, the habit of maintaining the same position, etc. These factors frequently lead to contractures of joints and even structural bony deformations. The number and variety of such deformi-

ties is infinite and only a few typical ones will be mentioned here. The most frequent deformity of the hip is the contracture in flexion and abduction. The knee-joint is often found somewhat contracted when the quadriceps is paralyzed, thus rendering the substituting value of the muscles on the back of the knee invalid. The foot is most frequently subject to deformities, such as the pes equinus and equinovarus, pes valgus and equinovalgus, pes calcaneus, and others. One of the chief indications for exercise treatment is to prevent contracture and stiffening of joints, although frequently the assistance of mechanical appliances, as braces or casts, is needed. The real value of preventive measures is too frequently underestimated, because it is impossible to say in a single case whether without appropriate treatment complications would appear or not, but the clinical observation of a great number of cases makes us certain of the results which we have obtained. We regret that our material does not give us much opportunity to demonstrate the preventive effect of exercise, because as we have stated, most of the patients come to us rather late in the course of the disease, with more or less marked contractures. In cases of minor degree of contracture the exercise treatment is at times sufficient to restore the passive mobility, while in graver cases surgical intervention is necessary.

Frequently the restoration of the function of paralyzed limbs depends not only on the relief of the paralysis, but also on the cure of the mechanical obstruction of one or several joints. In such cases exercises are indispensable, although operative measures are at times indicated.

Older patients with hemiplegia are likely to acquire hypertrophic osteo-arthritis. A certain amount of gentle exercise may avoid arthritic processes, or when they are already present may at least favor a partial restoration of the passive function, provided the pathological changes are not too severe.

Of importance is the influence of exercise on the development of the bones in paralyzed limbs of growing individuals. In cases of cerebral hemiplegia in children we frequently notice a distinct underdevelopment of the affected arm which

at times shows a considerable shortening of all bones, while the affected leg does not show any such underdevelopment. This may be explained by the fact that the leg naturally receives much more functional stimulation than the arm. If not especially trained, such children learn to do most of the necessary work with the healthy hand and are not anxious to make a sufficient use of the paralyzed hand, while the leg takes care of itself.

My experience is still too small to enable me to state definitely as to whether the amount of stimulation produced by exercise treatment will be sufficient to compensate entirely for the effect of the paralysis on development, but it seems as if this clinical observation teaches us very clearly the probable advantage of the best possible training by means of stimulating exercises.

5. The value which exercises exert upon the general health and upon the development and action of the internal organs in these paralytic cases is practically the same as in normal individuals. There are, however, some points especially worthy of consideration in paralytic patients. It is obvious that patients with any considerable amount of paralysis, especially of the lower extremities, suffer from lack of exercise. Children under such conditions are usually not able to get as much out-of-door exercise as their fellows. The consequence is that many of them are retarded in their general development and less resistant to disease and to the demands of life. This is especially true among the poorer classes.

Perhaps of still greater importance is the question of proper exercises for paralyzed adults. The difficulty which these patients have in moving about frequently induces in them a dangerous amount of idleness, the more dangerous as in most of these cases the vascular system is damaged. The muscles of the vessels require a certain amount of stimulation and work for the performance of their proper functions, and the effect, therefore, upon the general metabolism must at once be evident. It is hardly necessary to mention that in all cases with advanced arteriosclerosis any overexertion is strictly to be avoided.

6. Among the various other good influences which exercises exert on our patients not the least important is that on the mind. Everyone knows the stimulating and refreshing effect which regular exercises or sports produce. Paralyzed patients are usually not able to enjoy sports and games as do normal persons. Nevertheless they are very thankful when they have opportunity to engage in exercises, which, considering their conditions, play for them the same role as do sports in normal individuals. It is certainly striking to observe how many paralyzed patients show very marked improvement in spirits and in enjoyment of life, even out of proportion at times to the physical improvement. We have not rarely made such observations even in the most hopeless cases with patients who were no longer under their physician's care because of the absolutely unfavorable prognosis which had been given. This has convinced us that exercise treatment should not alone be regarded from the point of possibility of improving the paralytic condition, but should be considered an end in itself.

It seems to us a great cruelty to tell a patient, especially one who is young and is looking forward perhaps to a long life, that his case is absolutely hopeless, when it may be possible to do so much for him, both physically and, I think we may say, spiritually as well.

These various indications should be taken into account when planning the treatment. Especial emphasis should be laid on the following points:

1. That it is not wise to prescribe exercises in a general way and leave it for the parents to attend to the details.
2. That the physician or masseur must study the case thoroughly himself.
3. That he must know to what extent the nerves and muscles are affected.
4. That he must consider not only the mechanical possibilities of the affected limbs, but must also pay attention to the general condition of the patient, both mentally and physically.

With these points in mind the physician must work out a comprehensive plan for the treatment which is to be followed

by his trained assistant or by the parents of the patient, provided the physician is not able to do it himself. The importance of teaching the true spirit of the exercise treatment cannot be too strongly emphasized. The mere prescription of, for example, "flexion and extension of the elbow twenty-five times and elevation of the arm twenty-five times, etc.," is not sufficient. It is of prime importance that the operator learns to avoid injury to the delicate nerves, muscles, and joints. He must exercise patience as well, and must understand that success will come but slowly and that immediate results cannot be expected.

Although the general principles of exercise treatment apply to all forms of paralysis, its application varies to some extent with each case, according to the type, the nature of the disease, the duration of the paralysis, and the general condition of the patient. It is especially in regard to the neuromuscular apparatus that special kinds of manipulation are often necessary.

We come now to the discussion of the first group, to which belong infantile paralysis, peripheral mono- and polyneuritis, and paralysis due to an injury or other affections of the peripheral nerves, including obstetrical palsy.

INFANTILE PARALYSIS.

Infantile paralysis is the result of an infectious disease, anterior poliomyelitis, which is evidently caused by a specific virus. This disease affects chiefly the anterior horns of the spinal cord which carry the ganglion cells for the peripheral motor nerves. The peripheral axis-cylinder which is in fact only a part, the so-called axone of these cells, often becomes affected too, as the studies of Southard undoubtedly prove.

The treatment in the early stages of infantile paralysis has to bring the patient under a condition best suited for the process of recovery in and about the affected ganglion cells. Most competent orthopedic surgeons believe that this is best done by complete rest. We agree with this point of view but think that no definite time can be given for the

beginning of active treatment, but that the duration of rest should depend on the individual case. When the painful stage has passed and the child shows signs of beginning activity then a wide field for treatment opens with the indications outlined above. These indications can be briefly summarized under the headings: protection and stimulation. In what way protection will be afforded cannot be discussed in detail in this book, but it must be emphasized that the important principles of protection should also be considered in applying stimulative treatment, such as exercise and massage. The aims of protection are chiefly avoidance of deformities, so frequently seen in neglected cases of infantile paralysis, and avoidance of tension on the delicate muscle fibers.

It is characteristic of this disease that usually many more muscles are paralyzed in the beginning than in the final stage. As time goes on many muscle groups may recover while others remain paralyzed. In the majority of cases the extensor muscles which are mechanically under more unfavorable conditions are those which show the least tendency to recover while isolated paralysis of flexor muscles, the extensors remaining intact, is much less frequent. This experience shows that the restoration of the paralyzed muscles depends not entirely on casualties in regard to the distribution of the primarily affected nerve cells, but to a great extent on general mechano-physiological principles.

Moreover, we frequently see that even after years of complete disability of certain muscle groups recovery may take place when those muscles are brought under favorable conditions, *i. e.*, when the points of insertion are brought and held nearer together and thus the stretched condition is eliminated.

In this connection the effect of braces and corrective operations is sometimes quite astonishing. In a case of paralysis of six years' duration where an extreme valgus deformity had resulted, a wedge-shaped osteotomy of the astragalus and scaphoid with arthrodesis of the mediotarsal joint was performed. Six weeks after the operation I was

greatly surprised to see the extensors of the toes working again after they had been entirely paralyzed for so many years.

Considering these mechano-physiological principles in planning and carrying out exercise treatment we lay special emphasis on (1) the prescription of the position in which the limb is to be held in performing the exercises; (2) on the angle, through which the exercise is to be carried out; and (3) on the support which is given to the limb and the neighboring parts while this is being done. This is especially important for those cases where signs of recovery are seen, but should also be considered in giving passive exercises to a group of muscles which is for the time being completely paralyzed.

1. The position of the patient in performing the exercise should be chosen so that the least strain comes on the affected muscles, and so that the body in general is perfectly relaxed.

2. The exercise should be done in small angles until the muscles have regained sufficient control. Then the angle may be slowly increased, but, as a rule, the exercise should not be done through the whole physiological angle until such control is secured. Only in early cases and in such where there is no active power preserved may passive exercises be done through the whole physiological angle.

3. The moving part, such as the arm or the leg, must be well supported, while the centre about which the movement is done must be firmly steadied. The question of support is especially necessary in exercises of the hip and shoulder muscles. The patient who wants to abduct his leg but cannot do so without aid because of paresis of his gluteus medius, tries to perform a pseudo-abduction by lifting the same side of the pelvis with his lumbar muscles, and in so doing does exactly what we wish to avoid—he stretches his paralyzed muscles. In some cases there is danger that an already existing or threatening deformity may be increased when the patient tries to perform a certain movement which he cannot do properly on account of his paralyzed or paretic muscles.

How important this is has never been made clearer to me than by observation of a case of extensive paralysis of both legs, back, and both shoulders. In this case a masseur of good standing was employed, who for a considerable time had attempted to give resistive exercise to the completely paralyzed adductor muscles of the left thigh. The patient, unable to contract those muscles as ordered, made very extensive motion with his pelvis; thus finally bringing his leg into a position so that it was adducted by gravity. In examining the patient's spine while doing this motion I could distinctly notice that the lateral curvature, which had existed for several years, was markedly increased with each of those attempts. I have seen similar mistakes made from time to time.

Another mistake frequently seen is to exercise only those muscles which are well preserved, without consideration of their paralyzed or weakened antagonists. Our efforts should rather go toward restoring better balance than toward the opposite direction.

On inspecting a gymnasium for the treatment of paralyzed children the instructor took special pride in demonstrating an apparatus for the exercise of partially paralyzed feet. However, closer inspection showed that the only benefit derived from the apparatus was further strengthening of the gastrocnemius and soleus group which was anyway too strong to be counter-balanced by what was left of the dorsal flexors.

Beginners are often misled in regard to the actual amount of active control by what may be called leverage motion which we often see developed to a very high degree by those patients. For instance, with a good triceps the patient can raise his arm without the deltoid when the hand finds support. Or with the gluteus maximus he can straighten his knee-joint without the quadriceps when the foot is held by the operator.

The general principles of exercise which have been laid down in Chapter II apply also for its use in paralytic cases, but the great importance of this subject demands a somewhat more detailed description of the correct movements.

In particular it must be stated that a great deal of the success of the treatment depends on the accuracy of the movement. Each exercise must be done slowly and as perfectly as conditions allow. Quantity is of no value; it is only the quality that counts. The operator must be sure that the intended effect of motion is obtained, and that it is obtained in the correct manner by the muscle group which is to be exercised. For this purpose the careful attention of both the operator and the patient is demanded. The patient must concentrate his mind upon the moving limb and accompany the various movements with his will-power, or, to express it in physiological terms, the training of the peripheral neurons must be accompanied by a training of the central and associative neurons.

It is evident that such a mental coöperation cannot be expected in small children. Here we have to be satisfied with giving passive exercise whereby any active movement must be carefully guarded considering the rules laid out above in regard to the avoidance of tension on the delicate muscle structures.

In the following exercises of the shoulder, back, hip, knee, and foot, are described as examples.

1. Paralysis of the elevators of the arm (deltoid, supraspinatus).[1] In many of these cases the adductors and rotators of the humerus, the muscles of the scapula, and the biceps and triceps are active. The patient is placed on his back, with the elbow supported by a pillow. The operator takes with his right hand the patient's forearm, which is held in a right angle, and steadies the scapula with his left hand. From this position he has the patient rotate the arm in the shoulder-joint inward and outward, at first in a small angle and with sufficient assistance.

Then the operator raises the arm to a vertical position and makes slow passive movements in upward and downward direction within an angle of not more than 20 to 30 degrees. In doing the upward movement the operator advises the

[1] The principles for muscle training which we have employed in our clinic for many years are very similar to those described by Lovett in his excellent book on the "Treatment of Infantile Paralysis."

patient to assist him; that is to say, to try to contract his elevators if any traces of function appear. The scapula must be well steadied else the patient will draw it sideward with the anterior serratus or other muscles. The downward motion is to be done passively, because the adductor muscles of the arm are almost always good and strong and need not be treated. When a certain amount of power exists in the elevator and abductor groups the angle is gradually increased.

2. *Back.*—The treatment of paralysis of the back muscles, generally accompanied by deformities of the spine, follows lines similar to those of lateral curvature, and is undoubtedly one of the most difficult problems of orthopedic surgery. Many of these cases have at the same time a greater or lesser degree of paralysis of the leg muscles, rendering the statics still more difficult, and making exercise in any other position than lying almost impossible.

Exercises in prone position: The patient is lying on his face with a pillow under the abdomen in order to secure the best possible angle for the exercise. Elevation of the head, of one or both shoulders with and without the arms are done, and assistance is given if necessary. In case of a right dorsal scoliosis this exercise is done with the right shoulder only, in the manner described on p. 288. Then either leg is hyperextended with assistance. The operator then raises the chest slightly up and encourages the patient to contract the muscles needed to maintain this position. When this has been done the muscles are relaxed again and the chest is lowered to the table. This last exercise may be combined with rotation of the body.

Exercises in sitting: The patient sits on a high stool. The operator, standing on the right side supports the patient's trunk by placing his right arm under the arms of the patient. With the left hand he steadies the patient's back in the middle or lower part. From this position the operator performs forward and backward bending, lateral bending and pushing, rotation and combinations of these movements, encouraging the patient to take part in the exercise as much as possible. These movements may also

be done while the operator stands behind the patient, supporting the trunk with his hands under the patient's arms.

3. *Hip.*—Exercises of the muscles of the hip require steadiness of the pelvis, because the patient, desiring to obtain a certain effect, has the tendency to shift his pelvis in such a way that the leg is brought in a position favoring leverage. For example, when adduction is practised with the knee flexed and the adductor muscles are too weak to pull the leg inward the patient will try to twist the lower part of the trunk and the pelvis to such an extent that gravity assists the adduction. Therefore the first rule is to steady the pelvis. This may be done in children by the operator's one hand, or in older children and adults by another assistant, or by a strap that ties the pelvis to the table.

The leg must be supported and steadied by the operator. This is best done by placing one or both hands on the knee in exercises with the leg flexed, or under the calf in exercises with the leg extended. To what extent the movements must be done, whether passively or with active coöperation, depends upon the amount of paralysis and must be decided individually. Whether assistance or resistance is given in these cases where active coöperation is possible depends on the position of the leg, the direction of the movement, and the amount of muscle power preserved.

(*a*) Flexion: This motion should be done from a somewhat flexed position considering the rule of working in small angles. The patient must contract his flexor muscles, drawing up the foot on the table, while the operator steadies the knee. Then the leg is brought back to the original position and the exercise is repeated. Flexion may also be done with the knee straight, but only when a certain amount of control is obtained.

(*b*) Extension: The operator raises the leg with the knee extended to an angle of about 45 degrees, and advises the patient to contract his gluteal muscles while the leg is lowered, thereby giving just as much resistance as is necessary to localize the movement upon the extensor muscles and prevent coöperation of those muscles which tilt the pelvis backward.

(*c*) Adduction and abduction with the leg extended: The operator raises the leg up to about 10 to 20 degrees, placing his hand underneath the calf. Then he moves the leg inward and outward passively or with active coöperation of the patient according to the case.

(*d*) Adduction and abduction with the hip and knee flexed: The knee is flexed to almost a right angle, the operator steadying the leg and securing proper balance. The knee is moved outward with slight resistance, and brought to the middle line with assistance or passively. Then it is moved inward with resistance and brought back to the middle line with assistance or passively. Unless there is sufficient control of the hip muscles present it is necessary to divide the whole movement into two parts as described.

(*e*) Rotation with the leg extended: The leg rests on the table and the patient turns it outward and inward, the operator giving assistance or resistance in cases of preserved muscle power.

(*f*) Rotation with the hip and knee flexed: The operator raises the leg so as to bring the thigh in a vertical, and the lower leg in a horizontal position; the calf is supported by the operator's hand, or better, his whole arm. Then the lower leg is made to describe a circle of about 30 to 40 degrees with the knee and thigh as centre, either passively or with the active coöperation of the patient.

Exercises of the hip may be done with the patient lying across the bed, the legs projecting over its edge. The operator, sitting on the side of the bed is thus enabled easily to steady the pelvis with one hand and support and conduct the exercising leg with the other.

When a definite amount of control is obtained exercises of the hip may also be done in the sitting or even in the standing position.

4. *Knee.*—The prone position is best suited for exercises of the knee in that it allows the moving in small angles and the dosage of resistance and assistance to be done with greatest ease and most thorough localization. The operator, holding the lower leg above the ankle, flexes the knee

to about 60 degrees; then the patient is asked to coöperate in further flexion by contracting his hamstring muscles if they are not entirely paralyzed. Thus, flexion is carried on to the right angle or slightly beyond, and the leg is brought back to the original position by the operator.

Extension of the knee is practised in the following way: The operator holds the leg, which is flexed at an angle of about 70 to 80 degrees, and advises the patient to extend the leg, at the same time pushing against the operator's hand. If there is only a trace of motion possible, we control with one finger the effect of the contraction of the quadriceps. This is necessary because an effect similar to that intended may be obtained by the patient when he attempts to draw his whole leg and pelvis upward.

With increasing muscle power the angle of motion may be enlarged and the exercise may be done from other positions, such as lying supine, or sitting with the lower leg projecting over the edge of the table, or in standing with the affected leg placed forward, the patient flexes and extends the knee with increasing weight of the body upon it; or stepping on boards of varying thickness, beginning with one-half inch upward to the average height of steps.

5. *Foot.*—As a general rule for exercises of paralyzed feet it must be emphasized that the knee is held in flexion, because with the knee in extended position considerable strain is brought upon the posterior lever of the foot by means of the gastrocnemius. In severe cases we begin with exercises in prone position; the knee is flexed to about 35 to 40 degrees, the lower leg is supported by a pillow over which the foot projects, allowing perfectly free play; or the operator holds the leg with one hand and directs the movements of the foot with the other. From that position dorsal and plantar flexion, pronation, supination, combinations of these and circumduction are done passively or actively according to the muscle power preserved. Special precautions should be taken in considering muscle balance, which, as a rule, is defective. Training of well-preserved groups must be strictly avoided and all efforts be made to localize the effect upon those groups which are weak. More-

over the chances for substitution should be carefully studied and muscle training be directed toward this point.

Foot exercises may also be done in the manner described in Chapter II, with the patient sitting on a table, and the operator sitting in front on a chair holding the paralyzed leg in one hand and directing the exercising foot with the other.

In advanced cases and in those which have a definite control of the foot weight-bearing exercises may be done, such as described in Chapter XVIII. It must be borne in mind, however, that only such exercises are of value which warrant sufficient localization.

One word may be permitted about rational care of paralyzed shoulder cases in the early stage, although we have to admit that this assumption is based on theoretical principles only as we have never had a chance to treat a fresh case of that kind. Most of these cases come to us old and neglected after much valuable time has been wasted by electric treatment or massage. It seems to us rational to keep the arm of such patients abducted and elevated, supported by a brace as we use it generally for patients who have been operated on for the repair of a ruptured supraspinatus. I have been following this course lately in the treatment of an eight-year-old girl with infantile paralysis of the shoulder, though the time is still too short to expect any definite results.

The value of exercises in these cases should not be exaggerated so much as to leave other methods unemployed. Particularly in paralyzed legs it is much more important to prevent or correct deformities by braces or operations and thus make the patients use their limbs than to advise for a short time in the day exercises without giving a chance for proper function. The use of a home apparatus for exercise is much more problematic in the flaccid cases than in the spastic type of paralysis, for the reason that with most of such simple apparatus as can be constructed in the home of the patients the result will be that the stronger muscles alone are exercised and the weak antagonists neglected. We cannot too strongly emphasize that we

consider this a grave danger for the flaccid type of paralysis and that we rather advise against any exercise treatment that exposes those weak structures to an indiscriminate handling.

A much disputed question is, how long should one continue exercise treatment in hope of an improvement? Many observers limit this time from six to twelve months after the onset of the disease. We know from wide experience that this opinion is incorrect and have seen many cases which have shown a marked improvement of the functional ability many years after the beginning. It is true certain ganglion cells are destroyed and cannot be expected to regenerate, at least from our present knowledge of neuropathology. But undoubtedly in certain cases we find many muscles which are just inactive and can be restored to life by proper consideration of the mechanophysiological conditions and proper stimulations; the former indication being of greater importance. The objection of a neurologist that the patients would lose all that they have learned in a short time after the treatment is finished has not been proved in my experience, although it may be so when the treatment has not been carried out with sufficient persistency.

To avoid misunderstanding we want to emphasize again that we should not depend on any one form of treatment, such as exercise or massage. These cases must be under the care of the orthopedic surgeon, who not only decides about operations, braces, proper shoes and clothes, etc., but also applies stimulative treatment as indicated in the individual case. The special value of muscle training as a part of the orthopedic treatment lies in that it may be possible by exercise treatment previous to the operation to bring the muscle or muscles to be transplanted under better condition, and that by developing neglected weak muscles the defects due to actual paralysis may be diminished. The exercise treatment will be still more important after the transplantation, as Lovett and others have emphasized. The plan for a tendon transplantation should be made with careful consideration of the physiological relations and of the anatomical value of the muscles. The best results

are to be expected if it is possible to transplant muscles which are supplied by neighboring nerves and which in their new position form no great angle with the original position.

After the operation the first question that arises is, how soon is the exercise treatment to begin? I have seen a number of cases where after transplantation the foot was put in a plaster cast for three or four months. In these cases the real object of the operation, that is, to have an active power in place of the paralyzed muscles of one side of the foot, was obviously lost. The transplanted muscle and tendon were firmly grown to the tissues through which they were pulled and in none of these cases was a restoration of their func ion obtained. When the operation is done correctly there is no objection to beginning exercise treatment at the end of the second week, though it must be done with very great gentleness, particularly where a forcible correction or overcorrection was done at the same time with the transplantation. The method I have employed with benefit in a number of cases of my own and my colleagues has been as follows: At the end of the second week the cast is bivalved in such a way that the posterior shelf acts as a splint against the natural forces leading toward recurrence of the deformity and also against stretching of the transplanted muscle. The leg is taken out of the cast with the foot held carefully corrected and the patient is asked to contract his muscles so as to keep the foot corrected. This usually succeeds very well where the patient is not too young. (Children who are too young to warrant sufficient intelligence for such an after-treatment should not be subjected to an operation of this kind, a mistake which we frequently have seen made with lasting harm to the patient, who has come to our clinic years later.) Only when the patient is able to exert a considerable force in contracting the transplanted muscle may the foot be moved slightly, at first not more than 10 to 15 degrees, in the direction of the former deformity; thus giving the muscle a chance to move it back into the overcorrected position with appropriate assistance. With increasing power and strength that angle is gradually increased until a middle

position is reached, and only after full control in weight bearing is obtained do we allow the patient to move the foot *ad libitum*. The idea of such careful treatment is to avoid stretching of the transplanted muscle until it is strong enough to take care of itself.

The question whether and how long a brace is to be worn cannot be discussed in this place.

The following case may serve as an example of how a paralyzed extremity can be prepared by exercise treatment for an operation, though in this particular case the patient has not yet given her consent. It is also an example of the above-mentioned fact that the functional recovery due to steady training is at times remarkable.

The patient, a woman, aged twenty-nine years, had an extensive paralysis of the right shoulder and upper arm, which was said to be caused by a dislocation of the humerus when two years of age, but was undoubtedly due to an anterior poliomyelitis. The patient came to the hospital on account of pain caused by pressure of the head of the humerus on the nerve plexus. The shoulder-joint was extremely loose and she had no use of any of the muscles of the upper arm. Also the flexors of the elbow were completely paralyzed. The question of an arthrodesis was discussed, but exercise treatment was recommended for the beginning, although the patient and the attending physician were very skeptical as to the result. Distinct improvement was noticed after a few months and has advanced since. The patient has learned a number of motions which she has never been able to do so far as she remembers. She can now flex her elbow to a right angle, chiefly by means of the supinator longus, and can assist with the right hand in tying her skirts and in arranging her hair, which was previously possible only by supporting her elbow. In lying down she can balance her arm in a vertical position.

In relatively early cases, especially young children who have acquired contractures by shortening of muscles and tendons, attempts may be made to stretch them by passive exercises, but only when no conspicuous bony deformities exist or threaten to develop. Otherwise an operation for

the lengthening of the tendons is more advisable. To determine this always correctly requires experience and judgment, but in case of doubt careful experiments may be made for a short time. If the shortened tendons do not give way within a few weeks, it is not wise to force them any longer, though it should be admitted that even in such cases good results may be possible. The only danger is that when a tendency toward a deformed position or an actual deformity exists it may be increased by constant pulling on the shortened tendons. This impression we have had in a few cases of rotation of the bones of the lower leg, which is so frequently seen in extensive paralysis of the quadriceps and peronei. Also the subluxation of the contracted knee may be mentioned in that connection.

Massage can be handled briefly as its indications are more of a general nature, stimulation of the usually poor circulation and nutrition of the paralyzed parts; elimination of edema and swelling; and stimulations of the peripheral nerves and muscles.

As to technic it must be emphasized that paralyzed muscles should be handled with the greatest care. The reports of excellent results from vigorous massage in infantile paralysis should be mistrusted. Casual inquiry of such cases has shown that, as a rule, they belonged to the early type, where a definite judgment of the value of any physical method is more or less impossible, and where the opinion is justifiable that recovery took place perhaps not so much due to the treatment as in spite of it. We have lately heard of persons promising perfect cure in even old neglected cases by certain manipulations on the nerves and the spine. We cannot earnestly enough warn parents against such claims which show so distinctly the character of exploitation.

POLYNEURITIS AND MONONEURITIS.

Neuritis is an inflammation of the peripheral nerves caused by infectious diseases (diphtheria, typhoid, influenza, etc.); poisons (lead, alcohol, etc.); dyscrasia (cancer, diabetes, anemia, etc.), and other causes.

Its course is generally divided into three stages:[1]

1. The stage of progressive paralysis.
2. The stage of height.
3. The stage of regeneration.

We shall not discuss the details of the pathology and treatment but only briefly outline the value of exercise and massage in those cases.

During the stage of progressive paralysis none of our methods is of avail. During the second stage, however, exercises may be begun. Goldscheider advises having the patient do gentle movements of the affected limbs in the warm-water bath, where under the buoyant effect of the water and the relaxing effect of the warmth movements can be accomplished easier and with less pain than in bed. With intelligent assistance such movements can also be done in bed. Very useful is the method of having the knees pulled up by sand-bags which are fastened to a rope and pulley. The weight of the sand-bags is made just so great as to counter-balance the weight of the lifted knee, or the apparatus is arranged so as to have the patient coöperate with his hands in lifting the knee. The early movements will help to prevent deformities, though we usually need simple orthopedic appliances to accomplish this. Massage should not be done in the second stage except with greatest care and gentleness.

In the third stage, which may extend for years, thorough treatment by exercise and massage holds the first place. Here again the kinetotherapeutic baths as well as carefully measured assistive exercises are of great value, especially as long as the patient has not sufficient control. But the most important problem is to assist the patient to make the best possible use of his returning muscle power. It does not suffice to have a masseur work an hour and let the patient rest the remaining part of the day, but we should enable him as much as possible to use his paretic muscles properly. This can be accomplished by simple apparatus, such as a sling arrangement for foot-drop, a glove with strings for the

[1] See Goldscheider: Handbuch der Physikalischen Therapie, ii, 2, p. 412.

dorsal flexion of hand and fingers, etc. We may give the patient an apparatus to walk or teach him to make use of a few chairs between which he can do stepping and walking exercises. The combination of active voluntary contraction with the galvanic and faradic current is also quite useful. This is possible only when the reaction of degeneration has passed.

Massage may now be used to a considerable extent, though in the beginning rather cautiously. We begin with gentle effleurage over the muscles and joints and gradually add kneading. Massage of the nerves is not so advisable, according to Goldscheider. Massage may be connected with passive exercises. The active-passive or promotive exercises by pendulum apparatus and such fitted with a revolving wheel are quite useful. For the active exercises the same general rules apply as for cases with infantile paralysis, *i. e.*, care must be taken not to stretch the regenerating muscles.

Exercise treatment of mononeuritis as well as other peripheral paralysis due to injury, etc., is done along similar lines. In the latter cases the chief indications will be surgical—suture of the nerve, neurolysis, or excision of scars. Exercise and massage are of great importance for the after-treatment, but the technic goes along those rules given for other forms of flaccid paralysis.

Obstetrical Paralysis.—Birth palsy is a true peripheral paralysis and would need no special mention except for the fact that it offers several interesting problems. The question has lately been much discussed as to whether all these cases are paralyses—Lange, Peltesohn, and others believe that in the majority of cases the essential element of the lesion is a sprain or a distortion of the shoulder-joint, without involvement of the plexus; whereas the exact experiments and clinical observations of Sever of the ample material of the Boston Children's Hospital are apt to prove that a lesion of the brachial plexus takes place in most of these cases. The paralysis resulting from this lesion may heal in time, leaving as a sequela the contracture of the shoulder-joint.

It is of greatest importance in these cases to begin treat-

ment as early as the general condition of the child allows; this may be a few weeks after birth. The essential part of the treatment is to prevent contracture of the shoulder and to stimulate muscular action, proper coördination and sufficient growth of the affected arm. These can be best accomplished by forcing the baby to move and later to use his arm as much as possible, and by bringing the arm part of the time into a position opposite to that threatening to develop: adduction and inward rotation. This treatment is best done by regular passive stretching exercises in addition to bandaging either in special orthopedic apparatus or simply to the upper end of the crib or baby carriage. For a part of each day the *healthy* arm should be bandaged to the body, thus forcing the baby to use his affected arm as much as possible. Otherwise the treatment is best done in the form of instructions to the mother to make certain motions of the arm, hand and fingers several times a day, rather than to carry out the motions at the clinic only.

Usually we see these patients rather late after severe contracture has set in and the function of the arm is more or less neglected. In such cases treatment with massage and exercise may help if they are of moderate degree. If the changes are severe more effective measures are indicated, such as the tenotomy of the subscapularis (Sever), or the osteotomy of the humerus with following outward rotation of the lower fragment (Spitzy, Vulpius, Lange).

CHAPTER XX.

SPASTIC PARALYSIS. ATAXIA.

Spastic paralysis results from an affection of the central neurons that may be localized within the spinal cord or within the brain.

The most common forms of spastic paralysis of spinal origin are: (1) Transverse myelitis; (2) lateral sclerosis, and (3) multiple sclerosis. As all of these types have been rather rare in our clinic we shall discuss them but briefly.

Transverse myelitis: The most common forms of this affection have been in our experience those caused by tuberculosis of the spine, the so-called Pott's paralysis, and by injury of the spine. Pott's paralysis will in most cases clear up under orthopedic treatment, unless the injury to the spinal cord is too severe. In cases, however, which do not respond to orthopedic treatment alone in due time, a persistent application of exercise and massage is recommended. The following case may serve as an example.

The patient, a girl, aged fifteen years, had suffered from Pott's disease for over two years. She was in the ward in July and August, 1908, on account of difficulties in walking. Under rest on a frame her condition improved to some extent and the patient was sent home. Six weeks later she returned with considerable increase of the paralytic symptoms. The spasticity was very marked, the reflexes much exaggerated and the patient was deprived entirely of the use of her legs, although the sensation was not markedly affected. In spite of careful orthopedic treatment in the ward the patient showed only very slight if any improvement, and in August, 1909, the question of laminectomy was discussed. It was decided, however, to continue rest in proper position and add to this massage and exercise of the

legs. The patient responded to this stimulative treatment in a short time and showed an improvement which evidently was much more rapid than before. The treatment was continued for over six months. At that time the patient walked on crutches and had definite, though not perfect, control of her legs. Under further orthopedic ambulatory treatment improvement continued and the function of the legs was completely restored.

In cases of injury to the spinal cord by a fracture of the spine, bullet wounds, etc., the indication for exercise and massage depends on the severity of the symptoms. When complete motor and sensory paralysis with loss of the reflexes is found, such treatment will be of no value and only surgical intervention may furnish hope of recovery, though, as a rule, these cases are hopeless. But in all those cases where the paralysis is not complete and particularly in those where the paralysis shows a spastic type exercise treatment should be given a fair trial. From theoretical consideration and personal experience we believe that such patients can be much benefited by stimulation and reëducation of the affected nerves and muscles.

Lateral sclerosis and multiple sclerosis are generally believed to be diseases of a progressive nature. Off hand, therefore, one should not expect any result or at least no lasting benefit to be derived from conservative treatment. Experience with several cases of this kind, however, has shown that considerable improvement may be obtained by a long-continued use of rational exercise. The following case is an example:

A patient was sent to us from the nerve department with the diagnosis of spastic paraplegia, which had developed during the last five years on a not quite certain basis, repeated Wassermann tests being negative. He showed a very marked rigidity and weakness in both legs, and came to us in a wheel-chair as he was not able to walk the distance from one room to another. The knee-jerks were present and both very lively. Babinski reflex positive on both sides. Sensation normal in every form. The patient was told at first that treatment would probably not help him,

but he was finally sent to the orthopedic department for a support for his poorly balanced and weak back. We advised him to have regular treatment with exercise and massage which he started in October, 1915. During the first six months he showed very marked improvement; he has been able to raise either leg with but slight difficulty. He has learned to walk to and from the street car and even greater distances alone and without being much fatigued. The Babinski reflex has become negative. The foot-clonus has remained active but to a much less degree than at first. Treatment continued during the following six months has not shown such a marked change as the earlier months, though the strength and control have been somewhat increased. The following observation was of interest. In the fall of 1916 massage was not applied for about one month, which has led to an increase in the stiffness of the muscles, distinctly noticeable to the patient. The treatment of this patient consisted in massage of his back and leg muscles and in active and active-passive Zander exercises.

PARALYSIS OF CEREBRAL ORIGIN.

Of paralytic cases of cerebral origin we see most frequently the following types:

1. Adult hemiplegia.
2. Brain syphilis.
3. Tumor of the brain after operation.
4. Infantile hemiplegia.
5. Little's disease.

We shall first discuss the peculiarities of each type so far as exercise and massage treatment is concerned, and then describe in detail the treatment as it is more or less common to all spastic cases while passing over certain differences according to age and individuality.

1. **Adult Hemiplegia.**—Hemiplegia of adults is in the majority of cases caused by intracerebral hemorrhage. Thus the first demand is for rest. Those patients have usually a very high blood-pressure and it has been advised to apply massage as early as the second day with the idea

of lowering the tension of the bloodvessels. We believe that such a treatment may help those cases in regaining full consciousness, in absorbing the hematoma and perhaps in avoiding further bleeding, but should recommend the utmost care. Only entirely competent persons should be called for such management and the reaction of the pulse and blood-pressure must be very exactly studied.

When, however, the danger of secondary bleeding has passed, two or three weeks or more after the onset, such to be decided individually, massage and exercise become indicated. During this early period the treatment should be done with great gentleness in regard both to massage and exercise. As we have outlined before these methods may produce raising or lowering of the blood-pressure, according to the force and kind of manipulation applied. The deep though gentle muscle kneading is preferable to the other manipulations; effleurage should be done only with sufficient amount of grease to avoid irritation of the skin. Vibration, shaking and tapotement, so useful in the old cases, should not be applied in the early stage.

For exercise gentle and slow passive movements are best suited for the first few weeks. They will act soothingly upon the muscles and nerves as well as upon the central nervous system and aid in lowering the blood-pressure. At certain intervals the active coöperation of the patient may be called for and when the general condition of the patient permits, more and more active-passive and active-resistive exercises are done. Then the treatment will proceed along the lines described below for the old cases.

The management of cases of thrombosis or embolism of the brain will not differ much from the aforesaid conditions except that generally the care must be all the greater and treatment still more gentle.

The following case may serve as an example:

The patient, a man, aged fifty-seven years, was admitted to the medical ward March 22, 1915, with the following history: Nine days before, when considered to be in perfect health he found that he could not say the things he wanted to, could not articulate. After taking a dose of

castor oil the patient felt better and went back to business the next day. He was well until the day of his admission to the hospital, when he had a definite stroke which paralyzed his right leg and right arm. After a short interval of rest the patient was sent to the medico-mechanical department for massage and exercise treatment. On account of considerable weakness we started with massage of the paralyzed arm and leg, adding just a few gentle passive movements. It seemed wiser not to make any active movements at first because the patient was of a very nervous temperament, and being unable to control his paralyzed limbs, he attempted rather violent movements of the non-paralyzed parts of the body. The improvement which had already set in during the first weeks made a rapid progress, and when the patient was discharged May 3, about six weeks after the onset, he was able to walk, though with typical distinct limp, and to raise up his arm somewhat beyond the right angle. He also had considerable, though not perfect, control of his right hand. The patient was advised, however, to keep on with the treatment, and did so faithfully for several months longer, during which time he progressed so much that in the fall his right arm had almost completely recovered, and the limp was only noticeable on close inspection.

The treatment consisted in passive, later active-passive and active exercises, which were to some extent done on the Zander apparatus, and in massage of the paralyzed limbs.

One year after the first attack the patient had another attack of disturbance of his speech, but no other signs of paralysis. This, however, was relieved within a few days.

In such cases we cannot state positively how much of the improvement has come from the exercise treatment, as many of them clear up to a great extent in a fairly short time.

We believe, however, that the treatment may prevent the patient from acquiring bad habits in regard to imperfect control of the extremities, as well as articular complications so often seen in old cases of hemiplegia.

2. **Brain Syphilis.**—A number of cases of both these types are of syphilitic origin. The specific treatment which will

be applied in such cases can be assisted in a measure by the rational use of massage and exercise along the lines described under No. 1. A full judgment, however, as to what such treatment has done in a successful case is still more difficult to obtain, as we obviously see cases recover without anything but rest and specific treatment. On the other hand, we have frequently seen patients who had recovered only to a certain extent, and had come to a stationary condition. Possibly some of these patients might have shown a more constant progress toward further recovery if the safe and sound principles of physical therapeutics, particularly appropriate exercise, had been applied.

3. **Tumors of Brain.**—The management of patients with excised tumors of the brain must be entirely left to the judgment of the surgeon. The use of physical therapeutics might come in question along the lines marked for convalescent cases in general, and in the after-treatment the management of a recurrent hemiplegia does not differ much from the treatment of other cases of that type.

4 and 5. Whether and to what extent the general and local conditions of children with infantile hemiplegia and Little's disease can be benefited by a primary treatment with massage and exercise and possibly some other form of physical therapeutics, we cannot say from personal experience, but we believe they could. The general tendency of physicians and parents to let nature do its work alone, unaided, is so great that obviously the best time is wasted before anything is done.

When we see the children the condition is often stationary; sometimes a certain progress is still noticed by the parents. We have to work under very unfavorable conditions; many important nerve tracks have not been used for years, or never at all, as in congenital cases. Many muscles have not been worked, many muscle fibers are weakened and undeveloped, unable to contract and relax, and what is of most importance the whole system of coördination is undeveloped and irregular. Those children have not learned many occupations of daily life which seem natural to us and regarding which we too easily forget that we had to learn

them as children. It is the education and reëducation which should make up the main part of the treatment. This being correct there cannot be any doubt that exercise is the most important form of physical therapeutics which is of value in those cases; all others, such as massage, electricity, etc., playing only a secondary role.

In many cases of infantile spastic paralysis contractures and secondary deformities have developed; or the spasms are so great that the balance between certain muscles and their antagonists is very much interfered with. Then operations such as tenotomies, myotomies, eventually osteotomies, or operations on the nervous system such as the partial resection of the motor nerve supply of the contracted muscles (Stoffel's operation), or the partial resection of the posterior roots (Foerster's operation), or the decompensation for relief of intracerebral pressure (Sharp), are indicated, but as Foerster, Biesalski and others point out, those operations should find their primary value in that they smooth the path for education by exercise treatment.

In considering the advisability of such operations one should carefully consider the individual and social conditions and rather advise against them if conditions are such that good after-care cannot be taken. In most cases it seems to us advisable that exercise treatment should be given at first and operations done when the stationary character is manifested. This would have the further advantage that the children have learned the idea and means of application of the exercises and could take up a well-known subject after the operation instead of learning entirely new things. It would further enable the physician and the patient himself to obtain a much clearer idea of the effect of the operation.

The following case is an excellent example: The patient, a boy, aged six years, had shown considerable stiffness of his legs from birth. He walked very poorly, with a typical spastic gait. The coördination of all movements of his legs was very deficient and balance was greatly disturbed. The question of operative procedures was discussed but we decided to apply exercise treatment and educational muscle

training for six months before doing anything further. The improvement under this treatment, which was conducted by Dr. H. C. Low, and carried out by the patient's mother, was so satisfactory that after six months the boy walked almost as well as any normal child. Moreover, the effect of the physical improvement upon the mental development of the child was very gratifying.

Before we discuss the exercise treatment of the old cases of spastic paralysis we shall briefly repeat the indications which have been outlined in the foregoing chapter. There it was stated that the treatment has to attack not only the primarily affected neurons, but the whole complicated system of the motor and sensory nervous apparatus as well as the muscles and joints; and that the general condition of the patient, both physical and mental, must be the object of our careful attention.

A few words must be added about the disturbed muscle balance and the defective coördination. From an anatomical point of view the flexors, adductors, pronators and inward rotators are stronger than the extensors, abductors, supinators and outward rotators, but under physiological conditions the balance between these groups is nevertheless perfect, furnishing the most rational economy and the most appropriate function. In spastic paralysis this balance becomes disturbed, generally in favor of the flexors. Foerster compares in a very ingenious way the spastic type of disturbed balance with that seen in infants. Here also we notice the superiority of the flexors and pronators, etc., over their antagonists, and it may be justifiable to speak of an infantile type of muscle balance in regard to the spastic paralysis.

This disturbance of balance involves grave dangers, as it not only interferes with the function but in time may lead to actual contracture and articular and even bony deformities. Therefore the most urgent indication is to restore proper balance as much as possible. The most effective treatment to accomplish this is often repeated passive stretching of the contracted muscles, aided by simple orthopedic appliances for maintaining the corrected

position for a certain length of time, as we shall describe below.

The restoration of coördinate function which is so much disturbed in these central lesions is a problem far beyond the relief of balance, though intimately connected with it. We shall first describe the conservative method used for the improvement and restoration of proper muscular balance. For this purpose we begin with passive movements and stretching of the contracted flexors, adductors, etc. These movements must be done in various angles up to the full physiological extent. They must be done slowly in order to avoid any spasm and involuntary contractions of the stretched muscles. If there is any active motion at all possible in the antagonists we ask the patient after a few passive exercises to do the same movement now himself, giving him just enough assistance to do so with perfect ease. This will enable us to study the progress and also to notice to what extent the motor impulses are "side-tracked." With this term we signify the frequent habit of such patients to contract other, sometimes distant muscle groups in attempting to do certain motions. Very frequently we see contractions of the inward rotators of the humerus and the pectoral muscles with, or instead of voluntary motions of the muscles of the forearm and fingers. The proper selection of support and sufficient assistance will often help to exclude such side-tracking.

Another point seems to be of importance. Such stretching, passive and assistive movements should not be done too often in succession. In severe cases three or four times, in milder ones twice as many may be done in succession, then another movement of a different muscle group should be done and the first one may be repeated later. These exercises are very tiring for the patient, especially if progress is slow, and we emphasize the desirability of making frequent changes, having a short period of massage intervene, and progressing as soon as is at all feasible to somewhat more interesting exercises.

These movements can be materially aided by simple orthopedic apparatus which must be constructed so that

the patient or one of his relatives can easily apply them. For the contracted hand and fingers we use a simple splint made of sheet-iron, padded with felt, and furnished with three or four straps. These splints which can be made by any blacksmith, have the advantage that the angle at the wrist can be changed with ease. When the contraction of the fingers is very marked, we bend the splint at the wrist so that the hand is placed in an angle of palmar flexion of 40 to 50 degrees or more, which usually allows full extension of the fingers. The angle is chosen so that the flexor muscles show just a slight resistance which is overcome by the straps. When with advancing improvement this contraction becomes less noticeable, the angle of palmar flexion is diminished until finally the wrist is brought into a position of increasing dorsiflexion. The time during which the splint should be applied must be decided individually. In severe cases we proceed as follows: After five to ten minutes of passive stretching the splint is applied and the patient rests for thirty minutes to one hour. When the patient has learned to apply the splint he takes it home and uses it two or three times a day for one hour each time. Later the splint may be worn overnight if this is not contraindicated by pain or inconvenience. Similar apparatus may be constructed for the elbow, the shoulder, or the lower extremity.

The methods described above are used mainly for the improvement of balance. In many cases such conservative treatment will suffice, in others more radical procedures have to be selected, such as forcible stretching or operations. As soon as conditions allow, the problem of the restoration of coördination will come to the foreground.

When a certain amount of active control is obtained we begin with "imitating" movements. We show a certain simple motion and have the patient copy it as exactly as possible. As long as support is needed on account of muscle spasm and side-tracking, the imitating should be done after the operator has made the motion himself and is ready to assist, or an assistant shows the motion while the operator gives the patient support and help in copying it.

Another valuable method is the symmetrical exercise

which may be done with benefit in even severe cases. The following case was of great interest: A small boy with severe infantile hemiplegia at first did not show any active impulse, but after several weeks he learned to do certain simple movements when he was doing the same movements with the other hand at the same time. Unfortunately the social conditions were such that treatment could not be given for a sufficiently long period to obtain anything like a satisfactory functional result. The symmetrical exercises are done either with assistance to both hands and arms alike, or in the manner of the imitating exercises, in that the operator does symmetrical movements and has the patient copy them.

In suitable cases symmetrical movements may be done before a mirror; this method is especially useful if the patient has acquired bad habits caused by side-tracking, such as certain motions of the shoulders in moving the forearm, etc. This form of exercise, however, should not be overdone, as it might cause a considerable mental strain.

All these exercises are at first intended for single muscle groups. The next move is now to combine two and later more muscle groups of the same extremity. The following may serve as examples: Extension of the fingers with extension of the wrist; flexion of the fingers with extension of the wrist; extension of the wrist with pronation of the forearm. Analyzing these examples it will be seen that some show a coöperation of antagonists and others a coöperation of agonists with the antagonists. Similar exercises may be done with the foot and leg.

Next would come simultaneous exercises with the arm and leg; here again symmetrical and alternating, simple, combined and more complicated exercises should be done. One of the difficult problems in hemiplegia is the exact coöperation of the right arm with the left leg and *vice versa* in walking. Another group of exercises are the alternating motions, *e. g.*, the left arm swings backward, the right arm forward; or the left wrist is palmar flexed, the right wrist dorsiflexed.

Figs. 86, 87, 88, and 89 illustrate a few simple exercises which have been worked out by Dr. H. C. Low on a case of Little's disease. These exercises may be further developed

and modified in almost infinite varieties. Easy games and light sports may be employed, but the main principle should never be overlooked, namely, that each exercise must be done correctly and with sufficient ease before a more difficult

FIG. 86.—Patient with a moderate Little's disease assumes the position with his left foot similar to that in which the right foot is held passively.

one is tried; that the general physical and mental condition of the patient must be carefully watched; and that the limitations for any form of treatment are considered and not too much expected or promised.

Tabes.—The so-called compensatory exercise therapy in tabes dorsalis and other disturbances of the coördination has been developed to a real system by E. Frenkel. He published his first report of 3 cases successfully treated in 1890, and has since issued a number of valuable papers and books on the same subject. His method is now almost

Fig. 87.—Same case as in Fig. 86. The patient grasps an object with his toes and hands it to the operator.

generally recognized and is in use in many clinics. It is based on the principle of compensating the deep sensation which is more or less lost, due to the degeneration of the posterior tracks of the spinal column. This compensation is attempted by the training of other senses, especially that of the eye. In the chapter on Paralysis we have briefly

FIGS. 88 and 89.—A case of Little's disease: Patient stepping on and between books spread over a blanket. By a persistent use of a number of exercises the patient's condition was improved so much so that he now walks and runs almost normally.

mentioned the correlation of the motor and sensory nerves. It is the correct coöperation of these nerves, both central and peripheral, upon which exact coördination depends, and the idea of Frenkel's treatment is to restore the disturbed function by substituting as much as possible healthy nerves for the affected or even destroyed nerves. How much this will be possible depends on many factors, such as the severity of the case, the existence of complications, on the intactness of the motor apparatus, both nerves and muscles, and last but not least, on the intelligence and energy of the patient. The physician who gives or supervises the treatment must make the patient understand that it has an entirely symptomatic character, and can never result in a cure of the disease itself; that, furthermore, the main idea of the treatment is to teach the patient proper coördination, and that the patient must not only make the best of the treatment as a course of lectures, but later on must utilize and develop more and more what he has learned. Just as in any other lectures a full knowledge cannot be obtained unless the patient continues to learn and to work in that time.

In certain hospitals elaborate apparatus are at hand for the treatment of such patients. While we do not doubt that costly and complicated apparatus have a definite value, we agree with Mitchell that no apparatus is required beyond what may be found in any household. With a few intelligent improvisations no elaborate gymnasium is necessary. In fact, in all cases of tabes which we have treated at the medico-mechanical department, we have developed a system of exercises independent of any apparatus. We prefer, therefore, to describe this form of treatment and refer the reader to text-books on neurology for further information.

The exercises are done: (1) In lying; (2) in sitting; (3) in standing position; and (4) with locomotion.

The lighter the case, the earlier we can progress from lying and sitting positions to standing and walking. But we insist that certain exercises are done well in No. 1 before they are attempted in Nos. 2, 3, and 4; or before they are further developed. We will describe a number of useful exercises for a moderately severe case, emphasizing, however,

that a careful individual consideration must always guide the selection of exercise in each case and in each lesson.

1. We begin with the lying position; the patient lies with head and shoulders somewhat raised so as to be able to observe the exercises closely. The first primitive exercise consists in anteroposterior and lateral movements of the feet; at first each foot singly, then both alternating and symmetrical. It is wise to have the patient's knee somewhat flexed and supported by a firm, round pillow, in order to relieve the strain on the posterior muscles of the leg. This is of special importance because, as we know, the tabetic patient has always the tendency to walk in a somewhat stiff manner with the knees more or less extended.

The movements of the feet are followed by those of the knees and hips; at first each joint singly, later in combinations. Hip flexion is done at first with the knee flexed in that the heel slides on the table. Later it is done with the knee extended, *i. e.*, the leg is lifted up from the table. Both these exercises are now used for a special training in precision as follows: In sliding the heel over the table this will be done at first in a straight line and later in figures. Next the patient lifts up the heel in drawing up the leg and places it down on a certain point at distances of one-half and one foot. This exercise may thus be developed to the well-known knee-heel movement, which is so often used as a test of the ataxia, and may be further developed in that the right heel is to slide along the left side, or that it touches the left foot, the tibia in the middle and finally the knee. The right heel may go from one place to the other directly, or it may always go back to the first position and so on in endless variety.

As soon as an exercise is correctly done the patient must repeat it with his eyes closed, whereby he must depend on his pictures of remembrance within the visual centres. If this does not succeed, the exercise is done again with the eyes open, and then another attempt with closed eyes is made, and so forth until the movements are done as well with the eyes closed as with them opened. The last mentioned exercises may be further developed by the use of

simple apparatus, such as a step-ladder, which the patient has to climb up at first with one foot and then with both while he remains in the lying position; or a board with figures drawn with chalk is placed on the table within easy reach of the patient's toes. He must follow these figures with one foot and then with the other, etc.

2. Nearly all these exercises can also be done in sitting, and they should be practised in this position as soon as they are sufficiently well practised in lying. Walking exercises in sitting may be added; at first for each leg singly, in that the foot is raised from the floor and lowered on the same place and then another place as indicated. This exercise is later done for both legs alternately, in as many variations as seem necessary.

In all these exercises support by the operator's hand is necessary as long as the patient has not learned sufficient control with the eyes opened. We believe that failure to observe this rule is the cause of discouragement and perhaps failure of the whole treatment. In this connection I remember very well a patient with rather advanced tabes who was advised by his physician to do several times every day a number of such exercises as have just been described. He had faithfully carried out the order for many months, and finally came to us complaining that he could not see any progress. The fact was that he was not able to do any of his exercises at all correctly without assistance.

3. The progress from the lying or sitting to the standing position is a very decided one and should not be made too early, because the difficulties of coördination are very much greater with weight-bearing than without. Therefore, when we see that the patient, after he has learned certain exercises correctly in lying and sitting, has great difficulty in doing similar exercises in standing, we rather wait awhile, continuing with the first group and make another attempt after a few days. A too rapid progress may easily lead to a definite relapse.

The exercises in standing may be divided into four groups: (1) Standing and stepping exercises with support; (2) the same without support; (3) connection of such exercises with

movements of the trunk and arms; and (4) standing on one leg with or without other movements. It does not seem necessary to give further detailed explanations, as the proper choice of exercises cannot be arranged according to any schedule but must depend on the individual need. For these exercises and also for No. 4, the exercises with locomotion, it is wise to draw certain figures on a piece of thick paper or oilcloth, and have the patient make steps accordingly. The exercises with locomotion are again divided into those with and without support, and with movements of the trunk and arms.

Support is given for the standing exercises by the back of two chairs between which the patient stands. Walking exercises may be done between a mantelpiece on one side and a long table or a few chairs on the other, unless one constructs a simple apparatus like a double bar. In severe cases the use of a so-called walking chair is advisable, which can be constructed at a small expense. Walking exercises are done at first in the way of simple steps forward, then turning half and full back; walking backward; walking in a circle; following a figure eight; stepping over smaller or larger obstacles, as a pile of books. All these exercises are done with closed eyes after being sufficiently practised with the eyes open. Excellent exercises are those where the patient with closed eyes takes steps of well-defined length, and so on. Also imitation exercises whereby the patient merely observes the operator and tries to copy his movements; exercises before a long mirror, and others may prove of value and make the treatment somewhat more varied.

These are only a few suggestions for the compensatory educational treatment in locomotor ataxia. I wish to emphasize, however, that the success of the treatment will not depend on the amount and kind of exercise, but on the way in which it is directed by the physician and carried out by the patient. It is entirely wrong simply to prescribe such and such exercise, so and so many times, to be followed by others.

Mitchell's advice to have the exercise done two or three times a day is excellent, but I am afraid it meets with great

difficulties in practice, as it may be hardly possible in the average case to procure his physician's or a trained masseur's coöperation, and we do not think that much can be gained by trusting the treatment to the patient himself, at least not until he has learned a certain control, which, as a rule, will need treatment of several weeks or even months.

It is advisable to begin with short sessions of treatment because the patients become fatigued very easily. There is, however, a special feature in the kind of fatigue in patients with locomotor ataxia, in that the subjective feeling of fatigue is not so pronounced in them as in normal persons, but it frequently shows in an increase of the incoördination; thus it would seem quite irrational to force the patient to work for a certain length of time when we notice that he is not doing his exercises as well as a few minutes before. This danger is perhaps best averted by beginning with very short treatments, not more than ten minutes in the beginning, and gradually increase the time of the treatment with advancing improvement.

As soon as exercise in the upright position has been started, it is advisable to keep an eye on the posture of the patient. In those exercises which have to be done with the control of the eye we have, of course, to allow the patient to look downward, but as soon as the coöperation of the eyes can be spared, the general poise should be well considered.

Massage is only of secondary value compared with the exercise, but we consider it an excellent stimulant if it is done for a short time before and after the exercise treatment. It should never be done in a rough way, but rather gently, as we also have advised for cases of paralysis.

To speak finally about contra-indications, we have only briefly to mention the following: Complications of the motor apparatus, such as severe atrophy of the muscles, especially if they are connected with signs of degeneration; furthermore, contractures of any joint of the legs. Some patients who suffer from complications such as gastric crises, etc., may not have the mental power to carry out the treatment, which cannot be of any use unless it is done with sufficient persistency.

In patients suffering from neurasthenic symptoms and general fatigue it should be decided from case to case whether it is worth while to start the treatment or whether the patient should be better prepared first by rest or whatever treatment may be necessary. Though we have not had any personal experience in such cases, it would seem to us that rest in combination with very carefully directed general massage may be excellent means to precede the exercise treatment, which after a while can be started from the simplest and easiest kinds of exercise, to be given in very small doses at first, and then gradually to be increased.

CHAPTER XXI.

PAINFUL AFFECTIONS—NEURALGIA.

Among one hundred patients with chronic affections who consult the clinic there are at least ninety who do so on account of pain; and probably one-half of these will tell us that they have used a liniment or that their doctor has prescribed one to rub on the painful spots. This method of treatment is undoubtedly very old and originated from the instinctive desire to press and rub the aching part. It is a matter of course, therefore, that massage operators have since ancient times especially cultivated this indication which in many text-books of massage plays a very prominent role. For this reason and, furthermore, because there are a number of affections which are characterized entirely or almost so by pain we have devoted a special chapter to this subject, although many of the painful affections have been discussed in other chapters.

The problem of medical art and science has always been to cure disease or relieve complaints, but it is only in recent times that the important demand has been sufficiently recognized that rational treatment must be based on a correct diagnosis. As we have said in the chapter on Arthritis this recognition has greatly changed and in many ways revolutionized our clinics. It is not many years since a patient with arthritis or neuralgia who entered the hospital was merely treated with whatever remedies seemed to be on hand to relieve his condition. Now he is made the subject of a most careful examination; joint consultations are held with representatives of various special branches, elaborate tests are taken, and thus the treatment is planned along entirely different lines. The symptoms, though carefully considered for making the correct diagnosis, are frequently pushed into

the background in regard to the treatment. Modern therapy has thus become much more rational and cases which have heretofore been considered incurable have since been greatly relieved if not cured. But with all this modern progress those methods of treatment which have been recognized for ages have not become obsolete, but they have rather gained in value as we have learned to apply them frequently in a more rational way, not simply symptomatically but directly serving the most important indications. Furthermore, with increased knowledge of many painful conditions we have learned to understand better why a certain method such as massage can be expected to promote relief and cure. To illustrate this idea the so-called neuritis of the shoulder may serve as an example: In most of these cases, as Codman observes, the pain is caused by subacromial bursitis. The rational treatment, therefore, is that indicated by the underlying condition and in this treatment massage has a well-determined place. Thus with the correct anatomical and pathological diagnosis we can apply massage according to its best effect and we can apply it moreover at the proper place.

The seat of pain is not always identical with the seat of the pathological affection causing the pain. In such cases we speak of referred pain. The brain centres to which signals are sent by the sensory nerves from certain affected parts of the body often refer the pain to a place considerably distant from the affected area. This fact, which is evidently of great importance for the protection of the lesion, is apt to mislead the superficial observer. A most striking example was seen in the case of a physician who consulted me for pain in the region of the right elbow and running down the forearm, which he had treated by massage for several weeks without relief. Examination showed the elbow and shoulder to be in normal condition. On the right side of the neck a few enlarged and slightly sensitive glands were felt and examination of the throat revealed a definite chronic inflammation of the right tonsil. The connection between the pain in the elbow and the inflammation of the tonsil and glands was at once evident and rational treatment was

advised. We see cases of this kind almost daily, and the attempt to cure them by massage or any other local application at the seat of pain would seem to be just as rational as to pour water over a fire-alarm box to extinguish a fire.

While, however, with increasing progress of medical science a great many cases of "rheumatism," "neuritis," and "neuralgia" are now classified where they really belong, there is still a considerable number of patients who suffer from affections in or about nerves, affections in which local treatment is not only advisable but where it may correspond to the proper indication from a physiological point of view.

In the chapter on Physiology of Massage we have stated that mechanical stimulation of a nerve or its endings, if done with sufficient strength, will relieve pain and have explained this by a state of fatigue into which the nerve is brought. Pflüger and Arndt have stated a physiological law as follows: The action of the nerve is quickened by a weak mechanical stimulus; it is further favored by a certain increase of the stimulus; whereas after the stimulus has passed over a certain threshold it is restricted and with further increase entirely eliminated. All explanations which are given of these interesting physiological facts are rather hypothetical and may be passed over. The existence of these facts is proved in our daily experience, although there are other factors which must be considered as well when we want to explain the pain-lessening effect of massage.

Mechanical stimulation, just as thermal, electrical, chemical or any other stimulation, causes hyperemia. The pain-reducing effect of hyperemia, however, is evident from the experience of daily life; and the well-known influence of baking, hot applications, Bier's congestive hyperemia and other methods give ample proof. The fact that under certain inflammatory conditions, or in many cases of headache, pain is reduced by cold applications does not contradict the stated pain-lessening effect of hyperemia, as we evidently have to do in such cases with a pathological state of hyperemia, where a regulating influence may be obtained by the cold application. Another explanation of the pain-lessening effect of massage and other methods has been attempted by

Winternitz.[1] This author who explains neuralgia by an accumulation of products of fatigue within the nerve, similar to that within the muscles, believes an effect of massage to exist in its influence upon the vasomotor nerves, by which a more active "exchange of currents" is obtained which neutralizes and eliminates the accumulated irritative products.

From the foregoing statements we conclude that in true neuralgia massage represents a very valuable method not only for relieving the pain, but actually for curing the affection, as frequent observations of many reliable authorities prove. We have stated before (p. 117) that the nerves are best attacked at those points where they run near to a bone or where they perforate a bone or fascia. The most serviceable manipulations are vibration, and to a lesser degree tapotement, but also upward stroking with moderate pressure is quite useful. Many masseurs prefer stroking in the reversed direction, but as Mitchell[2] says, "this is mostly a matter of individual trial." The pressure must be sufficiently great to obtain the effect desired, according to the law of Pflüger and Arndt. Sometimes the pressure must be all that can be obtained by using all the force possible on the part of the operator. On certain parts of the body, such as the sciatic nerve, vibration may be done by an electrical vibrator which can be pressed upon the nerve with a great deal of force.

Exercise is of minor importance in these cases and from general indications plays a part only in the after-care: strengthening the muscles, mobilization of joints in the neighborhood of the affected area, and general nervous stimulation. The so-called nerve stretching must be mentioned, however, as it has been advocated very highly and used by many physicians in the treatment of sciatica. It consists in the more or less forcible "straight-leg raising," *i. e.*, the flexion of the leg in the hip-joint with the knee kept straight. By this movement which is usually restricted in cases of sciatica (Lasègue's symptom) the sciatic nerve is stretched

[1] Cited by Bum, p. 193. [2] Page 73.

and thereby a benumbing and pain-reducing effect is obtained. The same may be done by an open operation, a method which has been performed by several surgeons but has been almost entirely given up in recent years. There is no doubt that in certain cases of sciatica the pain can be relieved by this method, which may require the use of an anesthetic to be carried out thoroughly, but as to the explanation there exists a certain dissension of opinion. Since Goldthwait's and Osgood's studies of the pelvic articulations we know that certain affections of the sacro-iliac joints may cause a spastic limitation of the straight-leg raising. We see it, for instance, as a typical sign of sacro-iliac displacement, and in such cases the displacement can be sometimes reduced by a forced straight-leg raising with or without other manipulations. But there is another explanation of the pain-reducing effect of this manipulation, namely, that by this movement the spastic contraction of the posterior muscles of the thigh may be overcome. As we have said in Chapter XV the lumbosacral and sacro-iliac regions are subject to a great many lesions which are frequently characterized by muscle spasm, and the straight-leg raising, active or passive, is one of the various movements for overcoming spastic contraction.

This manipulation may be done in three ways: (1) As a passive raising of the straight leg from the lying position; (2) as an active raising of the straight leg with more or less assistance or resistance; (3) as an active raising of the flexed leg which is then straightened and at the same time elevated as much as possible. The value of this last exercise is much increased by a resistance which is given by the operator at that moment when the patient straightens the leg. In giving the resistance the operator at the same time directs the amount of elevation, thus combining active and passive exercise in a most rational form. From frequent experience we recommend this last form of exercise as far superior to the other two.

An enumeration of the various forms of neuralgia does not seem to be necessary, as the treatment is more or less identical in all of them; in the following we shall briefly discuss

several painful affections in which massage has been found of value.

Headache.—It should be a matter of course that in cases of headache the underlying cause is sought for and if possible, eliminated, whether it be chronic constipation, eye-strain, anemia or any other cause. But there are many cases where this seems difficult or impossible and where we have to depend on symptomatic remedies; among which massage has been frequently recommended. The value of massage consists chiefly in the effect on the circulation, disturbances of which are frequently responsible for headache. The technic has been described in Chapter VIII (see p. 91).

A phenomenon which we have noticed sometimes seems worthy of consideration at this place; that is, the relieving effect of abdominal massage in cases of headache. The explanation of this phenomenon is not difficult when we remember the relation between the abdominal and the peripheral circulations which have been compared with two sides of a balance seeking equilibrium. Moreover, the experiments of Weber as to the effect of peripheral stimulation on the blood supply of the brain should be mentioned in this connection. It seems hardly possible to give any exact prescriptions for massage in the treatment of headache; in some cases the local applications are advisable, in others abdominal or general massage will serve better, and in some cases combinations of all these are preferable.

Rheumatic Wry-neck and Rheumatic Lumbago.—An affection which we have seen sometimes at the hospital and where massage has shown a very remarkable result is the so-called rheumatic myositis of the muscles of the neck, the rheumatic wry-neck, and of the lower back, the rheumatic lumbago. The pathology of these affections is obscure; they come on overnight, are very distressing and pass away as quickly as they have come, though sometimes they last for days. In a number of these cases we have been able to relieve the pain almost completely by one or two treatments, an experience which is also reported by other observers. A correct diagnosis is necessary here as elsewhere. In one case which at first glance resembled the type just mentioned, the

pain grew distinctly worse and under further observation the diagnosis of a true mononeuritis became evident.

It is almost impossible to enumerate all the painful conditions in which massage may bring relief. But, in order to be sure, it must be always our first duty to make a correct diagnosis and find out whether massage is indicated.

CHAPTER XXII.

NEUROSES.

Under the term neuroses are classified those numerous affections of the nervous system which have according to our present knowledge no definite pathologic-anatomic basis. As a disturbance of the function of the nervous regulations represents the most significant sign of these affections they are frequently spoken of as "functional neuroses." It is, however, of great importance that in many, perhaps the majority of neurotic cases certain somatic changes are found which have frequently been considered as pure symptoms, or accompanying signs, or as entirely unimportant. Therefore it is necessary to have each case of neurosis carefully examined and observed in order to study the connection between the psychoneurotic symptoms and the somatic disturbances.

As of frequent but still much-disputed connection must be mentioned the findings of neurotic symptoms in cases of faulty posture and visceroptosis. These cases often have a pronounced atony of the abdominal wall and the intestines. To consider such manifestations merely as a part of the whole symptom-complex, as several neurologists do, would seem to us a failure to uphold the old rule: *Mens sana in corpore sano.* Even though we admit that the connection between somatic disturbances or anatomic changes and neurotic symptoms is often difficult to ascertain, we feel with Goldthwait that our first efforts should be directed toward finding and, if possible, eliminating any physical disturbances. There can be no doubt that in many cases such clinical manifestations play a prominent role as causative factors, though probably acting upon a predisposed individual.

The indications for physical therapeutics and especially

exercise and massage in this respect have been discussed in other chapters. As an example may just be mentioned the great value of both exercise and massage in the treatment of faulty posture, visceroptosis, stasis, atony, obesity and other affections so frequently found in psychoneurotic persons.

It is perhaps more than a speculation that with further increase of our knowledge and with further application of rational therapeutic principles the whole treatment of neuroses will undergo radical changes. At present, however, we are still in the dark as to a great many symptoms and must to a large extent be satisfied with symptomatic treatment. In this physical therapeutics have for a long time played a prominent part, and the great value of massage and exercise is recognized by many authorities. Its recognition, however, by physicians in general has been rather slow, and we cannot fail to regret that this fact is to a large extent responsible for the flourishing of fraud and quackery in medicine.

The effect of massage and exercise in neuroses is explained to a great extent by physiological factors, though we admit that a great deal is still obscure and that we often simply depend on experience. The physiological factors which come chiefly under consideration are: (1) The reaction of the nervous system on mechanical stimulation; (2) the reaction of the circulatory system on massage and exercise; (3) the effect on the general metabolism.

1. As we have stated above massage influences primarily the endings of the sensory nerves in the skin and other peripheral organs. We have also mentioned that this influence is infinitely variable according to the amount of nerve endings stimulated and to the character and time of massage applied. These variations, great under normal conditions, are much greater under the complicated conditions as seen in neuroses. It is a very common experience, for instance, that light rubbing which would have no appreciable effect on a normal person, may be extremely irritative to a neurasthenic individual, or may in another case cause an effect exceedingly soothing and benumbing. Experiences like these which are hardly exceptional prove still more the

difficulties which we meet with in any attempt to analyze the physiological foundations of the effect of massage. But they seem to prove the chances to approach the nerve centres from the periphery. In which way such an effect takes place is not yet sufficiently known, though the experiments of E. Weber[1] may form a certain basis on which such explanations are possible. This author has shown on curarized animals that mechanical and electrical stimulations of the sensory nerves and their endings may cause distinct effects upon the regulation of the circulation of the brain, effects, as Rosenthal states, not unlike those observed after certain drugs (antipyrin, etc.) or certain hydrotherapeutic applications. Such experiments, furthermore, prove that the often so striking effect of massage in certain neurotic symptoms cannot be merely explained by suggestion but has a real somatic basis, though its full explanation is not yet known.

2. The experiments just cited lead us to note the effects of massage in neuroses by means of the circulation. We have briefly mentioned the influence of mechanical stimulations on the vasomotor nerves, and while again in these relations much is still hypothetical, it cannot be doubted that they play a prominent role in the explanation of those effects. Circulatory disturbances are so common in neuroses and hold such a prominent place in many cases (cardiovascular forms of neurasthenia, certain hysterical stigmata, angioneurotic forms, etc.) that their treatment by massage as well as exercise would seem entirely rational.

3. The general metabolism shows definite signs of grave disturbance in many cases of neuroses. Many of the patients are weak, run down and anemic; on the other hand, we not infrequently see neurasthenic symptoms connected with obesity. The digestive functions are often extremely low, the excretory functions considerably altered. Here are really wide and valuable fields for massage and exercise, which, as we have seen, may exert such a vast effect upon the metabolism.

[1] Ueber die Selbständigkeit des Gehirns in der Regulierung seiner Blutversorgung, Archiv f. Anat. und Physiol., 1908, cited by Rosenthal.

With these notes we have by no means exhausted the far-reaching and important relations between the physiological effects of massage and exercise and the numerous indications in the treatment of neuroses. We might just mention the refreshing influence of massage on fatigued muscles, or the soothing effect of tapotement and vibration of the back in palpitation of the heart to make it obvious that the scientific value of these methods cannot well be doubted even when they find no better indications than simply symptomatic ones.

The most important forms of neuroses are neurasthenia and hysteria. Easily distinguished in well-characterized cases these affections are so closely related to each other that their differential diagnosis may become very difficult. Therefore terms such as psychoneurosis or even hysteroneurasthenia are frequently used to avoid this difficulty. From this it is obvious that in the discussion of the therapy a very strict distinction of both these affections cannot be made for every case, and that much that is said about the one concerns to a certain degree the other. Moreover, experience shows that one and the same method of treatment or manipulation may be of benefit in cases of both types.

Before we discuss the value of massage and exercise in the treatment of neurasthenia and hysteria, a few words need to be said concerning their prophylactic value and some general principles common to all. Prevention of neurosis in a strict sense is hardly possible; all that can be done is to take proper care of people who seem to have such a disposition. This concerns particularly children and younger adults who are suspected of having inherited a certain disposition, children of psychopathic or psychoneurotic parents, drunkards, or those from an otherwise degenerate family. For these children rational gymnastics are of greatest value. Games and exercise out of doors, if possible under intelligent supervision, avoiding excessive exertion, are important constituents of the whole education. If there is a chance even in winter out-of-door playing should be encouraged, and this should be done if possible in the country. Massage is of less usefulness, though it may be applied at home in connection with

baths, or wet friction, unless pronounced anemia or other complications demand special precautions. Similar principles are of avail also for the care of patients who have been seemingly healed. Without exposing such people to the danger of overtreating, which certainly exists and should not be undervalued, we must consider that the disposition will probably persist and a rational care will possibly help to reduce the danger of recurrences. Here, again, carefully measured exercise, if possible some form of healthy out-of-door sport, walking, swimming, rowing, tennis, golf, etc., will be of very great value, provided exertion and overwork are prevented.

The great principles in the treatment of neuroses are identical with those applied in the therapy of many organic affections, such as cardiac or respiratory, and other diseases and their sequelæ: rest and exercise, both in the widest sense of the word. To accomplish the latter there are a number of methods on hand, among which massage and exercise hold just one, though a very prominent, place. Of others may be mentioned: Change of the surroundings, if possible staying in the country, at the seashore, or at the mountains. Mountain climbing has been found of particular value and would rather fall under our special subject. The various hydrotherapeutic and electrical applications as well as dietetic regulations are helpful. Drugs should be prescribed with careful selection and proper indications, but they should not come so much into the foreground as is frequently seen.

When massage and manual exercise are given the personal influence of the physician or the masseur is of great importance. It cannot be doubted that one and the same form of treatment may have a very different effect according to the person giving it. The simple prescription "massage" does not suffice. The person giving it must make a careful study of his patient and his peculiarities and must impress him with the spirit of confidence and hopefulness, otherwise the treatment may not have the effect desired.

The proper selection of treatment depends on a great many things: the age and sex of the patient, his social conditions, general education, occupation, general health,

previous treatment, etc. We have sometimes found patients who on the simple mentioning of massage became distrusting, saying that this had been tried without relief or even had aggravated their symptoms. We have then proposed to make another trial, suggesting that all depends on the way in which massage is applied, and have had the chance to prove its value with proper technic.

NEURASTHENIA.

The clinical pictures of neurasthenia are very different. Without going into details we may just mention the most common forms (Determann): (1) Exaggerated irritability; (2) pronounced general debility, often mixed with signs of the first; (3) cerebral forms with headache, sensation of pressure or tension of the head, subjective disturbances of hearing and sight, disturbances of mood, judgment, memory, etc.; (4) nervous insomnia, often connected with No. 3; (5) spinal forms: pain and tenderness along the spine and the large nerve trunks, numbness, feeling of cold, trembling, pronounced local weakness; (6) cardiovascular forms; (7) digestive forms; (8) sexual neurasthenia.

It is evident that in most cases a strict separation of these various forms is not possible, but we believe with Determann that thus a fairly accurate statement of the various indications can best be made.

1. **Exaggerated Irritability.**—When exaggerated irritability prevails massage may be of great value, but it must be kept in mind that such patients react more strongly upon stimulation than normal people. Manipulations which act soothingly under ordinary conditions may act here as extremely irritative. The most gentle kneading and friction are in our experience the forms which are best suited for the beginning in these cases. Stroking often causes too much irritation of the superficial sensory nerve endings. Tapotement and vibration should not be used until a certain progress is made and then mainly in the most gentle manner; the so-called rain douche massage or gentle tapping with the fingers is often found very agreeable.

Massage may be combined with gentle exercises, at first more of a passive or active-passive, later of active character. It is of great importance that these exercises are not in the least exerting. We begin with a few slow passive movements of the hands and feet, after a few treatments adding movements of the elbow and knees and later of the shoulder and hips with proper combinations. When we know enough of the reaction we have the patient take an active part, passing slowly over to resistive exercise with increasing resistances, and only after a certain length of time do we begin with free exercises, apparatus, sports, and games.

At what time of the day and how often these treatments should be given depends on many conditions. The best time is perhaps the morning hour; the patient may have a light breakfast before the treatment and should rest half an hour or an hour afterward. If sleeplessness exists the treatment may be given more properly in the evening.

2. **General Debility.**—In those cases where a general weakness prevails without a pronounced irritability the treatment may begin somewhat more vigorously. Effleurage of the extremities and the back with deep, though gentle kneading of the large muscle groups are here of value. Also tapotement and light vibration may be added. The chief indication in these cases is a thorough stimulation of the poorly circulated and nourished muscles. Also exercise may be given from the start as an active resistive exercise, beginning with light resistance and avoiding the sensation of fatigue. The use of light freehand exercises of a very simple character and not for too long a period is advisable after the reaction of the treatment has become well known.

These principles are of importance also for the other forms, as they follow more or less the one or the other type. Thus we shall restrict the discussion to the special indications. We also want to add once more that we do not mean here to recommend these methods as sole treatment, but that other factors must be considered as well.

3. **Cerebral Forms.**—In the cerebral form the psychical treatment is of foremost importance, but it can be well assisted by physical therapeutics which have for the main

problem the influence of the cerebral circulation; especially revulsion. This can be brought about to a very considerable, often a surprising, degree by massage, particularly that of the head. The pain-lessening effect of pressing and rubbing the aching forehead and temples is generally known. Almost everybody having a severe headache will do such manipulations instinctively himself. It is a matter of course that the trained masseur with his more complete technic will obtain a much better and more thorough effect. We begin usually with gentle but firm effleurage over the forehead, down the cheeks and the neck, along the large vessels as well as over the trapezius. This is followed by a deep kneading of the muscles of the neck and friction of the aching parts of the head. To these manipulations are added a few passive and active movements of the head. An excellent movement, cited as "Naegeli's manipulation" consists in a strong backward flexion of the head which is done in the following manner: The operator, standing on the right side of the patient grasps the head with his left hand on the occiput and his right hand on the chin. He lets the patient perform the backward flexion of the head to which he gives a fairly firm resistance. When the head is almost completely brought backward, the operator lessens the resistance, and using a gentle traction pushes the head somewhat back and upward. The head is held in this position for ten to fifteen seconds and then the manipulation may be repeated once or twice more. The effect of this simple manipulation is extremely soothing and agreeable if it is done correctly.

Manual vibratory massage of the forehead and scalp is very effective and evidently superior to that applied by an electric vibratory apparatus which is generally too strong for this purpose. Tapotement on the head itself should rather be avoided, but its revulsive effect by using it on the muscles of the back and shoulders may be very helpful. The quieting effect of general massage is often also of advantage. Exercise in these cases is best done in the open air; walking in pleasant surroundings; with improvement light sports may be indulged in, but strictly without overexertion.

4. **Nervous Insomnia.**—Nervous insomnia, one of the most distressing symptoms of neurasthenia, can at times be very successfully treated by massage. In the foreground stands general massage of the whole body with preference to the back and neck. The manipulations should be given without causing any irritation. Hence muscle kneading and gentle effleurage are best suited. In the beginning the sessions should not be too long because of possible irritation. The massage may be combined with light passive movements in the manner described under No. 1 (p. 372). Some observers use clapping and percussion manipulations as well as resistive exercises. Nissen calls special attention to the "downward" friction.

5. **Spinal Forms.**—For the forms with pronounced spinal irritation massage should be used only with great care. Any vigorous manipulations seem to have rather an aggravating effect. Protection and rest are more indicated than stimulation, though we admit that a gentle general massage of the extremities may be of advantage in certain cases. Massage of the back directly had to be given up in several cases after a few trials. Passive exercises are preferable to active resistive movements. Sports should not be recommended until a definite improvement has been obtained.

6. **Cardiovascular Forms.**—The cardiovascular forms offer a wide and profitable field for mechanical therapy. As we have stated in other places (p. 369) certain massage manipulations have a distinctly quieting effect on the heart. This is also of considerable use in those cases which show nervous palpitation. There are two methods of approach: one from the back and one from the front. We usually prefer the former method: effleurage and kneading of the back as well as tapotement and vibration. Determann and others recommend manual vibration and shaking directly over the heart from the front, and prefer this method to that of the electric vibrator. Furthermore, abdominal massage may be of great benefit, especially when ataxia and poor circulation of the abdominal organs exist. Gymnastic exercises, in the form of light resistive movements may be tried with frequent observations of the pulse. Daily walks, after a while on

hilly grounds, are refreshing and useful, and if intelligently carried out by the patient may be used for systematic training. Sports and violent gymnastics, however, should not be used except in patients with sufficient general strength who have a sedentary occupation and tend toward obesity.

7. **Digestive.**—In the digestive forms perhaps more than in any other is an exact differential diagnosis of greatest importance. Cases which have been regarded as gastric and intestinal neuroses and finally turned out to be chronic ulcers of the stomach or duodenum or chronic appendicitis, are not at all rare. Furthermore, the treatment depends very largely on the character of the case. In the spastic type massage is likely to be aggravating, while in the cases characterized by atony abdominal massage may be extremely helpful. This treatment is described in detail in Chapter XXV.

8. **Sexual Forms.**—In the sexual forms massage may be used according to general indications, particularly those discussed under "Exaggerated Irritability" and "General Debility." Local massage of the sexual organs is frequently advised, but should not be done except with the greatest care. Massage of the prostate is perhaps most to be recommended, particularly in cases with old gonorrheal infections. This last-mentioned type of patients, however, should be placed under the care of the genito-urinary specialist.

HYSTERIA.

The treatment of hysteria involves still more difficult problems than that of neurasthenia. Here also the psychical effect of the treatment stands in the foremost place and the result depends often not so much on what is done but by whom it is applied. The influence of a strong personality is the deciding factor here still more than in other neuroses. We therefore most strongly recommend that the physician apply massage and exercise himself if these methods are indicated, or at least that he be very careful in the selection of the proper person. If properly applied, massage may show effects in these cases which are truly astonishing, and in a number of cases they have surpassed our keenest expecta-

tions. It is wise, however, to be very cautious with the prognosis and never to forget that when the result is good the disposition remains. A distinct advantage of massage exists in the great variability of the effects needed and in the chance of personal psychical influence. These advantages in certain cases make massage the most useful method of treatment. The choice of the manipulations is here of much less importance, although the general rules given in the discussion of neurasthenia are also of value here. Patients with a fairly strong general health need vigorous manipulations; in weak, anemic individuals the most gentle and soft movements are indicated. In fact in certain cases of the former type the most violent massage manipulations such as we hardly dare to use in any other cases have given very satisfactory results.

It seems impossible and is perhaps unnecessary to discuss the many various symptoms and clinical pictures of hysteria in regard to the usefulness of massage and exercise. We shall, therefore, but briefly consider the most conspicuous types which have come under our observation.

1. Disturbances of the motility are seen as: (*a*) Hyperkinesis, cramps (both generalized and localized), hysteric chorea, tremor, etc.; (*b*) weakness, paresis, or paralysis; (*c*) contractures.

2. Disturbances of sensibility are seen as: (*a*) Pain, paresthesia, and hyperesthesia; (*b*) hyperesthesia and anesthesia.

3. Trophic, vasomotor, and secretory disturbances.

4. Hysteric anomalies of the internal organs: (*a*) Respiratory organs (coughing, sneezing, asthma, aphasia); (*b*) intestines (globus hystericus, cardialgia, ructus, meteorism, vomiting, diarrhea).

Disturbances of Motility. — (*a*) *Cramps.* — In the generalized forms of tonic and clonic cramps massage will be hardly of any use. In the early stage pressure over the cervical region may be able to prevent further development. In cases of hysteric chorea there is perhaps no other form of treatment so effective as general massage of the whole body. We have treated in that way two cases of most severe choreic cramps which had lasted for weeks and had in no way

responded to any other form of treatment. Both patients, young girls of eighteen or nineteen years, were discharged perfectly well after two and three weeks respectively. Gentle effleurage and muscle kneading had been given in these cases for thirty minutes daily.

(*b*) *Weakness, Paresis; Paralysis, Lack of Coördination.*—It is very important to begin the treatment as early as possible; in inveterate cases the prognosis is usually worse. Besides massage passive movements are here of great value. In cases of lack of coördination we begin with very slow passive movements, to which active movements are added at certain intervals. For instance, we flex the knee two or three times passively, and then order the patient to try to accomplish the same movement himself. Sometimes the lack of coördination is accompanied by tremor or cramps. In such cases the exercise should be freely mixed with massage. When, for instance, the active movement just mentioned causes tremor or cramps, the operator applies strong massage, kneading and pressing the affected muscles until they have quieted down.

(*c*) Hysteric contractures may represent most obstinate problems, particularly when they are at all inveterate. But even in a few rather old cases we have seen good results by persistent and untiring efforts with exercise and massage. Any violent and hasty movements should be avoided. We advise rhythmical and regular active contractions of the various muscle groups of the affected joint combined with gentle massage. We take frequent measurements of the angle of motion obtained. An improvement thus stated will be most encouraging to the patient. It is also important in these very tiring and annoying affections to impress the patient with confidence that the condition will be cured. In severe cases the exercises may be done in the warm-water bath.

Disturbances of Sensibility.—In hysteric neuralgia the electric treatment is probably superior to massage, though at times pressing on the nerves with steady pressure or in connection with vibration may give relief. Hysteric headache, with all its various accompanying symptoms,

is treated in a similar way as that in neurasthenia, from which it cannot always be strictly differentiated. Hyperesthesia and paresthesia may respond to effleurage and friction, but the effect is inconstant. Anesthesia is a good subject for massage, which may be used in strong forms provided there are no other contraindications. The transfer of symptoms has sometimes been noted (Determann), either that the zone of anesthesia has moved to another part of the body or that other symptoms have taken place after disappearance of the anesthesia.

It does not seem necessary to enumerate all the many various symptoms on the part of vasomotor and secretory nerves and the internal organs. In those cases a correct diagnosis is the most important demand, and we refer largely to what we have said in the discussion of neurasthenia.

When the hysteric symptoms have disappeared the treatment should not be given up at once. Those patients should not be considered cured, although it is better to let them believe this. We should carefully approach them, however, with the request that a generally invigorating care is advisable, not allow them to go back to the full amount of work too early and, if possible, send them to the country, or to the mountains for out-of-door exercise. This is preferable to indoor treatment in a hospital as it is beneficial to change the surroundings and bring the patients into contact with healthy people with whom they cannot and should not discuss their troubles. The less they find sympathy from other people the better for them. In the stage of rest any overtreatment is a very real danger.

CHOREA.

Systematic exercise has been highly recommended in chorea minor. According to Nebel's investigations it was first applied by E. Damon in England (1799). In acute cases, especially those going along with progressive physical weakness, general effleurage should be given for short sessions, once or twice a day. When the most alarming symptoms have been eliminated and the general condition has been somewhat improved, passive movements of the extremities

should be added; at first very slowly, in an even rhythm, with counting or perhaps with some form of simple musical accompaniment. These movements should be done over the whole body and not preferably with the chiefly affected parts. Gradually active impulses are added, beginning again with the simplest forms and making the patient relax after each movement. Later more complicated movements; combined movements of several extremities are made in the form of the coördination exercises as we have described for the treatment of ataxia. The pendulum and Zander apparatus have given very satisfactory results in the experience of Zander, Nebel, Determann, and others. The simultaneous use of iron and arsenic can hardly be missed in these cases.

OCCUPATIONAL NEUROSES.

The occupational neuroses such as writer's cramp, piano-player's cramp, and others, have long since been a profitable field for masseurs. The diagnosis of these cases is sometimes not quite easy. We have seen a number of patients who were sent to our department with this diagnosis "occupational neurosis" where careful examination revealed the presence of an arthritic process, a subdeltoid bursitis, etc. Furthermore, it must be considered that patients with true occupational neuroses are of a "neurotic" type and that the treatment of the "local" symptoms must be accompanied by the general care of their neurasthenic or hysteric habits. The treatment itself must be largely educative, wherein appropriate exercise plays a prominent but not at all the only part. The principles of rest and exercise, precaution, and functional training must be properly mixed. At this place we cannot go into details of such treatment and shall simply describe certain methods of exercise which have given good results in the hands of competent observers. We begin with simple movements: first passive, then active; flexion and extension of the wrist, the fingers, the elbow; pronation and supination, movements of the shoulder. These exercises are done at first with one arm, then with both combined, as symmetrical and alternating movements. The exercises should

be done in a strict rhythm, with fairly slow counting and to the full angle of physiological motion. Later combination movements are added. Finally, but not too early, light games and sports in the open air have their place.

Massage is of advantage particularly when considerable weakness and atrophy of the muscles exists; then manual massage, especially effleurage and kneading, are performed. Piano and violin players must suspend their playing for a certain length of time, and then begin with simple practising, avoiding at first any difficult pieces.

TRAUMATIC NEUROSES.

In recent years these cases have become more and more frequent in connection with accident insurance and compensation laws. The correct diagnosis in these cases and the differentiation as to how many of the complaints and symptoms are real and how many just neurotic or even simulated may be very difficult if not impossible. Experience shows that often the symptoms disappear as soon as permanent compensation has been granted. But certainly many of these cases belong to the neurasthenic types and should be treated accordingly. A strong and decided personal influence is here of greatest importance. The description of details may be omitted, as the treatment goes generally along the lines outlined for neurasthenia.

SPASMODIC TORTICOLLIS.

Many text-books do not even mention the value of massage and exercise in this very annoying condition, though it cannot be doubted that these methods rank among the first if they are applied with correct technic and for a sufficiently long time.

We agree with Courtney[1] who emphasizes that no immediate results should be expected and, furthermore, that a special effect consists in the possibility of combining psychical influences with mechanical manipulations, as we have

[1] Boston Medical and Surgical Journal, April 1, 1915, p. 483.

repeatedly pointed out for the treatment of neuroses. Unfortunately these patients who want to see quick results lose their patience easily, and hurry from one treatment to another. From an experience I have had several years ago I feel justified in warning against overtreating such cases. The patient, a man of about fifty-five years with a rather severe distressing wry-neck, was slightly benefited by massage and a Thomas collar. After two months I had to interrupt the treatment while on a European trip. During my absence the patient took a sea trip to Jamaica from which he returned slightly worse. Then he went to a sanitarium where all sorts of physical appliances were tried on him for four weeks with the result that on my return he was in the worst condition I have ever seen a patient with spasmodic torticollis. He was unable to stand straight, his whole trunk seemingly being involved in the spastic contracting motions. The patient then consulted an osteopath who promised to cure him within three weeks. As the conditions had become even a little worse under the osteopathic treatment he consented to an operation, which, followed by persistent psychical treatment under the direction of a very competent neurologist gave him considerable relief.

We employ very gentle stroking and kneading over the muscles of the neck and slow, gentle, active and passive movements. We do these manipulations in lying or in any other position which allows the best possible control. Only when a certain improvement is obtained may the exercise become somewhat stronger. Supports may be of value, but sometimes the patients cannot wear any mechanical appliances on account of the inconvenience caused by them.

In the treatment of psychoses and mental disorders physical therapeutics are frequently applied. They cannot be expected to cure these affections, but when properly applied will aid in maintaining the best possible physical conditions, upon which the possibility of a psychical cure or improvement rests to a considerable extent.

CHAPTER XXIII.

AFFECTIONS OF THE CIRCULATORY ORGANS.

Exercise and massage have found frequent application in the therapy of circulatory diseases, but their value has not yet been fully recognized by the majority of clinicians and practitioners. This is undoubtedly due not only to a certain difficulty in the application of the proper technic, but also to an insufficient understanding of the physio-pathological effects of these methods. Moreover, extravagant claims on the part of certain medical gymnasts and exaggerations due to lack of judgment have aided in producing a certain distrust of exercise and massage. It is much simpler and easier to prescribe rest and digitalis and leave functional recovery to nature and the patient's good will. But if we want to give our patients the best care, to have them recover in the speediest way from a broken compensation, and if we want to protect them against further attacks, we shall find medical gymnastic treatment a most valuable adjunct to the other generally recognized and used methods. The great principles of all therapy at least where functional disturbance in the widest sense is concerned, are rest and exercise, both in proper combination and neither alone to the exclusion of the other.

Affections of the circulatory organs frequently cause functional disturbances of the heart and vessels as well as other organs. When such a condition has set in, rest is generally indicated at first. Under rest and digitalis a state of correct balance will result, provided the organs in question are not too much affected. But from the state of proper balance in rest to the recovery of the function for the occupations of daily life is still a wide step, and guidance is necessary to avoid recurrence of decompensation

and weakness. This is one indication for a rational exercise treatment.

There is another, however, namely, the indication of rest. This may seem a paradox, but it is not when we remember the various effects which exercise and massage have on the circulatory organs, effects which have been described in detail in Chapters V and IX. With proper technic presupposed, we see as a factor common to the various manipulations of exercise and massage, alleviation of the function and elimination of resistances. The massaging hand pushes the venous blood along its way and sucks it from behind; the contracting muscle does the same. The deepened respiration alleviates the afflux of the venous blood and acts somewhat like massage on the circulation in the lungs and the subphrenic organs. Moreover, the effect of certain massage manipulations on the strained nervous apparatus regulating the circulatory organs is of a relieving and quieting character, adding to the mechanical effects. Thus from a simply theoretical point of view we come to an understanding of the clinical results which have been so frequently reported, and we comprehend the paradox that exercise acts as a factor for rest.

The ability of the circulatory mechanism depends on a number of factors, among which the following two are of special interest for these deductions: one is the strength of the heart and the other is represented by the sum total of peripheral resistances. Under normal conditions these factors act intimately together. When one of them is greatly altered, the other must necessarily be influenced. Each one is able to furnish compensation to a considerable extent, this being shown in the heart by hypertrophy and dilatation.

The peculiar action of digitalis consists in a stimulation of the heart itself. The same effect has frequently been ascribed to exercise, but as Hasebroek[1] states, this is probably not correct; or better, the chief beneficial effect which rational medico-gymnastic treatment may exert upon a

[1] Die Zandersche Mechanische Heilgymnastik und ihre Anwendung bei inneren Krankheiten, Wiesbaden, 1907.

circulatory disturbance does not consist in a stimulation of the heart itself, but the prime effect of this method is to attack the peripheral resistances and act upon them in an alleviating and relieving way.

Hasebroek believes that for the explanation of these effects the assumption of a decrease in speed of the blood stream is necessary, and bases his theoretical deductions on these premises. He thinks that the velocity of the blood stream can be preserved by an increase of the central propulsion as well as by the peripheral aspiration, and believes that the importance of the latter factor has not been sufficiently recognized. Proceeding from the assumption of a decrease of the velocity Hasebroek claims to see a vicious circle in the following: by the decrease of the speed of the blood the viscosity and resistance increase through the increase of carbonic acid. Transudation into the perivascular tissue results, making greater demands on the small veins and increasing resistance. Moreover, the increase of the peripheral resistance leads to a further decrease of the output of the heart, which in time diminishes the velocity of its beat. Briefly this vicious circle is as follows: decrease of the speed, increase of the peripheral resistance, decrease of the output, decrease of the speed, etc.

Hasebroek now considers the indication for exercise treatment in the attempt to break this vicious circle on the point of the velocity of the blood stream. "An improvement in this direction acts at first purely symptomatically inasmuch as the immediate disorders which are caused by the accumulation of carbonic acid and the reduction of oxygen will be relieved and eliminated." Thus the subjective comfort so often seen during and after treatment may be explained. Moreover, the acceleration of the reduced velocity of the blood stream will help to reduce the peripheral resistances, and thus to increase the output of the heart.

But this hypothesis of Hasebroek's is not generally accepted. Krehl[1] states expressly that the regulating mechanism of the bloodvessels is usually well able to take

[1] v. Mehring's Lehrbuch der Inneren Medizin, p. 305.

care of the altered conditions of the output of the heart, enabling the blood stream to maintain a normal or almost normal velocity. That, however, under severe conditions a considerable stasis may take place cannot be doubted, as is easily proved by the edema and other signs.

But also when we rely on the authority of Krehl, we see no reason to doubt the ability of certain active and passive movements as well as that of most massage manipulations to act in the manner described, namely, reducing the peripheral resistances. It will depend then on the condition of the centre and the periphery of the vascular system how much these physical methods can offer.

When the heart is greatly damaged its response to the alleviating effect of exercise and massage on the peripheral vessels will be only slight; when the heart is in a fair condition, but when the peripheral circulation shows a low tonus, that effect may be very considerable; when both centre and periphery are greatly affected no effect can reasonably be expected. This is just what we see in practice. The greatest improvement by exercise and massage is seen in those cases where the peripheral resistances are distinctly increased as in persons suffering from obesity with a markedly lowered vascular tonus, provided the heart does not show marked signs of fatty degeneration. These are the cases for which Oertel's cure was originally devised and where a systematic use of exercise can do wonders.

But also in cases of heart failure considerable results may be obtained, provided the heart muscle is still capable of compensation. If, however, the heart has reached its limit of compensation, if it is markedly degenerated and if, besides, the conditions of the vessels are such that they do not freely respond to the effects of exercise and massage these methods will fail and are contraindicated. To what extent the one or the other condition exists may be difficult to determine in the given case. Generally we may say that anemic persons respond rather poorly to such treatment, whereas patients with a fair state of general resistibility, and especially obese patients, are excellent subjects to medico-gymnastic treatment.

Special Indications.—From the foregoing deductions it is evident that we cannot generally recommend massage and exercise for affections of the circulatory system, but that we must make special indications and contraindications for the various affections.

Valvular Disease.—The indications to treatment in valvular disease are according to Litten and Bennhoff:[1] preservation of the compensation of the heart; repair of broken compensation; in cases with permanent weakness of the heart to accomplish the best possible ability; treatment of certain individual symptoms. The treatment must try to accomplish: decrease of existing resistances; elimination of new resistances; adaptation of the work of the individual to the ability of the heart; preservation of the powers of the heart muscle by conserving it, and its increase by exercise; stimulation of the mental qualities. This shows that both prophylactic and therapeutic measures are intimately connected, and can hardly be separated in practice. Hasebroek and others who have had a chance to follow many such cases during extended periods have frequently observed that the patients feel better and show a greater ability of the heart as long as they continue a certain amount of regular exercise, whether it be in a Zander institute or elsewhere, and that with cessation of such prophylactic measures noticeable disturbances occur which are again quickly relieved as soon as exercise is taken up again. In lesions of the mitral valves, the afflux of the venous blood and the pulmonary circulation need special consideration, and can be benefited by careful thoracic and respiratory gymnastics as well as by exercises which favor the venous circulation.

With a broken compensation any exercise treatment is at first contraindicated, and rest and digitalis with proper hygienic and dietetic measures are prescribed. As soon as compensation is sufficiently restored in rest, and even at a time when the patient is not yet allowed to leave the bed, we can safely begin with careful exercises: Fairly deep breathing, ten to thirty times at regular intervals, several times a

[1] Handbuch der Physikalischen Therapie, ii, 2.

day may be connected with slow passive movements of one or both arms; flexion and extension of the elbow; raising and lowering of the arms and legs, etc. When by such exercises the pulse rate is not increased, or when the pulse is even somewhat slowed, the passive motions may gradually be replaced by active resistive exercise, treating at first the arms, then the legs. This procedure is at the same time an excellent indicator which shows when the patient is able to leave the bed. We do the exercise at first with the patient lying on the back, later in sitting, and when the patient is able to walk we can prescribe a more elaborate system of exercise which may then be carried out at home, or better, under careful supervision in a Zander department or a similar place. From our experience we cannot recommend sending to a Zander department a patient with incomplete compensation from valvular disease, as we have sometimes found that the exertion caused by going to and from the treatment takes away the best part of the result accomplished by the treatment itself. We do not hesitate to ascribe some of the unfavorable results which were seen in our hospital to an insufficient arrangement rather than to the treatment itself. The best part of the treatment in such cases is given at the bedside of the patient. A careful use of general massage of the arms and legs, abdominal massage, especially when constipation exists, and, if turning in bed can be done with sufficient ease, massage of the back may be added to those exercises. But since, as we have seen, massage may easily overstimulate the vasomotor system, it should not be done except by a well-trained masseur, with great care as to the strength applied, for a very limited time, as a rule not more than ten minutes, and with frequent observation of the pulse.

The "Weak Heart."—The physical treatment of the "weak heart" or the muscular insufficiency of the heart is hardly anywhere discussed with a better knowledge of the subject and at the same time a better understanding and appreciation of the method than by Lazarus,[1] whose advice

[1] Handbuch der Physikalischen Therapie, ii, 2.

we shall largely adopt in the following. The points in which we especially sympathize with Lazarus' description are his wise judgment and his common sense. The value of certain methods such as Oertel's or Schott's which require trained assistants or special institutions is recognized, but as they are not within the reach of many, the spirit of these methods is of greater value than the form, *i. e.*, the author has always attempted to make what is good in these methods accessible to all his patients.

The first indication for patients with a weakened heart is rest and care, with a full understanding of their individual needs. Rational exercise treatment should begin with careful observation of pulse, blood-pressure and respiration before the patient is able to leave the bed. In this stage massage is of great value on account of its well-known effect upon the circulation: accelerating the venous and lymphatic stream, widening the arterioles, etc. Furthermore, abdominal massage and certain movements which have the tendency to contract and expand the abdominal cavity in a certain rhythm are of great value. These exercises, which are similar to those described on p. 108, as well as massage must be done with great care and full understanding and frequent observation of the heart. Indeed, we should expect the treatment to be carried out by the physician himself or under his direct supervision.

As soon as the patient is able to leave the bed a part of the exercises can be done by himself. At first he is to walk a certain distance in a certain time. Also simple free exercises may be done. After a while walking upstairs may be tried, again with careful observation of the effect. How much of the exercise should be left to the patient depends a great deal on his intelligence and faithfulness in carrying out the instructions of the physician. Generally the danger that the patient tries to accomplish too much is greater than the opposite. Therefore the prescriptions have to be made very accurately.

The coöperation of an expert masseur or gymnast is of great value for doing passive, passive-active and resistive exercises. But the person entrusted with the care of such

patients must be entirely reliable, and must realize that it is of far greater importance to understand the condition of the patient and his heart, than merely to apply a certain technic of movements and manipulations.

The use of Zander apparatus is of value after a certain strength has been attained. As we have said above, all these methods have no specific value in the treatment of a weak heart. Therefore to have a patient who should stay in bed get up to take Zander treatment is very unwise. But when strength has returned so far that going to the Zander room does not materially upset the patient, further training by the apparatus may be of great value, provided the treatment is carefully supervised. We have the pulse frequently counted before, after, and during the movements, and regulate rest and exercise in such a way that the rate of pulse is not increased, but if it was at all higher than normal in the beginning, it should show a reasonable decrease.

With further improvement home gymnastics, such as free exercises or the use of simple improvised apparatus, are desirable. Light sports may also be of value provided the patient is intelligent enough to make proper use of them. This is all the more important when exaggerations in sports and games have caused or hastened the break-down of the patient.

A few words need to be said about the so-called Schott or "Nauheim" treatment and the "Oertel cure." The brothers Schott in Nauheim developed to a great extent and described a combination of CO_2 baths with exercise, although other physicians of Nauheim and other bath resorts have before and with the Schotts studied and applied a similar treatment for cardiac cases. The essential of the Nauheim treatment is, besides the CO_2 bath, the resistive exercise which is developed into a rather complicated system, difficult to prescribe by the physician and to carry out by the patient. The resistance is given by the patient's own opposing muscles, with or without the assistance or instruction of a trained gymnast. Undoubtedly this exercise requires a great deal of intelligence, energy and patience, and as Lazarus points out, frequently causes a state of excitement on the part of the patient, which

may easily upset the beneficial effect obtained from the exercise. We do not believe that this form of resistive exercise has any specific value and feel that an equal effect can be easily obtained by simpler and safer methods.

Oertel's method has been developed from personal experience. The "patient" whose history is cited in detail in his book, is said to be the author himself. He suffered from "weak heart" due to general obesity and fatty infiltration of the heart, and cured himself by rational and systematic mountain climbing. No doubt that in such cases which would fall under that type where the centre is in fair condition but the peripheral resistances are very great, a systematic muscle training can accomplish a great deal. A mistake has been made by Oertel's followers, however, in irrationally applying his method in many cases where the central organ was in a poor condition. Oertel's mountain climbing has been discussed on page 56, the interrupted expiration on page 39.

PERICARDITIS.

In diseases of the pericardium which have led to adhesions gymnastic treatment is indicated after the acute symptoms and especially fever have entirely subsided (Lazarus).[1] Asymmetrical breathing combined with movements of the arms, in a similar way as in pleuritis, are prescribed; at first passive, later active and with resistance. Pain during the exercise is not a strict contraindication, provided the temperature remains normal. After a certain improvement general exercises of the whole body are given under careful supervision. Gentle vibration over the heart and gentle stroking of the intercostal spaces may further aid the loosening and resorption of pericardial adhesions.

ARTERIOSCLEROSIS.

The prophylactic use of rational exercise is of great value in cases showing disposition to arteriosclerotic changes. The physiological effect of exercise as well as massage upon the

[1] Handbuch der Physikalichen Therapie, ii, 2.

bloodvessels makes these methods particularly suitable for a systematic training of the arteries. The patient who realizes the danger of arteriosclerosis will learn to make rational exercise a daily habit. It matters little in what form such exercise is given, provided exaggerations are carefully avoided. Unfortunately we see these patients, as a rule, only when considerable changes have taken place. How much can then be expected from physical treatment depends on the alterations of the arteries. But even here carefully prescribed and supervised exercises will often show very good results wherein the mental effect is not the least important.

VARICOSE VEINS. PHLEBITIS.

Here also the value of physical therapeutics is far greater for the prevention of progress if disposition to varicose veins exists, than when considerable changes have already developed. The disposition to varicose veins is greatly favored by long-continued standing without sufficient active movements of the leg. We advise such patients, therefore, to avoid standing still on both legs, but to put temporarily the one or the other foot on a low stool or the like, and contract the muscles of the legs frequently. Tiptoe exercises, occasional flexion of knees and hips and similar movements have a good effect and should become a kind of a habit. This seems more rational than a course of gymnastic treatment for a limited time without proper care afterward. Massage is of doubtful value compared with exercise, and should be done only with great care.

When the affection is at all advanced, when blood has clotted in the enlarged veins and especially when inflammatory changes have taken place, rest and protective measures are necessary, while massage and exercises are contraindicated. The latter may be taken up with great care after all acute symptoms have entirely subsided.

With a certain hesitation we want to mention a few cases of chronic phlebitis which we have successfully treated with baking, massage and light resistive movements. We say "with hesitation" because we realize the great responsibility

in taking up such treatment. This should be done only by the physician himself, provided he is thoroughly familiar with the technic of these methods.

EDEMA.

In cases of edema due to local affections, injuries, infections, thrombosis, elephantiasis, etc., massage is generally effective, not only by its mechanical influence, but still more by the direct stimulating effect upon the lymphatic vessels, which will thus be trained to better activity. In cases of thrombosis greatest care must be taken not to loosen the thrombus. Hence the operator must carefully avoid the affected veins.

CHAPTER XXIV.

AFFECTIONS OF THE RESPIRATORY ORGANS.

We have omitted in this work a consideration of the affections of the upper air passages because we consider this the field of the nose and throat specialist. We shall merely say that various affections of the nose and throat have been made the subject of vibratory massage treatment by Kellgreen, Lanker, Gerst, and others, with good results. Massage is used either externally on the larynx, the trachea, the nerves such as the supratrochlear, the nasal, and the laryngeal nerves, etc., or internally as vibration with a probe or some specially constructed apparatus. This vibration can be done manually or by electrical apparatus. It may be mentioned also in this connection that in the treatment of stammering rational exercises of the respiration with and without general exercises play a very important part.

The indications for massage and exercise in affections of the lungs, bronchi, and pleuræ are naturally very limited, and these physical methods are largely overshadowed by others, especially hydrotherapy, balneotherapy and climatotherapy, and the most modern branch of physical therapeutics: heliotherapy. There are, however, certain affections which may be treated with benefit by systematic exercise aided by massage.

Among the affections of the bronchi, only those forms of chronic bronchitis should be mentioned which we find in lungs which are poorly ventilated and have an insufficient blood supply. We find such chronic catarrhs most often in children but sometimes in adults with stooped shoulders, flattened, depressed thorax and a generally poor posture. The treatment should consist in careful postural training with

instructions for proper aëration of all parts of the lungs. By this is chiefly intended a rational training of the respiratory muscles which are usually of a low tonus, and this is frequently obtained if the treatment is carried on for a sufficiently long time. In cases with a marked bronchial catarrh rhythmical compression and expansion of the thorax may be combined with arm exercises in a similar way as in emphysema. The stimulation of the circulation not only of the lungs, but also of the abdominal organs and the rest of the body should not be neglected and may be greatly favored by proper exercises. Massage is not especially indicated, but such procedures as tapotement and vibration of the thorax may benefit the usually rather sluggish circulation of the lungs. All such treatments should not be left to the patient alone, but should be carefully supervised. When available, the use of Zander apparatus is of great value in all these cases.

Tuberculosis of the lungs contraindicates exercise treatment, but many authors recommend systematic postural and respiratory exercises as a prophylactic measure in the so-called pretubercular young adults with a flat, depressed chest and stooped shoulders. A long-continued, carefully supervised treatment in the open air would seem to us very rational, though we hesitate to accept Rosenthal's advice of such treatment when signs of incipient tuberculosis are present.

In exudative pleuritis most authors consider exercise treatment useless if not contraindicated. Polito has seen good results—decrease of the dulness, increased diuresis, measurable increase of the respiratory capacity, etc.—by the use of an apparatus which keeps the healthy side of the thorax at rest and forces the affected side to hyperfunction. The results were obtained by about fifteen treatments of twenty to ninety minutes' duration each. During the treatment a temporary decrease of the blood-pressure and increase of the pulse rate were noticed. Such treatment is not without danger during the acute stages; when, however, the acute symptoms have subsided and the exudate has disappeared rational respiratory gymnastics are indicated.

Fraenkel[1] advises beginning this treatment two weeks after the patient has left the bed. At first the patient inhales deeply and exhales forcibly, six to twelve times every hour or two. Later, movements of the body and arms are added as follows:

1. Standing or sitting, the patient with a left-sided pleuritis bends the body to the right side, raises the left arm over the head and takes a deep inspiration. In exhaling, the body is straightened and the arm lowered, whereby the left hand may give a slight pressure upon the left side of the chest.

2. The patient stands in front of a Swedish ladder or some improvised similar apparatus. The left hand reaches up as high as possible and suspends the body somewhat while the right hand reaches down to give support. The body is slightly bent to the right side. In this position two or three deep inspirations and expirations are done; then the patient takes a normal position, rests a short time and repeats the exercise three or four times.

3. With the hands placed on his neck, the patient assumes a good posture. Then while inhaling he bends the trunk slightly backward and twists to the left; while exhaling he returns to the normal position. These and similar exercises may properly be done with a trained masseur who gives assistance and resistance.

All these exercises should be done with great care and under constant supervision of pulse, respiration, and temperature. Experience has shown that by careless handling and forced manipulations, tearing of the adhesions and the lung tissue followed by pulmonary hemorrhage or even pneumothorax may easily take place.

Just as in adhesive pleuritis, systematic exercise is indicated in cases of empyema. This affection sometimes causes a severe lateral curvature by the scar-contracture of the pleura and more or less the whole wall of the thorax, and it would seem rational, at least in those cases where such complication threatens to occur, to begin with

[1] Handbuch der Physikalischen Therapie, ii, 1, 448.

systematic exercise treatment as early as the general and local conditions of the patient will allow. This may be done even before the discharging sinus is entirely closed, as we have found in our own experience.

The following case may serve as an example:

A young man, aged eighteen years, who had been operated upon for empyema of the left pleura six weeks before, was sent for treatment to the Zander department. The wound was still discharging, so that daily dressing was necessary. His general condition was poor and his heart was very weak, the pulse rate increasing from 100 to 120 by the least effort. On the left side the respiratory excursion was absent, while the right side made an excursion of one and three-quarter inches. The patient was prescribed very slight and slow active and passive breathing exercises which were connected with vibration and tapotement of the back and side and with asymmetrical resistance movements of the trunk and arms. In twelve days the wound was closed, the pulse dropped to 88 and became more stable, the excursion of the left side was one-quarter of an inch. In another week it had increased to one-half inch and three weeks later to one inch. The patient became stronger and of better color and gained in weight.

EMPHYSEMA.

As in all other conditions which are characterized by a loss of the normal elasticity of the tissue, almost any form of treatment is useless when the pathological process has advanced too far. Thus in emphysema, exercise and massage are of far greater value as prophylactic than as actual therapeutic measures. The exercise indications are: (1) The training of expiration; (2) the improvement of inspiration because, as Egger[1] says, proper exhaling cannot be done without correct inhaling; (3) the stimulation of the circulation, especially that of lungs and abdomen; (4) regular action of the bowels; and (5) last but not least, the mental uplifting.

[1] Handbuch der Physikalischen Therapie, ii, 1, 401.

Egger divides the exercises which are useful for the treatment of emphysema into five groups.

1. Enforced breathing exercises; both the costal and abdominal types are practised.

2. Manual movements assisting the respiration: compression of the thorax in exhaling.

3. Movements of the trunk, arms and legs, especially those which favor expiration: Flexion of the spine, flexion of the hips and knees, adduction and drawing down of the arms and shoulders.

4. Strengthening of the expiratory muscles by resistance given by temporary closing of the glottis.

5. Intermissions of the respiration to modify the circulation within the thoracic and abdominal cavities. When the costal breathing is interrupted the pulmonary veins are emptied; with an intermission of the abdominal respiration the same effect takes place within the veins of the abdomen and pelvis.

In the following a number of exercises are described which have been found to be of great value. It is advisable to give exact prescriptions, taking three or four groups of exercises, two or three movements for each group, with an intermission of five minutes between the groups, in a way similar to that frequently used for the Zander apparatus.[1]

1. Costal breathing: During expiration a strong pressure is applied with both hands upon the sternum or the lower ribs or the lateral parts of the thorax.

2. Abdominal breathing: During expiration pressure is applied over the anterior or lateral parts of the abdomen.

3. The exercises No. 1 and 2 may be done in standing or sitting position and may be combined with bending forward or sideward, or with a twist to either side.

4. Standing: The hands are clasped over the lower back with the elbows somewhat flexed. During expiration the elbows are extended, the hands pushed downward and a strong pressure is applied over the sides of the thorax; during inspiration the elbows are flexed and the hands placed in the first position.

[1] Hughes: Text-book of Respiratory Gymnastics.

5. Sitting: This exercise is possible only if the hips and knees are sufficiently flexible. During inspiration the patient raises the arms over his head; during expiration he lowers the arms, raises one knee, grasps it with his hands and presses it against his chest, applying a strong pressure. The exercise is done with both legs alternately or both knees may be taken at the same time.

6. During inspiration the horizontally elevated arms are moved backward; during expiration the arms are moved forward and somewhat lowered until the hands are clasped, while a strong pressure is applied by the upper arms upon the thorax.

7. Sitting: The knees are separated and the hands placed on either knee; during expiration the arms move the knees toward each other against a resistance given by the abductor muscles of the hips. A strong pressure is applied by the upper arms and elbows upon the thorax. During inspiration knees and arms return to the first position. This exercise will be still more effective when the feet are placed upon a low stool.

8. Lying on the back with the arms extended over the head: During expiration the arms are lowered and the head is raised; with advanced strength the body is raised to a sitting position. Chest or abdominal pressure should be applied alternately.

9. Same position: During expiration the knees are raised and drawn toward the chest with the hands.

10. These and similar exercises may be also practised with temporary closure of the glottis during expiration.

In most of these exercises resistance may be applied by a masseur if necessary, and doubtless all these exercises are of greater value if done with proper help of a trained assistant.

In cases of emphysema with accompanying catarrh, vibration and tapotement of the thorax are advisable. It will depend on the amount of actual pathological change how much we can benefit those patients, but we believe in cases which are not too far advanced and in patients who are not too old a marked improvement can be obtained by rational exercise and massage of long duration, and particularly when the patient learns to make proper expiration his habit.

A number of types of apparatus have been constructed by Rohrbach, Strümpell, Langerhans,[1] and others, which have the object of educating the patient to proper respiration. As Langerhans says, these patients generally breathe quickly and superficially. When we succeed in making them breathe slowly and quietly we have already accomplished a good deal.

BRONCHIAL ASTHMA.

A similar treatment as for emphysema is advised also for bronchial asthma, except that here, as Egger emphasizes, the expiration is not to be forced to the same extent, but both inspiration and expiration are regulated and trained, except in those advanced cases where an actual emphysematous alteration has taken place, indicating special attention to the expiratory movement. It may be mentioned in this connection that some observers, such as Kuhn,[2] consider training in forced and long inspiration more important in bronchial asthma than that of expiration. Seydel[3] believes that patients with asthma who have been in the habit of breathing very lightly can be improved or even cured by correct respiratory training, and emphasizes that they must learn to make a habit of proper breathing. For this reason he recommends voice culture besides medical treatment. The consideration of the psychical moment is here perhaps still more important, especially when we have to do with nervous patients.

[1] Cited in Handbuch, ii, 1, 408.

[2] Physikalische Behandlung des Asthma Bronchiale, 27th Congress innere Med., 1910, Archiv f. Orthopædie, ix, 65.

[3] Atemübung bei Asthma, Die Stimme V, vol. ix.

CHAPTER XXV.

ABDOMINAL AFFECTIONS.

In a limited number of abdominal affections exercise and massage, both considered in their broadest sense, are widely recognized as very valuable remedies, but more harm can be done by an untimely and incorrect use of these physical methods on the abdomen than on almost any other part of the body. Therefore before such treatment is prescribed an exact diagnosis must be made. We cannot follow the lead of some authors[1] who consider even a fresh appendicitis an appropriate subject of massage. On the contrary we fully agree with Boas and many others in making strict contra-indications in all cases of inflammatory conditions, even when there is only a suspicion. Furthermore, all cases of ulcerations, malignant disease and obstructions should be absolutely excluded. It may also be remarked that in anemic and cachectic persons abdominal massage and exercise should rather be omitted or, when found advisable, it should be done with great delicacy.

The most suitable affections are chronic habitual constipation, visceroptosis with atony, certain cases of adhesions, hyperemic conditions of the liver and intestines, and certain nervous affections.

CHRONIC CONSTIPATION.

Nothnagel[2] divides the cases of constipation into three classes:

1. Those which are caused by influences of a rather physiological nature: Improper diet and insufficient exercise, including the action of the diaphragm.

[1] Abst. in Archiv f. Orthopaedie, etc., vii, 75.

[2] Die Erkrankungen des Darms und des Peritoneums, Vienna, 1895.

2. Constipation caused by certain pathological conditions such as diseases of the stomach, intestines, heart, lungs and liver, peritonitis, acute febrile disease, and certain diseases of the central nervous system.

3. Genuine habitual constipation.

The last class is divided into the following subdivisions:

(*a*) Abnormal nervous regulation of the peristalsis of colon and rectum, whether it be congenital or acquired, including bad habits of defecation.

(*b*) Intestinal atony.

(*c*) Adhesions and fixation.

(*d*) Changes of the position of the intestines: Congenital and acquired (visceroptosis).

In all three main classses the etiological factors are first to be considered. Therefore in most cases of the second class mechanical treatment would be contraindicated, while on the contrary, in many cases of the first and third classes exercise and massage serve the etiological indications very well and represent valuable therapeutic agents. We have in mind especially those cases where the constipation is caused and sustained by a sedentary mode of life combined with a certain luxurious living, habitual neglect of the regular function of the bowels, atony of the muscles, both of the abdominal wall and the intestines, insufficient action of the diaphragm, and visceroptosis.

Exercise and massage supplement each other in a very proper way. Both stimulate the so often very languid circulation and strengthen the abdominal muscles as well as those of the intestines, thus favoring the peristalsis. Furthermore, by massage a direct mechanical impulse is given to the movement of the fecal masses in the colon and rectum, and a stimulus may be applied to the nervous apparatus regulating the function of the bowels. Exercise also fulfills the general indication in cases of an habitual sedentary mode of life and in cases with flat respiration as well as insufficient action of the diaphragm.

In Chapter VIII we have described the technic of abdominal massage. It will now depend on the individual case as to which of the methods are most useful and which should be

omitted. In a fat abdomen, vigorous, deep kneading will be necessary in order to reach the intestines, while in slender individuals with relaxed abdominal walls, gentle effleurage and friction serve perfectly well.

Many authors prefer vibration, done with an electric vibrator, to the manual methods; while others with whom we agree do not believe that the careful individualizing manual treatment can be replaced by mechanical apparatus. The physician applying massage by his own hand will be able to study his case constantly; thus, as Bum emphasizes, manual massage may serve as a valuable means of corroborating the diagnosis. It will depend on the individual case whether the physician must carry out such treatment himself or whether he may entrust it to his masseur or to the patient himself. The last way will be sufficient in many cases where not even a suspicion of any contraindication exists. It would, however, not be advisable in cases with abdominal adhesions, enteroptosis, or wherever the diagnosis is not absolutely sure.

When the treatment can be left to the patient himself, this has the great advantage that it can be carried out at the time most suitable, that is early in the morning before leaving the bed. Every patient with an average intelligence may learn to apply gentle grasping, kneading and frictioning manipulations, which are better done by the hands of the patient than by an iron ball or similar instruments advised for such a purpose. Of special value is the combination of deep abdominal and diaphragmatic respiratory exercises with deep kneading. This may be done in the following way: The patient lies flat on his back, with the knees somewhat flexed and supported by a pillow. He presses both hands against the abdomen and takes a deep abdominal inspiration, resisting somewhat with his hands. Then when he exhales and his abdominal walls fall back, completely relaxed, he makes a few deep kneading manipulations. We admit that this can be done much more thoroughly by a trained masseur, but we feel that a great many patients would be deprived of a valuable form of treatment if this were made to depend on the presence of a competent expert.

After massaging his abdomen for five to ten minutes the patient is to rise and do some simple free exercises: Arm raising, trunk bending, leg raising, etc., all done slowly with deep breathing for about five to ten minutes. If there is time the patient may rest in bed for half an hour and then take his bath and dress. Many of these patients are accustomed to laxatives. These cannot be omitted at once, but should soon be reduced. Such drugs as infusion of senna, licorice powder or rhubarb are preferable to drastic salines, though the habits of the patient and individual indications must be considered. Many physicians advise injection of the bowels with cool water, or oil, or both in combination, to be done at intervals of a few days. Furthermore, the diet and the whole mode of life should be carefully regulated. Unless this is done by the physician and exactly followed by the patient, the stimulating influence of the massage cannot be expected to produce any lasting effect. It is here that exercise in the widest sense of the word comes into play. Home gymnastics, walking, best on hilly ground, swimming, bicycle or horseback riding, dancing, fencing, playing golf and many other forms of sports and exercise may be chosen according to the age, habits and social circumstances of the patient. When it is possible a regular course of treatment for two or three months daily or on alternating days, in a Zander institution may serve very well. Here also massage as well as instruction in self-massage and home gymnastics may be given. We do not think very much of the various Zander machines which have been especially constructed for abdominal massage, but attribute most of the benefit derived by Zander treatment to the appropriate use of the active resistive apparatus. Zander, Nebel, Hasebroek, Herz, and others claim excellent results derived from the application of the strong vibratory and shaking apparatus applied over the lumbar spine and explain this effect by a direct stimulation of the nerve centres situated in the lower spinal cord. This may be true, though we would rather not rely on a single mechanical application, but should employ the whole treatment, both dietetic and physical, with energy and persistence if we wish to accomplish lasting results.

It is very necessary to convince the patient that it is, after all, not such a treatment which cures or prevents relapses, but that he must change all his habits of life permanently; that he must himself learn to control and regulate these habits and that, in doing so, he will not only free himself of a very annoying and distressing affection, but will eventually become stronger, healthier, and more efficient.

As always the prognosis depends to a great extent on the duration of the affection, though the experience of Bum and others seems to indicate that even in much neglected cases a great deal can be accomplished by appropriate treatment. In fact Bum[1] claims good results in 98 per cent. of his cases, and explains the lack of cure in the remaining 2 per cent. by complications such as tabes, lead poisoning, morphinism, etc. Treatment for two months, at most for three months, was sufficient in all cases.

There is no doubt that such a treatment can be carried out much more efficiently under the constant supervision of the physician, as, for instance, in a sanitarium or a hospital; the conditions of an out-patient clinic are naturally much less favorable. As most of our own cases have been sent from the out-patient clinic we can by no means claim such good results as Bum's, but even so our experience has been large enough to convince us that an appropriate, strictly individualizing use of exercise and massage is most valuable if not necessary, in many cases of chronic constipation, and may give lasting benefit if followed by an intelligent change of habits and by a proper regulation of the whole mode of life, as has been pointed out repeatedly. In this sense the treatment has, besides its direct immediate effects, an extremely valuable educational influence, as we have already stated in connection with other affections in previous chapters.

A few words should be added about cases with abdominal adhesions and visceroptosis. In any affection eventually leading to adhesions treatment will be most efficient when it is begun before the newly formed fibrous structures have

[1] Massage und Heilgymnastik, p. 180.

become too firm and strong, and it depends largely on the nature of the affection how early this can be done. To decide when the best time for mechanical treatment has arrived is often quite difficult, and this is especially so for the abdomen on account of its peculiar anatomical and pathological conditions.

Mitchell's opinion, based on a considerable experience is expressed in the following sentences: "In all instances where massage is to be used for the resorption of adhesions it must be remembered that the best effects will be had from the application of the treatment after the inflammatory process has entirely subsided, but before the new tissue has taken on a completely fibrous or cicatricial character. If manipulation be not applied until a later period than this, a much longer duration of treatment will be needed to gain the same results."[1]

If we accept at all these statements which, at least from a theoretical point of view, contain much truth, we should demand that in all such cases the physician shall carry out the treatment himself personally, because the responsibility placed on the masseur would be too great.

A very careful technic is needed in cases with abdominal adhesions; all manipulations must be made with great gentleness, yet at the same time deep and strong enough to be efficient. The deep finger friction seems to us to warrant the best results, the fingers being guided by scars and infiltrations, by bismuth *x*-rays and the subjective sensations of the patient. Any lasting pain represents a strict contraindication against continuing massage, while, at least in the beginning of the treatment, pain and tenderness would not absolutely exclude friction.

In certain cases, especially those of a rather nervous temperament, any touching or palpation of the abdomen causes disagreeable sensations and irritative muscle spasm. In some of these cases the combination of deep abdominal breathing and kneading during expiration has proved to be of great value, as it was possible only then to obtain sufficient

[1] John K. Mitchell, Mechanotherapy, p. 61.

relaxation of the abdominal muscles. In cases of persistent irritability of the abdominal rectus muscles Mitchell[1] advises to have the patient seated and leaning forward astride a narrow chair with a high back, "the arms crossed on the top of the chair-back, and the head leaned forward upon them. The position makes contraction of the recti difficult, and although, owing to the narrowing of the accessible abdominal area brought about by the lowered rib margins, massage of the abdomen cannot be so thoroughly done, vibration and general up-and-down shaking of the abdominal contents may be readily accomplished by an operator kneeling behind the patient."

VISCEROPTOSIS.

Exercise and massage of the abdominal muscles represent an important part of the whole treatment in many cases of constipation, but it becomes of still greater importance in cases with pronounced relaxation and atony of the abdominal wall and ptosis of the viscera. The connection of the insufficient action of the abdominal muscles with constipation is explained without difficulty, as shown by Bum. Normally developed abdominal muscles with a good tonus contract an infinite number of times during the day in any average person. Every change of position of the body, rising from bed or chair, walking, running, climbing stairs, etc., causes contractions of the muscles whose mechanical effect cannot be underestimated. This effect is greatly reduced if not entirely eliminated in patients with relaxed and atonic abdominal muscles, hence a factor of great physiological importance is more or less absent in such persons and we must try to restore it. The first thing to do in such cases is the application of a proper support by a belt or brace, but an actual cure cannot, in our opinion be expected unless the muscles are retrained and proper tonus restored by exercise. Special prescriptions of such exercises do not seem necessary at this place, since proper selections may be found in the chapters on Free and Resistive Exercise, as well as in the chapter on Posture.

[1] Mechanotherapy, p. 61.

Zander apparatus are of value, but not necessary. The construction of a simple home gymnasium is advisable, as it will allow more exact prescription and furnishes some variety. Sports, games, and out-of-door exercises will become of great value after a definite muscular control has been obtained.

In certain forms of *chronic diarrhea* abdominal massage has been recommended by Mitchell, Jacksch, and others. We feel that this should be done only with very careful selection of cases and with the most careful technic. In mucous colitis Jacksch advises massage for the intermissions between the painful attacks, but not during them.

Affections of the stomach give indications for massage much less frequently; moreover, its effect is much more doubtful in gastric than in intestinal affections. In cases of visceroptosis a treatment of the stomach without regard to the intestines or *vice versa* would not be rational. The advice of enthusiastic supporters of abdominal massage such as emptying the stomach in cases of stenosis of the pylorus or in gastrectasis will hardly find general recognition.

LIVER AND BILE.

Chronic hyperemia of the liver can be much improved by massage, rather by that of the whole abdomen than by local massage of the liver, which seems quite evident when we consider how difficult it is to reach the liver directly from beneath the ribs, and how little can be expected by any form of massage through the thoracic wall. Of much greater importance would seem the so-called automassage of Moebius[1] consisting of deep breathing. This has also been recommended for insufficient secretion and flow of the bile. The value of deep respiration in such cases has been proved by experiments of Strauss[2] on animals and on a man with a fistula of the gall ducts following an operation for echinococcus. By exact measurements it was found that the pressure in the gall ducts was raised by changing from a lying to a sitting position and still more considerably by forced

[1] Münchener medizinische Wchnschr., 1899.
[2] Handbuch, ii, 2, 379.

deep inspiration and coughing. It was also constantly found that the flow of bile increased with deep respiration.

That massage has any value in ascites due to cirrhosis of the liver, for which condition it has been recommended by Reibmayr, is doubted by Strauss,[1] and will probably not be generally accepted.

Neurotic affections of the stomach and intestines have been discussed in the chapter on Neuroses.

[1] Handbuch, ii. 2, 397.

CHAPTER XXVI.

CONSTITUTIONAL DISEASES. CONVALESCENCE AND DEBILITY.

The beneficial effect of physical therapy, especially exercise, in many of the so-called constitutional diseases has been known since the earliest times. Galen and Celsus prescribed exercise for obesity, and the advices of Sydenham[1] in the treatment of gout may still be called modern. Increased knowledge of these affections has placed exercise—and to a certain degree massage—on a more rational basis, and has still further illuminated their extraordinary value.

OBESITY.

In obesity the physical therapeutics represent "the most rational indications, because they stimulate the metabolism and increase the excretions" of the organism (Weintraud[2]). Under normal conditions a complete balance of the metabolism exists; when the intake continually surpasses the output the fat deposits will increase and pathological obesity may result. The aim of the treatment must be to decrease the intake and to increase the output. The former indication is fulfilled by regulation of the diet, the latter by physical therapy. Undoubtedly the regulation of the diet will be sufficient in many cases, especially in those where abundant consumption of food is the underlying cause of obesity. But in a very large percentage this is not the sole and often not even the chief causative factor. Investigations of Jacket and Svenson[3] have shown that the oxidation is actually reduced

[1] Fr. van der Velden: Sydenham's Behandlung der Gicht; Therapie der Gegenwart, December, 1908.

[2] Handbuch, ii, 1, 242.

[3] Cited in Handbuch, ii, 1, 245.

in obese persons. This has probably much to do with the well-known laziness of such persons. The muscles which represent the chief localization of oxidation, show a more or less decreased activity. If these theoretical deductions are correct, a rational training of the muscles will evidently represent the most appropriate treatment in addition to regulation of the diet. As we have seen in the chapter on Physiology, exercise stimulates the circulation, favors the assimilation of proteids and increases the metabolic processes. Persons with occupations that require constant bodily work from morning until evening will rarely become obese in spite of a diet which contains a surplus of fat-producing food.

Although by many exact experiments the effect of certain exercises upon the metabolism is well known, and it would seem easy to make proper prescriptions as to the amount and character of movements, we meet in practice with many difficulties. Obese persons, as a rule, are not often inclined to undergo bodily exertions, and are frequently unable to muster that amount of force and energy necessary for the desired effect on the metabolism. Many of them will suffer from profuse perspiration which hinders them still more in their efforts. But of greatest importance is the condition of the heart, which is so often involved in the general obesity. Therefore we must base our prescriptions, not on theoretical deliberations, but strictly on the ability of the individual patient. This must be kept in mind above all else; by rational prescription the amount of work should be increased as it seems wise, and by appropriate use of psychical stimulation the patient should be inspired to increased activity.

The simplest exercise within everybody's reach is walking. As, however, the consumption of energy in this motion is not very much increased compared with rest, it will not have much effect unless it is done for several hours daily. Of much greater value is walking on hilly ground or actual mountain climbing. Oertel recommends this exercise not only to obese persons with well-preserved muscle power, but also to anemic and hydremic fat persons. Great care is necessary in prescribing such treatment. The physician

should know the locality and give exact prescriptions as to the length of the walk. A correct combination of breathing with the steps is important. In the beginning one or two steps should be taken during each phase of respiration while walking up hill; with increased practice even three steps may be taken without exhaustion. Whenever dyspnea and palpitation exist the expiration two or three times interrupted will often facilitate climbing. The effect of this form of expiration is regarded by Oertel as a direct mechanical influence on the heart—as heart massage. In cases with pronounced disturbance of the circulation the patient should begin with a few steps, about ten to fifteen, then rest without sitting, and repeat a number of times, before he is allowed to sit down.

In all such cases, however, exercises which allow careful supervision and control are much superior to those which are left to the judgment of the patient. Whenever we have the opportunity to send our patient to a special institution of mechanotherapy or have him work with the assistance of a trained gymnast we should do so because we then have a good chance of controlling the effect, of measuring the amount of exercise, and of giving careful graduation from the lightest amount which just exerts a certain influence on the sluggish circulation up to an amount of exercise requiring the coöperation of the whole musculature. Later, when the patient has made a certain progress in strength and endurance and when we know exactly the effect of motion on the action of his heart, we can gradually add out-of-door exercise, such as walking, climbing, etc.; or advise him to take gymnastic exercises in his own home. This will be necessary because the relatively short periods during which a patient can have mechanotherapy or manual treatment by a trained gymnast, will not be sufficient to obtain the result desired. For this it will be necessary that a considerable part of the day be devoted to exercise, the form and amount of which depend largely on the age, sex, habits and social condition of the patient. It is therefore not necessary to discuss in detail all kinds of exercise and sports, which may be chosen: Bicycling, if the patient has already learned it, rowing,

swimming, golf, tennis and other games may serve well, provided overexertion can be avoided with certainty. As it is of great importance that the exercise is done for a long time—we may better say should become a habit—we should try to give our patients the chance of doing exercises which produce some visible effect. Good as home exercise or mechanotherapy are, after a certain length of time, they are somewhat tiring. The patient likes a change and likes to see a definite result from his work. Here cultivating a small garden is an excellent substitute, for it requires all sorts of helpful movements—hoeing, digging, stooping, lifting, mowing, etc. Moreover, the work is done out of doors, and the flowers and crop will compensate for the amount of work done. In the winter time let your patient order his wood in big blocks and saw it himself instead of buying it already cut; let him shovel the snow in front of his door instead of hiring a man to do it for him. Carpentry work which many people can do in their cellars offers an excellent exercise, and acts in an inspiring manner by producing definite results.

It does not seem necessary to give any detailed prescription for resistive exercise or home gymnastics, because these will depend so much on the age, sex, and general condition of the patient and because there is no exercise which has a specific value. From personal experience we should warn against a number of irritating exercises which are found in gymnastic prescriptions, because of the danger to the joints of the spine and pelvis. Many elderly obese patients have a more or less developed hypertrophic arthritis, which causes, as we have seen, a definite susceptibility to strain and inflammation, a factor that should be well considered in choosing the exercises. The masseur or gymnast who gives the treatment to an obese person should be well instructed as to the condition of the heart, in order to avoid overexertion.

In considering these points the trained gymnast will find without difficulty a sufficient number of exercises, therefore we have omitted any special suggestions and will add only a few for the use of the patient himself.

The effect of massage on the reduction of fat is likewise over- as well as underestimated. Massage enthusiasts de-

clare that it is one of the most natural things in the world to pinch and squeeze the fat cells, smash them to pieces and thus drive their contents into the general circulation, just as we do with a hematoma or certain inflammatory products. We have stated in the chapter on Physiology of Massage that from a competent scientific view-point strong objections have been raised against such statements, and we would merely add that in our opinion the effect of mechanical stimulation on pathological products should not be compared with that on physiological tissues.

Still the idea that direct mechanical removal of fat by massage is possible is so common and is so much commended in text-books that we feel obliged to mention this method, although somewhat skeptical as to its explanation. Most masseurs connect such local massage with exercises such as extreme flexion of the hips and knees, forward flexion of the body, etc., which are also said to act in the same manner as the local massage. It cannot be denied, however, that the general dynamic effect of like movements explains the eventual result just as well if not better. Furthermore, it should not be forgotten that such local massage, at least as far as the abdomen is concerned, if done with such vigor as would be necessary to smash the fat cells, represents a very respectable abdominal massage with all its well-known beneficial effects. We are therefore not at all averse to the local massage, but will say that the frequently claimed explanation of its results would seem to admit of a certain objection.

The comparative effect of local and general massage has often been discussed and a very considerable dynamic effect has been claimed for the latter. Experiments of Leber and Stueve,[1] however, seem to indicate that such claims are at least somewhat exaggerated. These authors found that by kneading and effleurage of large fleshy masses the gas exchange was raised not more than about 10 to 15 per cent.; that corresponds to the simple, active, rhythmical contraction of the flexors and extensors of the fingers, an exercise which

[1] Cited in Handbuch, ii, 1, 278.

hardly anybody would consider as particularly appropriate for losing fat. We do not doubt that in regard to the fat-reducing effect exercise holds a far more prominent place among our methods and we cannot suppress a certain suspicion that many of such extravagant claims in favor of massage have been made *pro domo*.

Massage, however, both general and local, may be of great value in obesity in very weak, bed-ridden patients; with individuals to whom any form of exercise represents an enormous overexertion, or patients who suffer from neuralgia, arthritis and similar complications which enforce rest. In those cases a well-measured massage of the muscles and abdomen can often do a great deal to stimulate the languid circulation, while massage of the joints and nerves may relieve soreness and make gentle movements possible. In this way a start can be made to renew activity in the metabolism and establish confidence in the depressed mind of the patient.

DIABETES.

As obese people form a considerable percentage of those suffering from diabetes, rational treatment of obesity represents, in a way, a kind of prophylaxis against diabetes. Thus systematic exercise may have its field, though in the individual case its value in this respect can hardly be ascertained. But its importance in cases of diabetes has generally been recognized by Külz, v. Mehring, and others. Bouchaudat observed that agricultural laborers suffering from diabetes were free from sugar during the time of hard labor in spring and autumn, in spite of a diet containing a considerable amount of starches, whereas during the period of rest in winter a strict diet was necessary to reduce the amount of sugar excreted with the urine. Similar observations are reported by Trousseau on patients who spend several months on hunting excursions. Külz, experimenting on a series of patients, some of whom were treated with exercise and others without, came to the conclusion that exercise *can* be of great value in the treatment of diabetes in addition to dietetic treatment, but he emphasizes strict individualization and

points out that in certain cases exercise may not show any effect, or may even do harm. The question of overexertion is here just as important as in obesity, and perhaps more so as cases have been reported where coma occurred after exertion. Therefore, especially in cachetic individuals with weak hearts, prescriptions should be given with the greatest care. Weintraud advises rest treatment with frequent examinations of the urine. When the glycosuria is at all increased, exercise should be postponed and another test made after some time, or a minor amount of exercise should be tried.

The tendency of muscular action in diabetes is to burn the sugar within the muscles. The interesting question whether it is of greater value for the patient to have the sugar disposed of by the active muscles than to have it excreted by the urine is answered by Zimmer in favor of the exercise, because it produces warmth, strengthens the muscles, stimulates the metabolism, and improves the general condition. Furthermore, it relieves the polyuria and eliminates many complications such as skin affections, neuralgia, etc., by reducing the hyperglycemia.

The general management of exercise in diabetes is practically identical with that in obesity. Of the many forms of indoor and outdoor exercise at our disposal which ones are to be chosen will depend largely on the age, sex, social conditions, surroundings, and general health of the patient. There is no exercise of any specific value; what we strive for is a sufficient muscular activity accommodated to the individual needs of the patient. Wherever a supervision of the treatment is necessary the daily or at least frequent use of a Zander institution is very serviceable, as we know from our own experience. Nebel reports cases of diabetes of long standing which were treated with excellent results at his Zander room. Allen's advice of vigorous exercise has been mentioned on page 58.

Massage is of far less importance than exercise, although excellent results have been reported with it by Finkler and others, but as Weintraud rightly says, the same results may be obtained and in a much simpler and surer way by diet alone.

The value of massage in diabetes is somewhat similar to its application in obesity. It is very useful in feeble anemic persons, and in elderly individuals especially when exercise is prohibited or can be used in very small doses only. Under such conditions we begin the treatment with general massage of a part or the whole of the body, and add resistive movements in gradually increasing doses according to the reaction on the general health and the glycosuria of the patient. Massage of the abdomen will be very serviceable whenever indicated by constipation, circulatory disturbances of the abdominal organs, or minor digestive troubles. Peripheral circulatory disorders so frequent in diabetes may be greatly relieved by local massage, though this will hardly be efficient when gangrene has set in. We have recently had a case, however, where a sloughing ulceration of one toe healed promptly under baking and massage treatment.

GOUT.

Gout, the third of the three closely related constitutional diseases, was the subject of physical therapy in very early times, although we must remember that the difficulties in making a correct diagnosis were then still greater than they are now and many cases have been called gout without any foundation.

In considering the use of physical therapy in gout, we may divide the whole problem into three parts: (1) The prophylaxis and treatment of the gouty diathesis; (2) the acute attack; (3) the chronic changes of the joints.

1. Gout is essentially a metabolic disorder, and anything that improves the metabolism and favors the excretion by skin and kidneys will be beneficial. The uric acid deposits are found at first in tissues which are naturally poorly nourished; we find them in the cartilage which contains no bloodvessels and in the peripheral joints such as the first metatarsophalangeal joints. Thus anything that stimulates the circulation might be of value in prophylaxis. Of all physical therapeutics which would come under consideration, exercise is that which is most natural, within everybody's

reach and allows enough variation to be used for a long time, or, we may better say, used habitually. Again, as in the other constitutional diseases, diabetes and obesity, the selection of that kind of exercise which is most suitable for the individual case depends largely on the discretion of the physician. All sorts of sports and games would come under consideration and are generally preferable to manual gymnastics, Zander, etc.

2. During the acute attack rest is required and massage and exercise are contraindicated.

3. Both these methods become of value again after the acute attack is over, and tophi have formed and the joints have become more or less stiff. Massage may help in reducing the tophi and favor their absorption. The mobilization of joints stiffened by gout would hardly differ from the treatment of stiff joints otherwise and manual gymnastics in the various forms of resistive, assistive and passive exercise, pendulum and Zander apparatus, may all be of value. It is of greatest importance here, as elsewhere, to begin the treatment at the right moment before many lasting changes have taken place. In gout especially, the general indication of prophylactic treatment should well be considered because of the progressive character of gout; that here as in diabetes and obesity a rational management of the diet stands in the first place cannot be doubted, but a rational use of exercise to become a daily habit should be well considered.

ANEMIA.

In several places of this work mention is made of the frequent experience that under otherwise similar conditions anemic patients react much more easily to stimulations such as applied by exercise and massage. It is therefore only logical to exclude at least exercise from the list of physical therapeutics in cases of anemia and chlorosis. Rest, careful diet, fresh air and sunshine, iron, and arsenic must bring about the recovery of the patient; then a careful use of hydrotherapy and exercise will be very appropriate for

further invigoration and better stability of health, though we should warn against any exaggeration in sports and gymnastics.

THYROID GOITRE.

The complex of nervous symptoms which are so well known in the clinical picture of thyroid goitre has been much subjected to physical therapy, among which electro- and hydrotherapy will probably hold the first place.

CONVALESCENCE AND DEBILITY.

The recovery of patients who have suffered from long-continued diseases, such as typhoid and others, may be markedly hastened by the use of general massage and later exercise. Massage may be applied with great advantage even before the patients are able to leave the bed, and it may be combined with passive and active movements in a way similar to that described for cardiac affections (page 388). The use of Zander apparatus under careful supervision and in slowly increasing doses has been found of great value in many of our cases. The same may be said about cases with so-called general debility. Here, as in many other affections considered in this book, we would emphasize that a definite clinical diagnosis be made, and if possible that everything be eliminated which might act as a causative factor.

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