



**OSTEOPATHIC TECHNIC**  
**BY**  
**EARNEST ECKFORD TUCKER**  
1917

OSTEOPATHIC TECHNIC

# Osteopathic Technic

BY

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# OSTEOPATHIC TECHNIC

## PREFACE

### Principles of Osteopathy

A brief summary of the principles of Osteopathy so far as they relate to the matter to be discussed in this book is a fitting introduction to it.

Osteopathy rests on a very sure foundation. Its philosophy rests on axioms; its practice on facts; its profession and its history on success.

The axioms on which its philosophy is founded are:

I. Everything composed of mechanical parts is subject to disorder among those parts.

From this axiom there is no appeal. There is no exception to it. The solar system is not an exception, the eye of the beetle is not an exception, and the human body is not an exception.

A corollary of this axiom is that the greater the number of parts, the more frequent should be disorder or lesion among them; and there are a great many different parts to the human body.

II. If anything depends on the order, then that thing will be deranged by the disorder.

In the human body, function and health depend on the order; and disease arises from the disorder.

There is no appeal from this axiom, for the laws of mechanics are fundamental wherever they apply.

These are the two fundamental axioms on which the science is based. But let us go further with the matter. The human body is in all respects subject to the

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Operation of law. This is certainly axiomatic. Where law does not operate logic is impossible. If there be any parts not within the scope of law, then on those parts may we experiment. If all parts are subject to law, then the only experimenting that is justified is the experimenting to discover those laws; and this experimenting should be performed on animals, not on human beings. The only specific remedies that are possible are the specific laws that are violated.

But if all parts of the human body are subject to the operation of law, then it follows as an axiom that the only possible cure for disease is the removal of causes; for to make any other attempt is to try to suspend the operation of law.

Now there are only three possible kinds of causes of disease as there are only three possible causes for bad functioning in anything. They are causes that relate to the mechanism, those that relate to the operation of it, and those that relate to the source of it.

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In the human body, they are mechanical or structural disorder; functional strain or exhaustion; and hereditary weakness. Every incidental cause of disease must come under one of these heads. (It is possible to define them all as one — as structural, reckoning intracellular disorders as structural, though microscopic; but we preserve the distinction for convenience.)

Of these three, heredity is not a cause of disease, but of only the weakness that allows disease. Functional strain is sometimes fundamental as a cause, sometimes secondary. If the strain exceeds the total strength given by normal heredity, then is it a fundamental cause of disease; if, however, it exceeds merely the amount of strength left by mechanical lesion, then is it merely secondary.

Mechanical lesion, however, is always a fundamental and a primary cause of disease.

The final principle that it is necessary for us to consider here is that structural disorder may be a cause of any disease. The structural disorder is not itself directly a cause of disease, except the inflammation and repair process in its own involved parts. But it is always a source of irritation and strain to the co-ordinating functions of the body. The general co-ordinating functions of the body by their very nature reach and affect every function in it. Mechanical lesions affect naturally more strongly those functions whose nerves are situated nearest and in closest association with them; but every mechanical disorder affects the whole co-ordinating mechanism, and so may be a factor in the disease of every organ and every function in the body.

That is to say, any disease may be traced to mechanical lesions as whole or as part cause. Since this is absolutely fundamental, it should be the first thing considered in each case of every disease.

Since nature cannot invent functions to exist as disease, disease must therefore consist of normal functions disorganized, and of natural reaction to irritation and injury.

These are the axioms and major premises on which the science of Osteopathy is founded.

The practice of osteopathy is no less strongly built upon facts. A thousand men may be mistaken as to a question of opinion, of interpretation of facts, but as to the existence of those facts ten men or even three men cannot possibly be mistaken. There have been 10,000 men who bore testimony to the osteopathic facts.

These facts are discovered in each individual case, and treatment is applied to them as found. Each case contains its own evidence, and correction is directed to that evidence, not to any general formula of description, which may or may not apply in the individual case.

The profession itself grew up on a basis of success. Things do not belong wrong; when found wrong they were corrected — no other reason or excuse was necessary. But this was followed by cure. From the very first inadvertent experiment made by Dr. Still, the policy of correcting disorders was followed by good results, and was pursued only and solely for that reason. Other men seeing the good results that followed this policy

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insisted on being trained in it. From this beginning the school arose, and the profession was organized. There is no appeal from success. Things that succeed prove themselves true in relation with every law known and unknown that applies to them.

The success of osteopathy is not absolute. It does not claim to be the final revelation in the matter of healing. It believes itself to be absolutely fundamental, however, a necessary basis for whatever else of good may be found in the healing art; and to be unshakable in principle and in logic. Without vanity for itself or antagonism for others, but in a spirit of impersonal estimate, it sees itself as a real science of healing — i. e., the first; for surgery abandons the question of cure, and removes — saves, but does not cure; medicine counteracts, stimulates and sustains, and cares for; but neither these nor any other science except osteopathy alone bases its practice solely on the principle of removing fundamental causes.

Mathematics is an absolute science, in theory. In the application thereof to individual problems it is no stronger than the technic of the person so applying it.

The same thing is true of Osteopathy. The practical reality of the science is in its technic.

That every physician's technic is "different," is his own individual development, is well known. The only true contribution to the subject therefore is along the lines of conception of lesions, and the principles of technic, though much may be hoped for from merely comparison of the technical development of others. Details of technic are here given to illustrate the principles that are set forth. There is no thought, as there is no possibility, of exhaustive or complete presentation of such a subject.

Neither description nor illustration can convey a proper concept of any individual technic. The sooner we abandon that effort the better. Individual instruction, with supervision and correction to insure the carrying out of the individual's conception of his technic is the only practical method, certainly is the ideal method.

Description, however is necessary to lead to a scientific development of the subject, a discussion of dangerous and faulty methods and a definition of principles of technic.

In applying these principles to individual cases, that is, in cultivating his individual technic, the physician must consider the feelings of the patient. That technic is best which makes the most successful compromise between pleasing the patient and promptly correcting the lesions. The latter only is our problem here, and our purpose is to develop as clear a mental picture of the mechanics and the principle of technic as possible.

The matter of adjusting this to the susceptibilities of patients is the personal problem of the operator.

For a better understanding of the nature of lesions and the mechanics of reduction, some understanding of anatomy from the osteopathic point of view is desirable. In the rest of this preface a summary of the important points that are brought out here and there in the text is brought together. This subject might be called rational anatomy as distinguished from descriptive anatomy.

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Bones bear always pressure. Bone will form automatically from pressure, and adapts itself automatically to the pressure that bears upon it. The shape of every minutest bone in the body therefore is an expression of the forces of pressure acting on it.

For illustration, the sacrum, composed of the five vertebrae included between the iliae, has become solidified into one bone and greatly enlarged from the pressure exerted by those iliae. It is curved because as the body bends the great erector spinae muscle draws at different angles. The tension of this great muscle is opposed by the great sciatic ligament and other ligaments and is transformed by them into pressure against the sacrum in line with its axis.

The rounded skull sustains pressure from muscles, the occipito-frontalis and the temporal muscles, but chiefly it sustains atmospheric pressure; as in fact do all bones.

(In some birds, where there is great and rapid change in this pressure as the bird rises and descends in flight, the bones are hollow and communicate with the air.)

All muscles are so attached as to bring pressure on the bones they move. Muscle is attached in reality to periosteum, which encircles the bone, so as to bring pressure on its opposite side.

All joints therefore bear pressure. Nature does not endure tension on joints. Muscles are relayed across joints, criss-crossed as it were, bringing always pressure to bear on them.

This pressure is always perpendicular to the face of the joint. For if it were not the joint would simply slide to the limit of its motion in the direction of the diagonal pressure, and stay there.

An expression of this simple law is seen in the fact that joints on the same bone are always at right angles to each other. The shoulder faces inward, the elbow faces forward. But it is very conspicuously evident in the vertebrae and ribs, where the joints are close together. The reason is very easily seen. Given any one joint, motion is transmitted, which means that pressure is transmitted, parallel to the face of the joint.

All vertical pressure is taken up by the opposing face, and the parallel pressure or motion is transmitted. A second joint therefore will have its face perpendicular to the first; and a third joint will be perpendicular to both of the other two, like the corner of a box. If there is a fourth joint, it is a cartilaginous joint, like the cartilages of the ribs or the intervertebral discs; and is parallel to the line of intersection of the planes of two of the other joints.

In the vertebrae, the facets for the ribs are at right angles to each other and to the surfaces of the articular processes; reckoning the latter as one joint; while the fourth joint, that of the bodies with each other, is a cartilaginous one, parallel to the intersection of the articular facets.

The fact that pressure in articulations is always vertical to their surface explains the ease with which lesion may be produced and maintained. The joint, arranged for vertical pressure, is easily strained beyond the normal range of its motion by abnormal diagonal pressure. When a lesion has been produced the pressure still remains

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vertical except only for ligamentous tension; if it were otherwise, then would the diagonal pressure aid very greatly in reducing the lesion. The only diagonal pressure in lesions is due to the very slight angle that the ligament assumes in the abnormal position.

The perpendicular arrangement of joint surfaces to each other makes it possible to utilize one as a fulcrum by which to release another when that other is in lesion.

Ligament always bears tension. This tension is necessarily in the line of the fibres of the ligament; if not the ligament would turn until it was in direct line with the tension, like a piece of string. Ligament is always under slight tension in all positions of the joint, to prevent separation of articular surfaces. Therefore it is radially disposed to the motion of the bone it retains (the distal bone). Its proximal attachment is thus at the centre or axis of the motion of the joint, and it may spread out fan-wise over portions of the distal bone. But wherever there is considerable motion in the joint, its proximal attachment is brought to a focus at the axis of motion. (Note also that the attachment of muscles, where there is considerable motion in the bone they move, is brought to a focus and is tendinous.) For instance, the ligaments of the spinous processes do not run vertically from one to the other, but converge toward the articular processes, radially to the vertical motion of each spinous process.

Where ligament is stretched as the vertebra moves normally, it is of the yellow elastic variety; as in the ligamentum nuchae and the posterior longitudinal ligament of the spine.

This radial arrangement of ligaments makes it possible to exceed the normal range of motion with slight stretching of the fibres of the ligament; it helps to maintain the lesion when an angular position has been assumed in lesion; and it gives rise to the popping sound when such lesion is corrected.

A ligament which is radial to one motion of a vertebra acts as a restraining force in motion of another character, and thus acts also to change the direction of the motion — to produce "secondary" motions. This fact assumes some importance in the following study of motions and lesions.

The bone and muscle arrangements of the body are all levers, of great variety and of wonderful symmetry and sequence. Of these the joints are the fulcra; the part between the joint and the attachment of muscle is the power arm, the rest is the work arm; the muscle supplies the power. Where ligament acts as a restraining force it becomes part of the fulcrum, producing a double fulcrum with shifting of the axis of motion.

These leverages must be used to get control of parts in lesion.

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## CHAPTER I

### Training in Technic

The science of osteopathy is the most exacting technical study in the world. The practical side of osteopathy is its technic. The spirit in which it should be approached is that of technical framing.

Good exponents of the science state that it requires not less than a year to be at all confident in the matter of diagnosis alone, except in the more obvious disorders; that is, it takes a year to make a good beginning in diagnosis, the first step in osteopathy. To develop a matured and efficient technic is a matter of years or a decade.

Without adequate diagnosis, much can be done for a patient by stretching, passive motion and stimulation, the so-called general treatment, but this is not osteopathy. With adequate diagnosis, some means can usually be found, even if slow and uncertain, to affect a restoration. But this is not true osteopathy.

True osteopathy consists of adequate diagnosis and adequate technic. Adequate diagnosis consists of thorough and practiced knowledge of the structures of the parts of the body, a trained perception of touch and muscle sense and other senses used in physical examination, and a trained imagination. Adequate technic consists of thorough and trained knowledge of the movements, tensions of ligaments and muscle, limitations to motion, changes of motion, leverages, etc., of the parts of the body; a trained muscle sense and a well cultivated mechanical instinct. This is the requisite for a foundation. To it must be added the mechanics of lesions, the principles of technic and some training in actual forms of technic that illustrate these principles. The student should be made acquainted with some of the different forms of technic developed by different operators, if possible.

This is not a thing to be acquired in a term or from a book. All of the time spent in the school is not too much to devote to the subject. It requires also personally supervised and criticized individual instruction.

This may seem severe and exacting. I venture to say, however, that the majority of experienced practitioners in the field will say that not less but rather more than this should be required.

### Why Exacting

There are three reasons why the science of osteopathic technic is so exacting if it is to be at all efficient.

The first is that it deals with structures covered by skin and muscle and often fat. Among these structures it is necessary to locate disorders, and having located to define them in all possible ways; and having located and defined to devise some logical technic of correction, using such few and narrow holds thereon as nature affords. The second reason is simply that the health, happiness and life itself of human beings depends on the skill that can be exercised in that narrow field. Our sole immediate contact with disease, the one thing that makes the rest of the knowledge

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that we have acquired effective at all, is this one thing — technical skill. The third reason is that the sense of touch and the muscle sense are but feebly developed in human beings.

### Still's Technic

Dr. Still in training himself for the work of his life used to carry the bones in his pocket, where his hand could feel them, forming thus a sense-of-touch picture of them. Hour by hour he experimented with them until he had formed a moving picture of them in his mind. He also spent months and years in dissecting the bodies of the Indians, preserved in salt. The amount of time and concentration that he put into making mental pictures of the anatomy of the living body may be surmised from the fact that when he was seventy-five years old he still "camped in the liver" for a week or a month, and daily explored, as a re- search worker would explore, recesses in the human anatomy. Perhaps forty years was thus spent before he came before the world with his discoveries.

A very large part of the training that he gave to his immediate pupils, in the early days of the science, was in the practical subject of technic.

### History

Much of the technical training of Still survives in the profession, spreading hand-to-mouth as it were. The profession, however, and the schools have made no special effort to preserve it. They have not always kept clearly in view the exacting nature of the training necessary for true corrective work. They have been exceedingly busy the last decade in absorbing, digesting, adapting to osteopathic philosophy the accumulated medical learning (all, that is, except experimental medicine) and in meeting pre-existing standards in every way. This was perhaps a necessary phase of the evolution of the science and the profession. Technic, however, has remained an art, an individual and an empirical matter. There has been neither a model in the medical world nor a great leader among ourselves.

The phrases that have been our rallying calls, such as "Find it, fix it, and leave it alone," and "Ten-fingered osteopathy," have been rallying calls for the purity of osteopathy, rather than for the development of technic. And yet osteopathic technic is the only medium between our scientific knowledge and the diseases it should benefit.

### New Rallying Call

A new rallying call is needed for the profession — "No osteopathic physician is any better than his technic."

The profession as a whole is no better than the standards that it sets in this, the practical side of its work.

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As the twig is bent the tree will incline; so the proportion of time spent on this subject in the schools will determine largely the amount of attention it will be given by practitioners.

### Popular Conception

There is another excellent reason for putting stress on technical training. That concerns itself with the parasitic imitators of osteopathy.

First note that the philosophy of the matter is extremely simple. Moreover those simple rallying calls of our past have emphasized the simplicity of pure osteopathy, and rightly, no doubt. Note then that much can be done by perfectly obvious methods, and perhaps every case can be helped to some degree by measures dangerously simple and obvious. The field is broad for the most superficial methods, so long as they simply stimulate or "get motion"; and many there be that wander therein. Lastly note that the exacting nature of the technical requirements for true osteopathic work are by no means obvious to patients or to general public ; who wonder, therefore, whether it is worth the fees charged for it. Add all these together and let them get planted in the public mind, and we have the reason for the easy success and popular acceptance of the shallow imitator, and a condition leading rapidly to the sinking of genuine osteopathy. Says Dr. Fleck : "The corrective principle is so potent that anybody practicing it on even a hit-or-miss basis is sure to get some sort of results and so can get away with it." Our proper answer to the illegitimate practitioner and the fakir is to lay increasing emphasis on the technical training requirement for doctors of osteopathy, in schools and in publicity, until it has become generally understood.

### Ideals

The ideal training in technic would be one that began with the first day in school and continued till the last. Knowledge of anatomy is presupposed before study of technic can begin; but it should be put to immediate use, the very day it is acquired, in relation with the sense of touch, the sense of measurement, the muscle sense, and in forming a living and moving picture of all the parts of the body. In this way the real object of the study is in view from the first. The study of anatomy for osteopathic students also should begin with the part where osteopathic thinking begins — with the spine.

The student mind will take on the average just what is given it and no more — usually a little less — and in just the form in which it is given, and this it will try to utilize in therapeutics in the most obvious sort of way. There is little initiative in the average of human beings, and in any case it is unfair to demand it and rely upon it. It is therefore an ideal of technic that the parts of anatomy as they are studied should be immediately referred to the living body where alone the knowledge is useful; they should be outlined on the surface and practice in so outlining them should be given. Practice should include locating them by the sense of touch with the eyes blindfold. The sense of measurement should be cultivated by measurements first with tape line, followed by examination with the fingers to verify the tape line examination. This should be done in erect and flexed position.

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The senses of touch and measurement being a\* a rule so weakly developed in human beings, it should be the constant endeavor to educate them to a state of osteopathic proficiency. Psychology tells us that some persons are eye-minded, some ear-minded, some touch- minded — the latter vastly in the minority. This sense then suffers an actual handicap in a curriculum that consists so largely of reading, of pictures and of lectures.

Being so weak in civilized beings, this sense is subject to bizarre variations. Dr. White tells how he discovered by accident that things felt larger to his right hand than to his left. I have noted variations almost extreme between different osteopathic physicians in their interpretation of certain conditions. In justice to the student these anomalies should all be discovered and normalized or discounted. Training that would develop would also normalize.

So numerous are the elements that go into a perfect technic that they should be taken up one at a time and woven gradually into the composite sense of technic.

Those who leave the osteopathic schools bearing the credentials of the profession, take its reputation in their hands. It is the right of those who have labored to build that reputation to insist that those into whose hands they put it shall be sufficiently well trained in the distinctive osteopathic subjects to be able to uphold and advance the cause of distinctive osteopathy.

### First Principles

The first principle of Osteopathic technic is not to hurt the patient. That this is at all times difficult and sometimes impossible will be admitted, since quite some force must at times be used, since the structures are held together by high tension, since in them for their protection nature has placed nerves that are quite sensitive to any threatening force; since also they are at times quite sensitive from the abnormal state they are in. But this too must be evident, that it is at all times impossible without such a technical knowledge to use only the minimum force and to use it without awkwardness to the actual mechanical factors in the case, and that without this knowledge there is sure to be a very great amount of unnecessary pain and a great exaggeration of the really necessary pain.

For this reason, experience in being treated is also a necessity in the preparation for osteopathic work, in order that the practitioner may be able to see from the patient's point of view. I find that I am always more gentle with my patients after I have been myself recently treated. But familiarity breeds contempt. Not ourselves feeling the pain, and the patient feeling that it is "up to" him to endure what he believes to be necessary, we all allow our methods to grow more and more rough, intent only on the effort at correction and not on the feelings of the patient.

And the second principle of osteopathic technic is not to hurt the patient. For in order to cure it is necessary to hold the patient. For every case that is lost to the profession through failure to cure there are many lost through roughness in handling, through pain caused by the treatment. A great many practitioners in order not to hurt ignore the correction of lesions, or largely ignore it, and resort to simple stimulation.

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They at least hold the patients longer, only to lose them eventually through failure to cure, or through too great cost of the treatment. Some also follow the "general treatment" method through failure or ability to make diagnosis of mechanical disorders. It is safe to say that but for these two failures the profession would by this time have been immeasurably farther along the road to general acceptance. Both are failures in technic.

The third principle of osteopathic technic also is not to hurt the patient. The success of technic depends on the relaxation of the patient, and this becomes impossible if fear or motor reflexes are excited by pain. It was Dr. Harry Still who used to remark facetiously that if the patient could relax sufficiently he could move any bone any distance. When God punishes us for our sins, it is not His punishments, but our resistance that hurts. So is it in the corrective work. With a proper technic the only pain that the patient need suffer in the majority of cases is such as comes from his own resistance. To secure that relaxation is the first art of the practitioner. If there be contractures, then must these of course be relaxed. But the voluntary contractions are always to be obviated. The success of a proper technic is in direct ratio to success in this.

First there are the mechanical instincts of the body which oppose force with force. To offset this, the practitioner must endeavor to secure relaxation by gentleness, must win confidence with evidence of care — conspicuous carefulness, impressive caution; within the limits of positive and convincing work. With an assured technic this is not difficult. It is the bungler who excites the patient's resistance. But often some definite training of the patient's muscles in the art of relaxing is necessary.

And the fourth principle of osteopathic technic is the same — not to hurt the patient, not to increase his nervous excitement by fear. There is such a thing as disease-fear, the fear of the subconscious mind when a state of disease exists in the body. Although sometimes this very fear enables the patient to yield to and endure things that it would be impossible to yield to in a state of self-confident health, yet also it may act to magnify the ill results of ungentleness on the part of the operator. The nervous system is always in a state of excitement in disease. The shock of correction may at times be unfavorable.

The nerve strain from a continuing lesion is always greater than the shock of correction, provided correction is actually obtained. It is better to correct with shock if necessary than to allow the lesion to remain. But there is no excuse for making any more shock than is absolutely necessary at any time.

It is usually desirable to make the first treatment as light as possible, an educative sort of a treatment.

To the patient visiting a new doctor and trying a new form of treatment, this will seem heavy in any case. It seems wise to explain to the patient that there is likely to be some soreness or stiffness from the first manipulation of the deep tissues of his body, and to explain why — just as there is likely to be stiffness from the first day's skating or any unaccustomed form of exercise. Following treatments may be made heavier at need,

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and little soreness from the treatment itself is to be looked for after the second or third treatment.

Nor is it wise, except in the case of strong constitutions, to attempt to correct every lesion at one sitting.

The shock of correction is to be reckoned with. The value of the treatment is diminished if the patient leaves the office exhausted. Most practitioners require the patient to lie down for five to fifteen minutes after a treatment.

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## CHAPTER II

### Soft Tissue Technique

Lesion in the Osteopathic sense is the original or responsible cause of disease. Unless otherwise specified, it refers to bony or mechanical disorder or strain.

It is rarely that disease arises from one cause only.

Nor is it possible to choose among the many causes and say which is primary and which secondary, except in time. All causes acting at one time are responsible causes, "procuring causes" as the legal phrase is. Mechanical lesions are, however, always fundamental and determinable.

Analysis of mechanical factors in disease so far as at present understood shows that they may be divided into several classes as follows:

Osteopathic

Myopathic

Neuropathic

Visceropathic, etc.

The reason for so dividing them is that they need to be separately studied, since they require different forms of treatment.

Osteopathic lesions, much the most important, will be discussed last.

Myopathic lesions are those in which contracture of muscles is the cause of further disorder, is the mechanical factor that needs to be removed. These may be themselves secondary, or may be merely a part of the whole abnormal condition; that seems to make no difference in the effect. The removal of this part does in fact relieve, or tend to relieve, the whole, and to react on the primary condition from which it arose. The discussion of that fact is a matter for the subject of principles. We are here concerned with the technic for removing such contracture.

(The word contraction is used to indicate normal contraction; contracture is used to refer to the pathological continuance or exaggeration of contraction.)

### Areolae, Tissue

With myopathic lesions should be included contracture of areolar tissue (which being briefer will be considered first). This proves to be very widespread, though rarely very acute, but is important as a cause of disease. The same irritation that causes contracture of muscle may overflow into areolar tissue and cause contracture of that also. The more sluggish and less controlled areolar tissue may then remain in contracted state much longer than the muscular tissue.

All living tissue is contractile. The contraction of areolar tissue may be at times surprisingly vigorous.

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Under the irritation of shock, as from a blow or cold, etc., it shows itself. It may remain long after the cause has been removed. In that state it becomes a cause of trouble in nerves and in venous and lymphatic drainage. This humble and ignored kitchen-drudge tissue of the body has some highly important functions. Normally it is in a state of slight contraction. It holds the skin in position so that it does not drag and stretch by its own weight. It holds the skin against the underlying structures so that it prevents accumulation of lymph, etc.; it guides the lymph along to the opening of the lymphatic ducts and aids it to enter. It adapts itself to variations in atmospheric pressure and in position. In inflammation, it contracts vigorously around the inflamed area, being sufficient to seal up the part and prevent the diffusing of the inflammatory exudate; so that it acts to circumscribe inflammation; and in so doing converts the part into erectile tissue; whence the swelling. In wounds it prevents the escape of lymph and helps to close up injured blood vessels.

When so occurring it is likely to remain almost indefinitely, as though it lacked the power of spontaneously relaxing. It is when thus remaining contracted that it becomes a source of mischief.

The effects of its contraction are in line with its function. It overdoes that which is normally its work. It has in normal tissue the effect it should have only in wounds, etc. It checks the lymph, retards the blood, numbs the nerve terminals, prevents the easy adjustment of part to part and so causes friction, etc.

There are certain areas of the body where this tissue is especially abundant, where such disorders are of greater relative frequency, which should be mapped out and studied; as for instance the back of the neck.

The relaxation of such tissue is best accomplished by manipulation beginning gently and increasing gradually, so as not to rupture the delicate fibres. A sense of coldness and of resistance may be noted, and a distinct though vague sense of comfort like that from removing tight clothes is noted by the patient. Around bruises or boils, etc., there is an area more or less wide-spread of such contracture. By beginning far enough away and gently enough and approaching gradually nearer the injured part, one may often in a few minutes handle it with ease and practically without pain, and greatly improve lymphatic and venous drainage and nerve tone. After fractures, sprains, etc., it has been found that such relaxation of areolar tissue hastens recovery markedly. Hot applications may be used to numb the nerves if necessary, after which manipulation will be found to give much less pain.

The treatment is of course contraindicated in focal infections and bleeding wounds.

### Muscular Contractures

Muscular contractures are almost invariably associated with disease. Disease is always a matter of excess. This excess takes the shape of nerve overflow, and causes contractures around the nerve centres of the parts affected, at the spine, or in areas supplied from the same segment. Relaxation of such muscles does in fact have a beneficial effect on the disease; the reason for which pertains to the subject of principles.

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For the relaxation of contracted muscle there are three mechanical methods: manipulation (rhythmic stretching with the hand) stretching (by passive movements of the body) and inhibition (pressure with the hand, on the muscle or its nerves). To this may be added exercise, to promote functional relaxation.

Five minutes of massage will exhaust temporarily any normal muscle. From one to two minutes is all that is usually required to relax single muscles in contracted states. The time that it takes to get this relaxation is a rough measure of the depth of the pathological excitation.

The difference between these methods is not very great, and the one that should be used is more a matter of the convenience of the operator and the patient than that of pathological indication.

Probably the best method is a combination of the three. Placing the patient in a comfortable and relaxed position such that the contracted muscles are extended but not to their fullest extent, apply pressure to the muscle while extending it further, for three or four seconds, then release for a second or two, and repeat, until the muscle is found to relax.

Students should practice with a dynamometer at their side until they can gauge the amount of pressure they are applying. In no other way can they criticize or standardize their own work or successfully compare it with that of others. Rarely as much as ten pounds need be used on the neck, in adults; more in the back, still more in the lumbar region.

Where muscles are found to be sore, manipulation should be gentler at first, increasing in weight; should be farther away, approaching nearer the focus of disorder, as the pain diminishes under the manipulation.

The pain should disappear under the treatment, or shortly after. The reaction time of the sensory nerves measures the reaction time of the nerves involved in the pathological condition, so that when the change has occurred in the one, it will be found to have occurred to some degree at least in the other also.

Failure to secure results in such treatments is due first to failure to secure perfect relaxation. It should not be prolonged beyond the point of relaxation, but should not be left until at least some relaxation is secured. Dr. Tyndall states that "We often miss the whole effect of a treatment because we do not make it a point to secure perfect relaxation at the segment treated."

Failure may be due also to ignoring of the deep muscles of any given segment. These are apparently the ones most affected and closest to the nerve centres involved. When the more superficial muscles have relaxed, the examining finger should pursue the investigation to the deeper tissues, until the whole palpable area of the segment has been outlined and relaxed — short always of overfatigue of the nerves. The normal un- contracted muscle should be almost unpalpable — as soft as the cheek. In very thin persons the tendons of spinal muscles will often be mistaken for contracted muscle fibres. Often after treating a certain area a short time and leaving it for some

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other point and then returning, the first point will be found to have become relaxed. It is best always to return to make sure.

In severe conditions heat may be used to aid in relaxing. Heat tends to produce a paretic condition of blood vessels, cold to produce a spastic condition of them; and the effect on muscles is of the same kind.

Knowledge of specific centres is very valuable in soft tissue treatment. The treatment should be begun and carried to a finish first at the specific centres for the organs affected. Other contractures may if necessary be ignored for the time.

Frequency of treatment is a matter of the severity of the condition and the character of the disease. Contractures will recur if the irritation from which they arise remains. In pneumonia these recur sometimes in a few minutes or half an hour. Short of causing unfavorable reaction from the treatment itself the tissues may be relaxed as soon as contraction recurs.

This is not always possible. In pneumonia every hour is not too frequent, and some physicians treat as often as every twenty minutes. In the exanthemata the usual practice is three times a day except in more dangerous states, when it may be more frequent, graded according to the strength of the patient. In the average chronic condition the frequency of treatment is determined by mechanical conditions of the framework. Twice to three times a week is the average. In asthma, once in a week or ten days is best, more frequent is regarded as hazardous.

Relaxation as a preparation for reduction of bony lesions is by some regarded as essential. In general it is advisable especially if the sensibilities of the patient need to be considered; but it is not always mechanically necessary.

### PRESSURE TECHNIC

Have patient lie on right side on table; right leg extended straight with the body; left leg drawn up and forward, knee resting on table in front of right knee.

Draw shoulders well back; left shoulder slightly in advance so that chest slopes slightly toward table; head resting on a pillow high enough to keep neck up, straight with spine.

The longer muscles of the right side — erector spinae mass — will be found to be on tension; those on the left side relaxed. The deep muscles of the left side may sometimes be stretched, according to the position of the patient. Contractured muscles may be easily noted on the left side.

The bodies of the lumbar vertebrae have sunk toward the table farther than the spines thereof (rotated). It will be noted that the axes of rotation of lumbar vertebrae are posterior to the tips of the spines in general.

The articular surfaces on the left side are telescoped into each other, those of the right extended; the costal processes are approximated on the left, separated on the right.

Standing behind the patient place one or both thumbs on the top or left side of the spinous processes and slide them forward following the contour of the bone, keeping

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the muscular mass in front of them, until they meet the resistance of the contracted muscle; then press them against the mass, swinging the lumbar spine forward with the pressure, and release and repeat, slowly and with graduated pressure, until the contractures are overcome. This pressure and motion tends to separate the costal processes from each other on the left side, swinging the bodies still farther toward the table, and to stretch the muscles. Having relaxed the larger and more superficial muscles, carry the exploration deep into the tissue between the vertebrae.

This is effective as far up as the eighth or ninth dorsal.

To increase its effectiveness in the lower dorsal and to carry it up into the mid dorsals, grasp the patient's shoulder with the right hand, drawing back or merely holding, while the slow rhythmic pressure is applied with the left thumb.

To make it effective in the upper dorsals, place the patient's left elbow in contact with the table fairly close to the body and hold it there with the left hand while applying rhythmic pressure with the right thumb.

In dorsal vertebrae, this pressure does not cause further extension with stretching. Stretching is here produced by side-bending, the shoulders being carried upward. Pressure against one side of a vertebra tends to carry it forward, but that movement is slight. There is always enough elastic "give" to ligament, cartilage, and even bone, to insure some motion and some stretching of contracted muscle, by this alone. But this motion is opposed by several factors in the chest. The articular surfaces are flat against it. The ribs also, sustained by the pectoral muscles and the intercostal continuation of them, do not yield and so prevent rotation of the vertebra. Lastly is the fact that the centre of rotation of a dorsal vertebra is in front of the body, so that it can rotate only by carrying the rib with it. To produce further stretching in this position the shoulder must be used to produce side-bending.

If, however, the operator puts the fingers of his left hand on the corresponding rib at about the centre and presses down and forward so as to carry the rib away from the spine, this together with the thumb pressure at the spine rotates the vertebra to the limit of its capacity; and aids in relaxing the deep muscles of that segment.

If instead of holding the shoulder the operator carries it up so as to stretch the pectoral muscles and elevate the ribs and then applies pressure to the left side of the dorsal vertebrae, he produces side-bending with stretching, especially when the patient inhales.

As the patient exhales this may be changed into a primary rotation, with rotation downward of the rib on transverse process and between vertebral facets.

In the upper dorsals and ribs there is very little real motion. A slight flexion and extension; a slighter unilateral flexion and extension or side-bending; a still slighter rotation, are all that are found in the average person. (For these reasons the articular surfaces are irregular as shown in the analysis of that subject made at the A. S. O.)

When, however, the head is drawn back and the face turned toward the table, pressure on the left side of the vertebrae here causes the transverse processes to be separated

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to the full limit of their possible motion on the left side, with corresponding motion at all other parts, and with stretching of the muscles.

Pressure technic is little used for the neck; caution must be exercised on account of the possible pain to the patient.

It is not necessary to press hard enough to produce motion in all cases. The pressure alone will ultimately relax all of the muscles that it reaches. It is not necessary to make the pressure greater as the contraction is greater. We are dealing with not mechanical but vital structures; gentle pressure will be pretty sure to win in the end. Prolonging the pressure is better than increasing the force of it.

### Traction Technic

Have patient lie on right side on table; operator stands in front. Anchor patient's knees against operator's abdomen (on innominate bone, or fix with right hand). Reach with left hand (or both hands) across body and place fingers in contact with left (upper) side of spines of lumbar vertebrae; slide them forward following contour of bones and drawing muscular mass before them (caution — the finger tips should not be used, as the clawing so produced may cause pain) ; use the balls of the fingers. Draw with rhythmic motion until muscles relax.

The position of the knees has no effect on the position of the lumbar vertebrae or the tension of lumbar muscles unless they be carried high enough to produce extension of the vertebrae and tension of hip muscles; in which case it is the larger superficial muscles (erector spinae mass) that are tensed, and not the deeper and more important ones.

The effect of the drawing on the muscles is slight as to relations of the vertebrae, producing some slight rotation and flexion of those whose muscles are drawn upon. The chief effect is on the muscles themselves.

To make this treatment effective in the lower dorsals, hold knees as before, and place hand on patient's shoulder to hold or to push while drawing forward and upward on the muscles of this area.

The effect of this, beside stretching of the muscles to which tension is directly applied, is to cause unilateral extension (side-bending) of the vertebrae at the focus of the tension, with rotation downward of the ribs unless this is offset by sufficient pressure on the shoulder to tense pectoral and intercostal muscles.

The same technic applied to the ribs causes rotation downward or upward according to the tension on the pectorals and intercostals, and with respiratory movements, stretching of muscles and ligaments below the rib, and with side-bending of the vertebrae to which they are attached; (rotation if the traction is low enough with less pressure on shoulder).

To make this technic effective for mid and upper dorsals, anchor the patient's elbow against operator's abdomen or by means of left hand, while applying tension to spinal muscles with right hand. Or, with operator's left hand on patient's left shoulder,

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patient's arm thrown over operator's arm, the arm may be carried up toward patient's face until tension is produced on pectoral and intercostal muscles, with similar traction. The student should explore the various effects of different positions and tensions of patient's arm and shoulder on vertebral and rib movements, while applying traction to muscles and ribs.

To make this technic effective in upper dorsal and lower cervical areas, carry the patient's head slightly back with left hand, and press his shoulder slightly back and down with right wrist while right hand is applied to muscles of upper dorsal or lower cervical areas.

For the neck, however, this technic is best applied with patient supine, operator's left hand on patient's forehead, rotating it in direction opposite to traction, his right hand passing across the neck to the left side of the spinous processes, applied to the muscles of the neck. The effect of traction in this position, beside the tension on the muscles, is to cause complicated movement of the cervical vertebrae. The traction alone would cause the head to roll to the right with approximation of articular surfaces on right, extension on left. The rotation by the forehead alone would cause first rotation of the atlas-axis joint then extension of the right articular surfaces and approximation of those on the left. The combination of the two causes extreme rotation of the atlas on the axis to the left, rotation side-bending of the lower cervical vertebrae to the right, and extreme lateral motion of the vertebrae over which tension is applied (a sort of combination of many motions) to the left. The picture varies with the kind and degree of tension and rotation applied. The student should try to form a moving picture of the actual movements of the different parts of the neck.

There is an endless variety of ways in which the pressure technic and the traction technic may be applied to the relaxation of muscles, according to the convenience and stature of the operator and the conditions in the patient's body.

## CHAPTER III

### Neuropathic Lesions and Specific Centre?

Neuropathic lesions in the osteopathic sense are those conditions of the nervous system in which a given co-ordination of nerves maintains itself against the co-ordinating power of the rest of the body and nervous system. Usually some source of irritation is found in close proximity to the nerves involved, as an osteopathic lesion. Habit may play a part, as in habit spasms, etc. A shock or severe abuse of function may be the cause. Once the co-ordination for injury has been made, nature responds with the routine for tissue repair; and this co-ordination may be excited by summation of stimuli from various sources, none of them as severe as a genuine tissue injury. This is an osteopathic expansion of the general subject of neurology. Reflexes and specific centres are concerned in the therapy thereof.

Specific centres are points within reach from the outside of the body where direct effects can be had on a given group of nerve centres. Usually they correspond with the location of these centres in the spinal cord, though not always. Thus the fourth dorsal proves to be a specific centre for the vagus nerve; the sciatic nerve proves to be a specific centre for the inhibition of menstruation and uterine reflexes generally.

The reasons why treatment of specific nerve centres has the success that it proves to have in controlling disease processes and in curing disease is a matter for the subject of principles. Neuropathic lesions do undoubtedly exist, and can unquestionably be controlled or removed entirely by specific treatment.

As osteopathic experience broadens, it seems to point to a more and more accurate definition of specific nerve centres. It seems to indicate that the neuropathic treatment to be effective must be applied to the specific centres, and is wasted in so far as it misses these points, which are often not only confined to one particular segment of the cord and column, but to one particular side thereof. The determination of those centres is matter for principles or for osteopathic practice, or both, rather than for technic.

In considering the technic of treatment of these centres, the first point is always to secure relaxation of the muscles if contractures are definable around the centre. As a rule, these contractures will themselves indicate the specific centres for any given condition. But sometimes the contractures are so general that it is impossible through them to locate specific centres; and in rare cases contractures are not found at specific centres at all.

The first point in the treatment is to secure the relation of these contractures. This alone, if sufficiently done, constitutes an effective treatment to the neuropathic lesion. In many cases it is inadvisable to push the treatment to the point of complete relaxation, which is sometimes due to exhaustion, with possibly less effect than would come from less treatment. Often the neuropathic condition is corrected by less than enough to secure total relaxation of muscles, and on returning to them after some minutes, they are found to have relaxed from that alone.

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From means so simple as this it is hard for minds steeped in the mystery sense of disease to expect results as potent as are actually obtained. The effect is in reality very powerful. It is necessary to form some estimate of the powerful effect of such local stimulation on organs connected with the nerve centres stimulated. This differs by immense degrees in different individuals, but there are certain factors that may serve as general guides until the personal equation of the patient has been determined.

Racially, the Hebrew race seems to be endowed with a nerve mechanism whose sensory side is extremely developed; possibly from inbreeding. It seems to be necessary to keep this fact constantly in mind in treating members of that race. It is certainly not alone the higher nerve centres, but the whole sensory mechanism, organic as well as psychic, that responds with comparatively greater keenness.

In the English race the sensory nerve mechanism seems to be extremely stable, but there is possibly some relatively greater liability to err in the motor nerve mechanism.

In children the sensitiveness is in proportion to age. Children respond with many times as great sensitiveness as mature persons.

After discounting the general factors so far as they can be determined, one may then study the individual. People of highly developed literary, musical or artistic faculties usually show greater sensitiveness of the sensory mechanism; which is doubtless the reason why they have become artists. There is, however, an individual diathesis in practically everyone. In persons of high sensitiveness treatment should be gentler and more frequent. In a stable nervous mechanism it may be more prolonged and not so frequent. In others we find the diathesis to be vaso-motor rather than in sensory or motor nerves. In others the chief weakness seems to be in the organic activities. Since these peculiarities will show themselves in the types of disease from which the patient suffers, as well as in the results of treatment, it is not as a rule difficult to discover them, and no especial difference other than the relative strength, duration, and frequency of treatment need concern us. It is perhaps always wise to make the first treatment or two gentle and to study in them the types of reaction of the nervous system of the patient. The power of this specific treatment may be seen from some very simple illustrations. A sneeze represents a reaction of the sensory mechanism to irritation of the vaso-motor apparatus. It is imperative and often powerful. Yet it may be checked in mid-career and almost instantly in most persons by simple pressure with the finger in the angle between the nose and the upper lip, or in general on any point in the "pituitary area," comprising the area between the mouth below, the eyes above, and the malar bones on the outside.

Hemorrhage of the nose represents either actual traumatism or vasomotor spasm often of an intense character. Yet it may be checked in sixty seconds or thereabout by vigorous stimulation of the tissues in the angle between the occiput and the neck, which cause a vasoconstriction with possibly a curling up of the walls of the ruptured vessels sufficient to check the hemorrhage.

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Diarrhoea may be checked by inhibition for twenty or thirty seconds over the second sacral nerves. I have also seen violent hysteria with intense headache of the vertex and palpitation checked in a few minutes by inhibition at this point.

The action of the heart is markedly influenced in a few seconds, sometimes in five seconds or less, by vigorous stimulation at the cartilages of the first ribs; and may be influenced with less promptness from all upper dorsal nerves.

That this is true not only of motor functions but of secretory functions as well may be shown by pinching the septum of the nose ; when in a few seconds a marked increased secretion in the lachrymal glands may be observed.

In fact, in all functions of the body that may be tested it is found that stimulation has a very powerful effect, immediate in some cases, slow in others, according to the quickness or slowness of the natural functions of the organ. In the organs that cannot be so tested, it must therefore be assumed that there is an equally powerful and prompt effect. It is found also that the character of the stimulus applied affects, at least in the first stages of the response, the character of that response. It is found that different effects are had from different nerve centres; and that for specific effects it is necessary to determine the specific centres for those effects.

In a recent case treated in my office the patient complaining of cramps in the legs, inhibition and relaxation of the eleventh dorsal nerves caused cessation of that pain, but the nerve overflow appeared in the head, as violent headache. Similar treatment of the sub- occipital nerves relieved that symptom in a very few minutes, but the pathologic excess then appeared in the vagus nerve, as nausea. Inhibition of the fourth dorsal nerve drove it from that point to the vasomotor nerves, and it appeared as chill, goose-flesh, and trembling of the muscles. Continued treatment of the fourth dorsal drove it from that point, and it then began its wanderings all over again. Disappearing from one of these points, it seemed to be able to move to one of the others, nor was I able to determine what direction it would next take. But to drive it from any one place it seemed to be necessary to treat the specific centres involved. After perhaps thirty minutes of this experience I allowed the patient to rest, and after an hour there was an abatement of the intensity of the pathologic excess. The source of this pathologic force was finally traced to shock to the endocrine mechanism due to a number of causes — pelvic disorder, pelvic traumatism (operation) lesions at fourth dorsal and twelfth rib, etc. The point to note here is the prompt and powerful effect obtained by specific treatment.

When treatment is of an inhibitory character it is possible to estimate the probable effect by its effect on the operator himself. From continued pressure in spot the nerves of the finger finally become numb, and perhaps tingle. It is probable that the physiological processes in the patient are very close in time to those in the operator; and the time when numbness begins in the fingers should mark therefore the time when inhibition is effective in the patient's nerves.

That there is a practical and real difference between the effects obtained by so-called stimulatory and inhibitory treatment is evident. The scope of the difference is not great, however, and is applicable to only a few cases. When it is applicable, however, it is

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important. The chief difference is in the immediate effects; the ultimate effects being more and more nearly the same as more time passes.

The difference is most easily seen in for instance an excited stomach with tendency to emesis. Vigorous stimulation to the fourth dorsal nerves on the right side is apt to bring on the emesis immediately; inhibitory treatment to allay it. Relaxation of the muscular fibres gives a more perfect relief. The contracture recurs, however, if the condition is due to irritation from the contents of the stomach, which should then be voided.

Stimulation is obtained also by "getting motion" in the joints of the segment where the specific centre is found. And getting motion here means stretching the tissues of the joint with more or less force at the limit of their normal motion. This is in effect stretching also of contracted areolar and ligamentous tissue, which usually participates in the contracture, particularly if the case is of long standing. In some cases such vigorous stimulation as this — and it is possibly the most vigorous of all the available methods — is necessary to secure sufficient reaction to overcome the deadlock in the nerves.

Vibration and electricity are as a rule contra-indicated. The effect of both is to cause fibrous deposits and interstitial hardening.

The first effect of stimulation is on sensory nerves connected with that segment; more prolonged stimulus reaches motor nerves; vasomotor effects are then observed, in turn; while if effect is desired on organic functions, particularly the more remote organs of internal secretion, it requires much more prolonged effort.

Treatment to nerve centres and to soft tissue generally is a thing that for its best adjustment and success must be guided by an intelligent and vital sympathy with the nervous state of the patient, by judgment of individual cases, by experience. Insofar as it can be discussed scientifically it is subject to the same laws that govern the disease process generally. The disease process is the reaction of nature to irritation or injury or abuse that has overwhelmed its normal equilibrium. All such stimuli, as all stimuli of whatever character that affect the body, are absorbed by the sensory nerves and transmitted to the higher centres of the nervous system. When they are in excess, they follow a different route from that followed if they are within the normal range.

Their normal route is to pass at once to the higher brain, over nerve tracts each of which is more sensitive than the one below, as we approach the highest; there they are co-ordinated with all of the messages arriving at the time, in agreement with the accumulated wisdom of the individual.

Each higher relay of nerves is, as we said, more sensitive than the ones below. Now excess of stimulation becomes irritation, and irritation causes, as everywhere in life, the withdrawal of the part irritated. When irritation reaches these sensitive higher nerves, they withdraw from the co-ordination. These higher nerves are more sensitive, and a degree of stimulation that is not too strong for lower tracts becomes too strong for the higher ones. Picture then a stimulation slowly growing in intensity. There comes a point when it becomes irritation to these higher nerves, and they withdraw. The irritation has then to overflow into the motor nerves without the co-ordination of these

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higher nerves — it as it were short-circuits, and reaches the motor nerves at a lower level and in more intense form. We have therefore from this slowly growing irritation first intense mental reflexes, as a short temper; then physical pain; then involuntary motor spasm, focal at the nerve centres that govern the part affected; then vasomotor spasm, or inflammation, in its increasing stages of severity.

The effect of stimulation to specific centres is first of all the same as the effect of any new stimulus; it causes a suspension of existing co-ordinations until they have taken cognizance of the new one — it acts as an inhibition until the new stimulus has been co-ordinated. Re-co-ordination is just what is called for in a neuropathic lesion. A new stimulus sufficient to break up the existing deadlock of the nerves allows the normalizing tendencies of the whole body to assert themselves. It matters nothing what is the stage of this slowly developing process, the effect is still to cause a re-co-ordination toward the normal. This effect is first on the higher or sensory co-ordinations, and reaches the greater depths of false co-ordination with more persistent treatment. It seems to be the case that a lighter treatment, an inhibitory form of treatment, is best for sensory disorders; an active relaxation seems to be necessary for motor disorders; a vigorous stimulation for control of vasomotor spasms; and a more prolonged and deeper stimulation to reach the trophic functions. In diseases of long standing, chronic diseases, the same general principle holds true — it takes longer in proportion to the age of the disease. On the average it is said to take a month for every year that the affection has continued; though this does not hold always, for I have seen troubles of ten years standing relieved at one treatment, and I have also seen diseases of a few weeks standing resist stubbornly for months. But "You have to keep on feeding a calf to make it fat," says Dr. Still.

Too severe a treatment will often confine the effect to the immediate locality and lose all general effect. Certain tissues are in particular sensitive in this way, notably the eye. Local treatment to the tissues about the eye must be very carefully guarded. The palate, tonsil and eustachian tube are also very sensitive, a provision of nature to guard the entrance to the alimentary tract and the lung; and direct treatment should be given very carefully. The abdomen generally is subject to the same rule. In such diseases as asthma and hay fever the whole nervous system requires to be handled carefully.

A wise rule is never to push a treatment as far as it can be pushed at one time, but to stop as soon as a definite reaction has been secured; unless the condition is one of emergency.

## CHAPTER IV

### Proper and Secondary Movements

Proper motion of a joint is the motion defined by the articular surfaces within average limits of motion. The limitation to this proper motion is given by ligaments, or by cartilage as in the case of the intervertebral disc, or by bony contact; and this limitation then transforms the proper or primary motion into secondary motion. For illustration, a vertebra rotates to one side, the plane of motion being the base of the body of the vertebra. But the intervertebral disc or the ligaments in front of it check this motion almost immediately, and act as the ropes of a swing, transforming the horizontal motion into motion around the attachment of those ligaments as an axis. The latter is a secondary motion.

These secondary motions are of vast importance. Beyond the limit of normal motion lies danger of lesion; and lesions almost invariably occur through exaggeration of secondary motions. They are also important in the correction of lesions; for it is necessary to carry a joint to the limit of its normal motion to get any tension upon it. The character of the tension produced depends on this secondary motion.

Extensive laboratory work needs to be done on this subject. A beginning of work of this character was made by the classes of the A. S. O., to be described later.

In the spine as a whole, extension and flexion\* occurs \*Note. Extension and flexion are loosely defined. Accurate definition is needed for this work. As here used, flexion means bending toward the umbilicus, or toward lines drawn vertically and horizontally through it; extension means moving away from the umbilicus or vertical and horizontal lines drawn through it.

Thus, flexion of the spine involves opening out or extension of individual vertebral joints; but to avoid confusion, such motion will be referred to as flexion of the individual joint, the umbilicus being regarded as the basis of comparison. The ribs are extended in inspiration, flexed in expiration.

In the lumbar region, rotation in the dorsal, both in the cervical, except in the axis, in which rotation only occurs.

Side-bending occurs in all vertebrae except the axis.

The work of the students in the classes of January and June, 1917, of the A. S. O., referred to, was on the subject of axes of rotation. That of Messrs. (now Doctors) Fish and Lawrence was published in the A. S. O. Journal in 1916. The same discovery was made by each of these gentlemen working independently of the other, and both of them deserve credit for the discovery. The work of one student, Mr. (now Dr.) Louis E. Browne, alone, was on the subject of axes of flexion and extension, and the credit for the verification of those axes belongs to him alone.

Mr. Browne's work showed that the axes of flexion and extension in the dorsal region coincided closely with the position of the head of the ribs as they articulate with the facets on the bodies of the vertebrae; the axes in the lumbar vertebrae and the lower two or three dorsal vertebrae were in the same relative position, coinciding with the

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position of the semi-solid core of the intervertebral discs in those regions. This theory had been advanced in class; but "he who proves discovers," and Mr. Browne's was the first work aiming to prove this point.

The work of the other two students (Fish and Lawrence) came, however, as a complete surprise. Their work dealt with the axes of rotation; and proved that the axes of rotation of lumbar vertebrae lay at varying distances behind the articular surfaces, in some even behind the tips of the spines of the vertebrae. When a profile drawing of the spine was made and these centres were placed at the proper distances behind, a further discovery was made; that a line drawn through all of these centres formed a continuous curve. The centre of rotation of the fifth lumbar was about three inches behind the tip of the spine; and the line beginning there swept forward to opposite the second and third vertebrae, then backward again until opposite the eleventh dorsal it was practically at infinity; in other words there was no rotation in the eleventh dorsal spine — the surfaces lay in the same plane; there was slight rotation in the twelfth (inferior articular surface of the twelfth with the superior articular surface of the first lumbar) ; most and sharpest rotation between the second and third lumbar, less again as we approach the sacrum. Doubtless these facts conform to some natural law of mechanics. We find also that the spine of the second lumbar is the largest, usually, corresponding with this fact of greater rotation and also being the point where the lines of tensions from iliac crests to ribs cross each other.

The centres of rotation of dorsal vertebrae, on the other hand, were shown by these drawings to be in front.

The centre of rotation of the eleventh dorsal was neither in front nor behind; those of the tenth dorsal and of all other dorsal vertebrae were, however, in front of the articular surfaces. Here again when these centres were placed on a profile drawing of the spine, and a line was drawn joining them, it described a continuous curve, farthest away in the lower dorsals, nearest in the mid dorsals, farther away again in the upper dorsals, until with the first dorsal or seventh cervical it again reached infinity.

At this point the centres of rotation again jumped across to the rear of the spinal column and again described a continuous curve, convex toward the spine as before.

This work was subsequently verified by the other students in the classes, though there was much variation in the results. For instance it was found that the centres of rotation for the upper dorsals, determined with the most careful work, were very irregular in many spines. This means merely that the amount of motion there is so slight that nature did not develop the articular surfaces in accurate conformation with the dynamic or mechanic law, whatever it is, which led to the fairly accurate relations of surfaces in other parts of the spine. It also implies the opposite, namely, that articular surfaces are developed normally in automatic adjustment to the mechanical laws applying to their motion.

Variations were found also in the lumbar region. In some the articular surfaces of even the fifth lumbar vertebra faced each other so sharply as to throw the centre of rotation near to or in the tip of the spine of that vertebra (which means that gross lesion might exist here with no evidence thereof in the relation of the spines) ; in some they were

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not curves at all, with no point of rotation, but lay at an angle — almost a right angle — with each other, indicating that there was no rotation here, that the only motion possible in these joints was that of bilateral or unilateral flexion and extension (the latter meaning side-bending). In many the two articular surfaces on either side of the same vertebra did not have the same centre of rotation, but that of each was centred around a point lying in or directly posterior to the opposite surface — each surface determined the centre of rotation of the opposite surface. This fact probably indicates that rotation was not a proper function in those vertebrae, but was accomplished by a primary side-bending and secondary rotation.

In some spines the centres for the lower three or four were found to lie behind, those of the upper three or four to lie in front; but again at such relative distances as to form continuous curves, as in the dorsal and lumbar regions.

In the work done by Mr. Fish, for instance, it was found that in the spine he examined the centres of rotation for the facets in the lumbar region did not coincide on the two sides, being farthest apart in the fifth lumbar (where the articular processes are farthest apart) and approaching each other evenly until they coincided opposite the tenth or eleventh dorsal. These were centres for rotation; but it was the side-bending involved in rotation that gave these different centres, as will be shown later.

The centres for side-bending or tilting to right or left were not determined. The centre probably varies with each instant of motion, being first the centre of the body of the vertebra, then its inferior surface, then moving to the point of greatest resistance, which appears to be usually the articulation of the convex side. Side-bending occurs as said to a slight degree in all vertebrae, but apparently chiefly in the lumbar region.

In other words, in the lumbar region the lateral motion is usually probably primarily side-bending, secondarily rotation; whereas in the dorsal region it is probably primarily rotation, secondarily side-bending. The distinction is merely theoretical, for they both occur together, and one hardly occurs without the other. The intervertebral disc in the dorsal region is, however not thick enough to allow much side-bending. The angle of motion in the dorsal region, in its various parts, may be quickly learned by taking each vertebra in turn and sighting with the eye so that the articular surfaces of the inferior costal facet and of the inferior articular process will both lie in the same plane.

In the dorsal region and the ribs the smallness of the articular surfaces indicates that the amount of actual motion is very slight. Articular surfaces in the spine never move over the full range of their surfaces; they probably rarely even approach each other's limits, or even move so that half of either surface is uncovered. One articular surface is always larger than the other; and the actual range of normal motion is probably comprised within the larger of the two — limited to the distance that the smaller can slide around without leaving the surface of the larger. This for the reason that articular surface forms automatically when bone slides on bone, and if the range of motion were exceeded more articular surface would tend to form. The slightness of the motion in the dorsal region is still further indicated in the smallness of the costal facets on the vertebral bodies, and in the flatness of the superior and inferior surfaces of the vertebral bodies with the thinness of the intervertebral discs. A mere cartilaginous yielding distributed through the whole spine amounts to a very large total of motion.

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The proper motion of the ribs is practically limited to that as seen in respiration, which, variously adjusted and combined, can allow all of the actual motion that is observed. Examining the facets on the transverse processes we find that they are in many if not most spines not facets at all, but deep grooves, covering in some cases the half of a circle. The only proper motion possible here is a turning motion — a sliding in and out being prevented by the articulation of the head of the bone with the bodies of the vertebrae. The head of the bone is carried with one or the other of the two vertebrae that it touches (the one body in the case of the twelfth and eleventh ribs) and slides on the facet of the other; but this motion is so slight at the facet on the transverse process as to cause little more than an elastic yielding. "Bucket-bail" motions of ribs do not seem to be possible, judging by the anatomical conformation of the facets.

Some work done by Mr. (now Dr.) Schoonmaker in the A. S. O. shows that the facets on the transverse processes of vertebrae also vary in continuous and graded series. In the vertical plane they face toward a point in front of the lower part of the chest ; in the transverse plane they face directly forward in the first dorsal and turn gradually to face forty-five degrees out in the tenth dorsal. The axis of turning (flexion and extension) is of course the center of each rib itself. These facets represent the direction in which normal pressure is brought to bear on the articulations, from muscular action and from atmospheric pressure without, and from blowing, etc., within the chest; for of course articular surfaces must be directly perpendicular to the pressure that bears against them, or they would slide to the limit of their motion and stay there.

The proper motions of cervical vertebrae are direct extension and flexion in the median line, and unilateral extension and flexion. Experiments made on each other by students in the A. S. O. classes referred to showed that here also one side moved at a time. In the first stages of this unilateral extension, the concave side is fully extended or approximated before the opposite side begins to move, but the limit of approximation is soon reached, and then the opposite side begins to open out, or flex, while the approximated side remains stationary with only the slight turning on its own axis that is necessary. Each side becomes the centre of rotation for the other side. This fact is not expressed in the articular surfaces for the reason that they must be smooth to allow the other motions, that require gliding in other directions.

The proper motion of the atlas on the axis is a pure rotation around the odontoid process.

The proper motion of the occiput on the atlas is extension-flexion, or nodding; with slight side-bending and slighter rotation. The atlanto-axial is almost a ball-and-socket joint with very slight ranges of motion.

### Limitations to Motion

None of these proper motions remain proper for long — they are proper motions in only the first stages of motion. Ligaments and bony interferences quickly change the character of the motion and develop secondary and even tertiary motions. The more it departs from the proper motion, the more it enters the phase of secondary motion, the greater the danger of lesion; and when it has passed the normal limits to secondary

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motion, it may be said that momentary lesion is always and necessarily produced — but in a vast majority of cases such lesions correct themselves. In the hundredth case, however, it does not correct itself but remains in the abnormal position until corrected. The frequency with which that hundredth case arises is a matter for Principles of Osteopathy, not for technic.

## CHAPTER V

### Normal Movements and Digital training

The student should hold his mind at this point; not only until a mental picture is formed, but until the conception of these proper motions has woven itself into the structure of his thought; not as things to be remembered, for it is certain that they would not be remembered at all times, and would be laborious and uncertain; but until they have become the sub-conscious basis for all thought applied to the correction of lesions. "Become familiar with the normal," says Dr. Still. "Study the normal, and the abnormal will then be its own evidence."

Two excellent aids in forming mental pictures are studying the motions in the animal spine, where they are easy to realize, and studying the mechanical laws expressed in the forms and the motions of vertebrae.

In the animal body, the spine is suspended after the manner of the Brooklyn Bridge. But the hind end (tail) has grown very small and thin, the front end has grown very huge, and added the City Hall for a head, and the Metropolitan and Woolworth towers for horns; so that the head and neck balance a large part of the trunk, and bring the major portion of the weight of the animal upon the front legs. The front legs are therefore straight, as all weight-bearing structures should be. But the legs transmit this support through muscle and ligament to the upper ribs — wherefore in the animal these also are very nearly straight; and by consequence the upper part of the chest is narrow, which incidentally allows the forelegs to come close together and to be straight.

What of the motions of these vertebrae and ribs? They were evidently devised for weight and tension bearing first, and for motion second. The movement of flexion and extension is performed almost entirely in the long neck — the joints in the upper dorsal part merely yielding a little; the motion of side-bending is the chief movement of these bones, as the animal walks on first the right leg and then the left; but that too is slight; the actual shifting of weight occurs by swinging the head — that is, almost entirely in the neck, with merely an adaptive motion in the dorsal vertebrae. In walking, the dorsal spine side-bends slightly, becoming concave to the side which is supplying the support. The centre of this concavity is below the level of the spine, hence the centres of rotation of dorsal vertebrae are in front of the bodies.

In the human spine the curve of the ribs has changed considerably, and the curves of the articular planes somewhat; but aside from that the inner conditions are practically the same, and the same conceptions of motion are applicable.

In the mid and lower dorsal parts of the spine of the animal, the ribs serve as trusses supported by muscle and ligament and they in turn support the spine. Motion grows freer as we move toward the lumbar region; but is still centred about points below the spine, or ventrally from the bodies of the vertebrae. The lumbar vertebrae, however, swing free; they are suspended from the dorsal spine in front and from the sacrum behind, and swing much as a hammock might, except that the central parts swing more sharply than the end parts. As the right hind leg is lifted it bears the right side

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down; as it is drawn forward, the muscles at the same time bend the lumbar spine to the left, the bodies swinging farther than the spines. In the sagging curve of the lumbar spine, this produces just the motion that we have described, a sort of hammock motion in which the centre bends farther than either end, the body farther than the spinous process. The centre of rotation of lumbar vertebrae is therefore posterior to the spine.

In the erect human spine this curve is somewhat accentuated, but the difference is not so much as it at first seems; the difference is mostly in the legs and hips. In any case, the same types of motion are observed.

It is interesting, though not important, to note a few of the motions of the neck and the reasons therefor, in the animal as compared with the human neck. The neck and head are supported by the ligamentum nuchae, which acts on the same principle as the long muscles of the thigh and leg — makes much easier, that is, the holding up of the heavy head, so long as the head is kept down and parallel with the dorsal spines, making a parallelogram with the ligamentum nuchae and the column of bone. The cruelty of the check rein in horses lies mostly perhaps in the fact that it takes all tension off of this ligament, and throws the effort of holding up the hundred pounds of head and neck entirely on the muscles of the neck (note how the muscles around the root of the neck are developed in horses subject to check-reins). In the grazing animals, it is the neck that must be long enough to reach the ground, hence the flexion motion is chiefly developed in the last cervical vertebrae, (in human subjects chiefly in the sixth, whose spine therefore disappears behind that of the seventh in extreme extension) so as to allow all of the length of the neck to be used. The nodding motion is developed just at the back of the head, where it is most useful; the motion of rotation is developed as near the head as possible, that is, in the second joint from the head; far enough from the head to give effective attachment to muscles, and near the distal end of the neck so as not to weaken the structure of the neck itself. These same conditions are found in the human neck.

The second of the aids to realization spoken of is found in the mechanical laws that are expressed in the shapes and motions of bones and ligaments. This is a subject for rational anatomy rather than for technic, but a few of them may be referred to here.

The first of these laws is that bone always bears pressure, directly perpendicular to articular surfaces, and in the direction of the length of long bones, and of the grain of all bones. This is true of even the curved ribs, and of the dome of the skull. The shapes of bones is an absolute indication of the direction and degree of pressure that they bear, from weight, from muscular and ligamentous action, from atmospheric pressure, from all possible sources. There is not space here to expand that subject. It is important in the development of a scientific technic, however. For instance, the spinous processes of vertebrae bear pressure from muscular action and from ligaments. The muscles that attach there are those of the shoulders, drawing up and out; they are opposed on the opposite side by the interspinous muscles in mid-positions, and by spinal ligaments also in extreme flexion. The combination of these two is pressure on the spine in the direction of its length. This direction proves to be almost parallel with the articular surfaces of the vertebrae, as it naturally would be, to admit the greatest facility of motion. When, therefore, traction is put upon these

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muscles, or on the ligamentum nuchae, its result is to flex the vertebrae to the limit, and, if unopposed, to produce lesion. (It is when we consider two vertebrae together that we find this pressure in line with the spine transformed into pressure directly against the articular surface.)

(The habit of having the patient clasp his hands behind his neck or head, passing operator's hands under patient's axillae and over patient's hands so clasped, or his wrists, and jerking the head and neck forward with a lift of the body, is, in my opinion and experience extremely dangerous, causing more lesions than it corrects. It almost invariably produces a "pop," but the pop may signify the production as well as the correction of a lesion. The reason for the producing of lesion is here seen.)

To the transverse processes are fastened the muscles running from below, and pulling down and in, hence the up-and-out direction of these processes. Whenever an articulation is moved to the limit of its normal play of motion, these muscles and ligaments are tensed, and the tension so produced may be easily calculated from the direction of the processes or the grain of the bone. For the correction of lesions it is necessary to move them to the limit of their normal motion in order to get tension on them, so that these factors are of extreme importance.

We seem to have contradicted ourselves in saying that pressure on articular surfaces is perpendicular to them, and then that the pressure from tensing muscles of the spine is parallel to them. Let it be remembered that the tension of muscles does not stop with the bone to which they are attached, but is taken up by other muscles or ligaments beyond. The bone makes merely an angle in the tension of the muscles. The combined tensions bring pressure on the bones. The case of the sacrum, already cited, is an illustration of this. For the sake of building a clearer mental picture of articular surfaces and their relations, let us review more in detail the law mentioned, that when there are two articular surfaces on any bone, they are always perpendicular to each other; if there are three, these are all perpendicular to each other, like the corner of a box. More than three there cannot be without making motion mechanically impossible; a fourth, if there is a fourth, becomes a cartilaginous joint, as in the costal cartilages. The reason for this is extremely simple. Let us repeat first that pressure on any articular surface must be perpendicular thereto or the bones would slide to the end of their possible motion and stay there.

But suppose that angular pressure is made; the articulation sustains all of the pressure that is perpendicular to it, and transmits the rest, as motion or as pressure, in a direction parallel to its surface. If then a second articulation forms, its angle must be perpendicular to the first, for the same reason; and if a third forms, it also is perpendicular to the other two. A fourth point of contact with bone must be able to yield in any direction governed by the other articular surfaces — hence a cartilaginous joint. Illustrations of this law we find in the intervertebral discs, the costal cartilages, and also in the joint at the symphysis pubis. Such a cartilaginous joint must also be found in or near the general plane of the other joints. The symphysis pubis for instance is in the same plane with the base of the fifth lumbar, with the lumbo-sacral, and in a plane parallel with the articulation that is sometimes found on the dorsum of the sacrum

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opposite the second sacral spine, with the overhanging posterior superior spine of the ilium.

At the heads of the ribs the two articulations are found to be perpendicular to each other, and the facet on the tubercle is perpendicular to both. The costal cartilage is parallel to the last, the end of the bone itself in line with the intersection of the first two.

The articulations of vertebrae are perpendicular to both the costal facets, and the fourth articulation, that of the base, is cartilaginous; it is also opposite to the other articulations, as in ribs and innominate. The extreme logical perfection of nature's mechanisms makes us wonder and admire; but they do more; for these facts aid us in our osteopathic thinking, and indeed become the basis for scientific technic.

The planes of articulation of the innominate are at the sacro-iliac articulation, vertical antero-posterior; this being so rough and uneven cannot be considered as one plane, but includes planes tilted in and out; the (psuedo) articulation between the posterior superior spine and the second sacral vertebra, transverse-horizontal, tilted so as to be perpendicular to the base of the sacrum; and the symphysis pubis, cartilaginous, parallel to the sacro-iliac.

With patient lying on right side, pressure over anterior superior spine of ilium makes a fulcrum of the symphysis and the upper anterior edge of the sacro-iliac articulations, and tends to gap open the posterior side of the sacro-iliac and the posterior superior spine. Pressure over the ischium makes a fulcrum of the symphysis and the lower posterior portion of the sacro-iliac, and tends to gap open the upper anterior portion of the sacro-iliac.

The planes of articulation of the sacrum are the sacro-iliac, vertical- antero-posterior and uneven (to be considered therefore as more than a single articular plane), the sacro-lumbar, vertical-transverse (tilted so as to be perpendicular to the base of the bone) and the base, cartilaginous, transverse, perpendicular to the articular surfaces. Pressure on the right side of the tail of the sacrum makes a fulcrum of either sacro-iliac articulation, whichever is the more rigidly fixed by ligament, and draws down on the left side, up on the right side (provided the corresponding ilium be fixed). In lying on the right side, the weight of the body makes a fulcrum of the lower (right) joint. Traction through the spine on the sacrum acts at a considerable angle backward. Against this fulcrum it draws up and back on the upper (left) joint. It will be remembered that the sacrum lies at a sharp angle with the spine, so that straight traction through the spine becomes dorsal traction on the sacrum. Traction, plus posterior rotation of the left side of spine, however, greatly increases the effect in drawing back on the upper (left) sacro-iliac joint.

The planes of articulation of lumbar vertebrae are vertical-saggital, at the posterior portion of the spinal articulations, vertical-transverse at the anterior portions thereof; these articular surfaces are usually curved, concave in and back, the curve being great enough to include both saggital and transverse planes; though sometimes they consist of two definite planes as described, with a very short curve at the intersection, or even a groove marking the separation between them. This description is approximate only, since the planes of articulation show usually a graded variation.

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The articulation of the base, cartilaginous, is horizontal-transverse, also approximate, graded from forty-five degrees down anteriorly to a few degrees up anteriorly.

With patient lying on right side, the spine of any lumbar vertebra being fixed, posterior rotation of the spine makes a fulcrum of the lower (right) articular surface, and is effective in gapping open and drawing up and back the upper (left) articular surface.

With patient seated, complete flexion of the spine makes a fulcrum of the intervertebral disc and draws the articular surfaces out from each other; rotation added to this flexion makes a fulcrum passing through the base and the articulation of the convex side, and draws back and up the articulation of the concave side.

The planes of articulation of dorsal vertebrae are the vertical-transverse, at the articular processes, vertical-transverse also at the transverse processes, the sagittal forty-five degrees up and in at the superior costal facets on each side, (at right angles to each other), the sagittal — forty-five degrees down and in at the inferior costal facets on each side, and the transverse horizontal (cartilaginous) at the base. All of these planes are subject to graded variation. The student should be familiar with these and should rehearse the various leverages and their effects.

The planes of articulation of ribs are the transverse-forty-five degrees down and in at the superior facets, transverse-forty-five degrees up and in at the inferior facets, transverse vertical at the tubercle, and sagittal-vertical (cartilaginous) at the costal cartilages. These are also subject to graded variation, as shown in the preceding chapter. Pressure on the spinal end of a rib makes a fulcrum of the resistant tissue surrounding the whole rib, and tends to gap open the articulation at the transverse process, sliding forward at the articulations with the bodies of the vertebrae. Pressure at the costal end, if inward, makes a fulcrum of the head only, gapping open the tubercle-transverse articulation as a whole; if out, makes a fulcrum of the tubercle and slides forward the articulation at the head; if downward or upward it makes a fulcrum of the resistant tissue around the whole rib and has the reverse effect at the transverse process.

The student should apply these principles to all articulations of the skeleton and rehearse them until thoroughly familiar with them.

Having formed mental pictures of these motions and their laws, it then becomes important to realize them digitally, with the sense of feeling and of measurement.

Have the patient seated on the table, operator standing in front; place towel or thin pillow on the top of the patient's head and draw it against operator's chest, against the gladiolus or upper part of manubrium; have patient place hands on operator's shoulders; pass hands under patient's shoulders, around patient's body, fingers on tips or either side of spinous processes, beginning with lowest. Draw forward with hands until joint is in extreme extension, (operator may bend or step back slightly) then pressing against head with manubrium, carry patient back to extreme flexion, feeling carefully the movements until familiar with all qualities of motion in the joint. Then pass to next joint, and so on up the spine. Then begin again with fingers this time on transverse processes, then on costal processes (on ribs in dorsal area). Repeat again, making lateral movement instead of flexion-extension.

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This practice is very soothing to patients, is an excellent diagnostic method, and is corrective for slight lesions. It may well be a routine practice with all patients, especially in the beginning (it is a standard procedure with many very successful practitioners. It originated, I believe, with Dr. Achorn of the Massachusetts College). It is effective as high as the upper dorsals, and may be applied even to the neck.

To become familiar with the normal movements of the neck have patient seated on stool or table, operator standing behind. Place fingers on anterior corners of cervical vertebrae (costal processes) with thumbs on tips of spinous processes, gently or even loosely; have patient flex and extend, rotate, and make all possible motions with head and neck, noting character of motion in vertebrae.

The student should not fail of course to make note of character of motion in each joint of all patients at all times, as this varies in different spines and under different conditions of lesion and muscular contracture. It should not be left to reason, but should be made a habit; always making a moving picture in the mind of the actual position and relation of the bone. The only proper osteopathic technic is to correct the lesion; and "We do not push bones into place, we think them into place." When we are trying to adjust a bone in lesion, we must "be that bone."

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## CHAPTER VI.

### Neuropathic Lesions

#### Sacrum limitation to motion:

#### Lesions: Correction

The study of the limitations to motion in the joints of the body is important for several reasons; first among them this, that beyond that limitation is the danger of lesion; second, that since, for correction, tension must be gotten on the bones in lesion, and since to get tension on them they must be carried to the limit of their normal motion, therefore this knowledge is essential to a scientific technic.

There is no proper motion at all in the sacrum. If it moves at all it is in excess of the limitations of its motion, and with danger of lesion. Normally there is a mere elastic yielding of the ligaments of the sacrum, with possibly a slight grinding of the articular surfaces. In view of the fact that many statements on this subject have been made of an opposite character, this statement requires some supporting.

In the first place I challenge anyone to show where Dr. Still has said that the sacrum normally moves on or between the innominates in mature persons. That the sacrum is found in lesion, having been moved abnormally, he has said; and the fact is proven daily in Osteopathic experience. But this is not to attribute normal motion to the sacrum.

Tests made in the classes above referred to at the A. S. O. seemed at first to give positive results in many cases. First the diameter between dorsum of sacrum and symphysis pubis seemed to be increased in flexion of the body, decreased in extension. A moment's thought will reveal the interesting fact that this is motion in the wrong direction, if it is motion at all. Second, the interval between the posterior iliac crests seemed to decrease with flexion and to increase with extension. This again is the wrong motion, if the sacrum moves as above indicated. A moment's thought will reveal the interesting fact that to accomplish this motion either the bones at the symphysis pubis must be absolutely separated from each other and by several times as much as they are approximated at the posterior superior spines — being much the longer arm of the lever; or else the sacrum must slide forward far enough to allow this approximation — a very great distance, because the sacro-iliac surfaces are not bevelled in and back at all points of the surface, but are uneven and actually slope out and back at some points, which points, small though they be, would absolutely determine a separation instead of an approximation of these spines if the sacrum glided downward and forward in flexion of the trunk within the area of the articular surface.

This seeming motion was then found to be due to the tensing of the fibrous mass at the root of the erector spinae muscle, both over the dorsum of the sacrum and between the iliac spines. It was found impossible to make satisfactory measurements of body movement in active motions of the body on account of this fact; and in passive movements there was to some extent the same difficulty, and also little or no force leading to movement of the sacrum in any case.

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We then have resource to anatomical examination of the parts for evidence of movement or the lack of it. All evidence points to lack of it. We find that the sacro-iliac joint is not smooth, as it would have to be to permit of actual normal motion; that fibrous adhesions are the rule between the opposing surfaces. Why then the articular membranes, or the remains of them? Examining the surfaces with the eyes closed, the fingers are able to outline in practically all sacra an uneven groove about the width of the ends of the fingers describing a fairly accurate curve, concentric about a point which proves to be the point of attachment of the sacro-iliac ligament — the great ligament by which the sacrum is suspended. It may be supposed then that the sacrum did move about this centre in early life or in foetal life; perhaps chiefly at the time when the child is learning to walk upright, before the bone is fully developed. This groove should define whatever motion might be normal to the sacrum ; which would be a turning about this centre with a freer movement of the caudal end; but at the caudal end this motion is checked by the great sacro-sciatic ligament, and is probably no greater than is allowed by the stretching of this ligament. (In the immature, before the sacral vertebrae became ossified, motion might have occurred with bending of the sacral vertebrae on each other.)

Why would not motion occur in the opposite direction, that is with depression of the caudal end and relaxation of the sacro-sciatic ligament? Because every normal force that applies to the sacrum forces it in the opposite direction. On the front end the full weight of the body together with the force of its muscular action pressed down; on the caudal end the great tension of the erector spinae muscle pulls up. Of the other muscles, the gluteus maximus and pyriformis pull out, and the muscles of the pelvic floor, small and delicate, are the only ones that pull down.

The sacro-iliac joint is a spring joint, a safety joint, without normal functional movement.

The limitations to motion in this joint are those of the uneven (as though dove-tailed) joint, the great sacro-iliac ligament, largest in the body (sometimes an inch in diameter); the sacro-sciatic ligament, scarcely less strong, and the suspensory ligament on the ventral aspect. Sometimes there is a further limitation formed by actual contact of the posterior superior spine of the ilium with the dorsum of the second sacral vertebra, making another pseudo joint in the horizontal plane. Except for the elasticity of these ligaments and the cartilage of the joint, these limitations are absolute.

Although the sacrum does not move, it yields in elastic fashion to forces of movement. The direction of the fibres of ligaments is the key to the direction of lines of tension. Some of the fibres of the sacro-iliac ligament incline inward, from iliac crest to sacral spines, indicating that there is often tension in this direction; which tension would incline the articular surface to gap open on the dorsal side, with leverage at the ventral side of the articular surface; as in walking when the opposite leg is lifted. Advantage is taken of this in the correction of lesions. The greater proportion of the fibres of this ligament extend directly down, in the line of the weight of the body.

### Mechanics of Sacral Lesions

More than ninety per cent of the lesions of the sacrum present a slipping of that bone ventrally on its articulation with the ilium (the so-called posterior innominate). This may

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be unilateral, the axis of rotation being of course the opposite side; or as in probably fifty per cent of the cases, bilateral.

This lesion would seem to involve a direct stretching of the great sacro-iliac ligament. The size of this ligament is tremendous, such that production of lesions would seem to require overwhelming force. This, however, is not the case. Lesion does not involve direct stretching of this great ligament, but on the contrary stretches only a few of its outer fibres. Examining the mechanics of the part we find that as the sacrum slips forward it first turns so as to lie at a more acute angle with the ilium, and that then the tension on the fibres of this ligament draw down the crest and the posterior superior spine closer to the dorsum of the sacrum; draw it down by as much as the fibres are tensed, so that only those fibres close to the ilium itself are unduly stretched, while those farthest from it (those passing to the sacral spines) may be actually relaxed; the intervening ones being neutral, or slightly stretched or slightly relaxed, according to position. The articulation itself is then gapped at the bottom and under heavy pressure at its top edge, where an indentation is made in the soft tissue of the periosteum and the articular membranes by the upper corner of the sacral articular surface; the whole bone on that side being found slightly forward of its normal position. This change is, of course, reflected to the opposite articulation. If on the depressed side there is a gap below, then on the sound side there must be a corresponding gap above, with tensing of the ligaments along the upper edge. Wherefore we often find that there is more tenderness along the inside of the iliac crest of the sound side than there is on the side in lesion; except that at the point where the sacrum emerges from between the ilia (the sacro-iliac "X") there is always more pain on the lesion side.

Nature always distributes equally the tension on ligaments so far as possible; indeed that is a mechanical result in any structure not absolutely rigid. That brings about secondary changes in position of these bones. The ligaments involved here are the two sacro-iliac ligaments, the one tensed, the other partly tensed and partly relaxed, and the suspensory ligaments, the one tensed (on affected side) the other relaxed. We have also the joint gapped below on the affected side and gapped above on the sound side. The natural effect therefore is to so swing the whole pelvis that these tensions are balanced. Being hinged only at the symphysis, this shift of position is easy. The first shift swings both articulations to the side opposite the lesion. But this leaves the gaps still greater. To more or less close those the second shift occurs, which is a rotation, forward on the sound side, backward on the lesion side. Experimenting with the actual bones in the position of sitting one quickly realizes to what this leads — a tilting of the two innominate so that the posterior superior spine of the affected side is lower or nearer the table than its fellow. It is this secondary result that gave rise to the diagnosis of "rotated ilium." But the sound side being shifted forward there is a natural tendency to force this ilium backward — to cause lesion also on this side.

There is usually a perceptible difference in the tension of the sacro-sciatic ligaments, it being less on the sound side.

The relative height of the posterior superior spines from the table in sitting is altered by difference in thickness of the cartilaginous pads, in tension of muscles, in habits of

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sitting, etc., which make that an unreliable basis for diagnosis. In general all measurements that involve other joints or other factors than the actual bones in lesion and at the very points where lesion occurs, are unreliable. Diagnosis should be made at the very point where lesion actually exists, or as near to it as possible.

Diagnosis of sacro-iliac lesion should be made at the only points where the bones are in actual contact that is reachable by the examining finger — at the points where the sacrum emerges from between the two ilia, the sacro-iliac "X," just below and in contact with the posterior superior spines of the ilia.

Patient seated on table; operator seated on stool behind; places two thumbs on posterior superior spines and notes corresponding points of the two; passes thumbs downward until they come into contact with the dorsum of the sacrum. The thumbs should then lie with the balls pressing on the dorsum, the upper edges pressing against the inferior margins of the posterior superior spines. Difference may be noted on the two sides. On the side in lesion there will be greater depth between posterior superior spine and sacrum, possibly a definite gap; possibly the edge of the ilium below the spine may be felt as it turns forward and grows more sharp. More or less sensitiveness should be noted on the affected side. There is rarely so much fat here as to make diagnosis impossible.

### CORRECTION OF ANTERIOR SACRUM

The lesion above described is usually defined as a "rotated ilium" or "posterior innominate," but in reality is much more accurately defined as a sacrum anterior on one or both sides.

Patient lying on side on table, lesion side uppermost. Assume that lesion is on right side. Patient lies on left side. Extend left leg; draw right knee in front and place in contact with table. Operator stands facing patient. With left hand outlines the crest of ilium, places forearm along crest so as to bring pressure on whole anterior and upper edge thereof, especially over the anterior superior spine.

(Caution: Operator must not allow elbow to come into contact with patient at any point, as it causes exquisite pain; operator must not allow forearm to slip down from upper edge of crest so as to bring pressure on the fibres of the glutei muscles which are here raised from the bone in tented fashion; as this both defeats the purpose of the technic and causes much pain to patient.)

With forearm thus placed operator is in position to produce pressure downward and forward over iliac crest and particularly over anterior superior spine, the effect of which is to bend the ilium down in front and up in the back around an axis passing through the symphysis and the points in contact in the lesion, so as to reverse the gapping in the lesion; to cause, that is, gapping behind; and to prize up the engaged corner of the lesion from its indentation.

Operator then places right forearm in the hollow of the patient's right shoulder (grasping for convenience the fat of the patient's forearm), being careful that the sharp olecranon process does not hurt patient's pectoral muscles). He rotates the shoulder

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back and slightly down, and rotates the ilium forward and slightly down, both at the same time, until all of the intervening joints are at the limit of their normal tension, making sure that the patient's muscles are all relaxed. This position alone with practically no tension is sufficient to correct many lighter lesions, proving the correctness of the technic. Pressure is then exerted backward and downward on the shoulder, forward and downward on the ilium, until the articulation yields and is restored. Force must be adjusted to the stubbornness of the lesion. A quick and shallow thrust is better than a gradual one which requires to be much heavier, as will be explained later.

**Mechanics:** The student should follow the effect of the force that he applies from the point where he applies it, through all intervening joints, ligaments of muscles, to its actual effect in correcting the lesion. The force applied to the shoulders tenses pectoral and serratus muscles, passes to ribs, thence to transverse processes and the spine as a whole, which it carries back over the fulcrum of the right shoulder and also rotates, as far as the sacrum, which is being held. At the sacrum it is effective in drawing back the base, through traction, and drawing back the upper articular surface through rotation over the lower articular surface as fulcrum.

The effect of the force applied to the anterior superior spine is as noted.

**Criticisms.** This technic as practiced especially by beginners shows usually certain typical faults. The operator forgets and leans his weight on the pelvis without making sure that it is applied at the anterior superior spine. Or he makes jerky motions without first getting the patient relaxed and his spinal joints all at the limit of their motion — in which case the whole effect of the energy is used up in them, and not in correction of the lesion. Or, before making the quick and shallow thrust, he releases, draws back as it were, however slightly, when of course the patient's muscles follow him and the effect is lost because the joints are not at the limit of motion before the corrective pressure is applied.

Some straining of the pectoral muscles is usually felt, but is not so severe as to make the treatment painful, with care and practice. Poppings at various points along the spine may be noted, which may or may not have significance. Usually it is very easy to correct lesions and very hard to produce them, so that unless specially indicated these poppings may be ignored, as they are probably corrective in themselves.

In some patients, especially in females with large pelves and short waists, this technic puts such a strain upon the tissues about the twelfth rib that it cannot be used.

### Other Lesions of the Sacrum

In rarer cases the sacrum is found deviated not at all ventrally but caudally — the articulation having slipped in its longitudinal axis. Diagnosis of this lesion is very difficult. When it is suspected, have patient on side with lesion uppermost, as before, his back near to back edge of table; extend left leg; lift right leg, carry backward beyond edge of table, and allow it to hang down as far as possible. Operator now fixes shoulder of patient with his right arm or axilla, while with right hand (if possible) he presses up and forward on affected tissues, and with left hand lifts patient's right leg

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and then carries it smartly downward behind table to full limit, so as to spring the right ilium away from the sacrum, which is being held by traction through the spine. The practical success of this technic seems to depend on keeping the pelvis in such position off balance that the downward thrust takes effect at the articulation, and not on the muscles in front of or behind it; and on keeping the spine in such alignment that it exerts firm traction on the sacrum.

**Mechanics:** The lower articular surface becomes the fulcrum, traction through the spine over this fulcrum draws upper surface; force applied to leg finds its fulcrum at the symphysis and the sacro-iliac X and so gaps open the whole joint and draws down on lesion.

In still rarer cases the sacrum is found displaced dorsally. These cases give a history usually of some unusual form of violence, as wrenches in football games, railroad wrecks, etc. Diagnosis is difficult, may even be said to be presumptive and by exclusion. The correction is, however, extremely easy, so easy in fact that there is danger of over-correction, or of producing lesion where none exists.

Patient seated on table, operator stands behind. Assuming that the sacrum is displaced dorsally on the right: Operator places fingers of right hand along crest of ilium with enough pressure to secure a hold for the fingers; the thumb extending over the crest and bringing pressure ventrally on the dorsum of the sacrum by means of the hold with his fingers. Operator then passes his left arm under patient's left axilla and grasps patient's right shoulder, carrying patient slightly forward and partly supporting his weight. With the left arm he then rotates the patient's shoulders, the right forward, the left slightly backward until the spinal joints are all at the limit of their motion and on tension, then brings extra tension to bear in the same direction, with pressure from the right thumb. The lesion is usually felt to yield immediately.

**Mechanics:** Elastic yielding is prevented by thumb and finger pressure so that joint is gapped by the rotation and slid forward by the thumb pressure.

Many other forms of technic are in vogue. Many of them are open to criticism on this very simple mechanical ground — that they do not consider the necessity of having tension on both of the bones involved in the lesion. To break a stick it is necessary to have hold of both ends. For instance the following very simple form of technic for right anterior sacrum which looks at first sight very simple and correct, is yet found to be not effective, and for the reason that will be pointed out. Patient lying on face on table; operator stands on side opposite to lesion (left side) ; draws patient's shoulders from table until patient's axilla rests over operator's right thigh; grasps shoulder on side of lesion with left hand and lifts until all spinal joints are at limit of motion. With right hand reaching across table he presses down on posterior superior spine of ilium in lesion; then with extra pressure and lifting-rotation-traction of shoulder he endeavors to correct.

This technic is rarely successful for the reason that the pelvis is not fixed; so that the only effect of the effort is to turn the pelvis around the axis made by pressing the anterior superior spine against the table. The effort is not focussed on the lesion and

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is wasted. Sometimes, however, it is successful (where pelvis is heavy enough to fix left ilium against table).

The same criticism may be made of the technic which lifts the leg of the side in lesion while pressing down on the posterior superior spine. There is nothing to hold the sacrum. Except in patients with very large chests and relatively stiff spines, the effort is wasted.

Two forms of technic which depend for success on a sudden jar rather than on well directed tensions may be described. Patient prone on table. Operator stands at side of lesion. Lifting heels and sliding knees from table toward side of lesion (toward himself), with turning of pelvis, he carries knees well up (while chest remains flat on table). Operator then hooks pisiform bone of other hand under posterior superior spine of lifted ilium, prepared to follow it with pressure as it rotates toward prone position in next phase. Then grasping and lifting ankles until tension is complete, and keeping ankles well in air so as to lift knees above level of table, he swings legs back to prone or median position and beyond, with pressure always over posterior superior spine of affected side.

Mechanics: At moment of correction there is tension caudally (through legs) and ventrally (through pressure of hand) on ilium; and tension upward and dorsally on sacrum (through spine). The value of coming suddenly to limit of motion in this way is that patient's muscles are all relaxed and that the quick tension in the right direction more easily overcomes the elastic "set" of the parts.

The other form of using this same principle is applied with patient prone, assistant maintaining continuous heavy pressure over posterior superior spine of affected side; operator grasps ankle and lifts leg of affected side, and without allowing it to touch table, cracks it downward as though cracking a whip — a downward and an upward jerk, with traction.

## CHAPTER VII

### Aetiology of Lesion and Principles of Technic

With the description of the sacro-iliac lesion before us for illustration, it is possible for us to consider the etiology of lesions and the principles of technic. To some extent the conditions of the sacro-iliac lesion are true of all lesions, that is of all primary, direct or traumatic lesions as distinguished from warp or habit lesions. The contrast between these two and a more detailed description of individual lesions will be given later; the general principles only will occupy us now.

Primary lesions are due to a sudden straining of an articulation beyond its normal range of motion so that it is unable to return spontaneously. There is then found to be a double deviation, a deviation in two directions, from mid-position, as though having reached the limit of normal motion, and being strained farther, it turned in some abnormal way. In such position the articular surfaces are no longer parallel but assume an angle to each other. Some part of one side then engages against the opposite surface, and makes a dent, so that when released it does not slide back normally, but under the tension of the stretched ligaments assumes even a sharper angle, restrained by the dent it has made. The ligaments, radially disposed, permit this abnormal motion and even provide for the secondary deviation. In the resulting position the fibres of this ligament are not necessarily all stretched, but possibly only a few of the fibres are stretched, the rest relaxed.

The factors in lesion then are: motion beyond normal under high tension; assuming of an angle; indentation of a surface by a projecting portion; high tension of part or all of restraining ligament; in partially re- turning toward normal, the assuming of position still farther from normal.

The principles of technic here described apply to all such lesions. They are necessarily mechanical principles, and are exceedingly obvious as principles, though not so easy of application as they are of understanding.

First, it is necessary to have tension or pressure or fixation on both of the bones involved in lesion; as on both sacrum and ilium.

Since, however, it is rarely possible to take hold of the two bones, and in most cases is impossible to get effective hold of either of them, as in the dorsal and lumbar spine, it is therefore necessary to use other factors — positions in which there is ligamentous drag on the one, through the weight of the body; and motions in which all of the joints are at the limit of their motion, between the lesion and the point that can be taken hold of. This principle — that joints must be at the limit of their possible normal motion before corrective force can be transmitted through them or made effective on them is the point that seems to me most neglected, and to be responsible for most of the failures in technic. As for instance it is necessary to have all of the joints of the spine and of the shoulder at the limit of their motion before tension can be transmitted through them to the sacrum.

Third, it is necessary to so direct this tension or pressure that it comes to a focus at the point desired. As in breaking a stick held in the two hands it is possible to break it

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in the middle or near either end by differently adjusting the force of the two hands, so is it in directing the force of correction.

For instance in the first technic described for correction of anterior sacral lesion, if the pressure of the left arm is over the middle of the crest instead of over the anterior superior spine, the effect is not to cause gapping of the lesion, but to cause increased pressure over the point in lesion. The technic then takes effect at the last lumbar joint. So also if the spine be flexed, the effect of rotation of the shoulder backward is to cause strain at the apex of the posterior curve rather than at the point desired.

Fourth, it is necessary so to direct the force that it serves to release the engaged part from its indentation against the opposite surface; as in pressing down on the anterior superior spine the articulation is gapped open in the back, the front edge being the fulcrum therefore. To do this it is usually necessary to use one part of the articulation as the fulcrum for the other part. In a rotated dorsal vertebra, for instance, the engaged side is the side toward which rotation has occurred; as in a spine rotated to the right, the articular surface on the right is caught in flexion, the left side extends alone, producing secondary rotation to the right. To release this it is necessary to carry the left side to the limit of its motion and with that limitation as a fulcrum, to gap open and release the engaged part.

Fifth, with all articulations at their limit and the leverage adjusted, a quick spring is much more effective than steady force; it needs only a fraction of the force, with less danger of injury to soft parts, and gives a cleaner and more perfect correction. This because the parts engaged are elastic. The quickness of the spring should be in proportion to the elasticity. It is also easier to apply just the right degree of force, calculated beforehand, in the quick spring than in the steady pressure. A quick and shallow springing motion does not go so far beyond the instant of actual correction as a steady force, because in the latter it is impossible to calculate the moment of release, and so to check the corrective force.

### Meaning of the "Pop"

The instant of correction of a lesion is usually indicated by a "pop." This is not always the case. Also the pop may signify the making as well as the correction of a lesion. Let us examine the mechanical factors in the "pop."

In the lesion we have articular surfaces at an angle with each other, and some edge of one surface engaged against the other surface, making an indentation or a wrinkle of the tissue, by which it is held as a lesion. But this means that whereas at one point there is compression, at another there is separation, with a vacuum, or at best negative pressure, suction as we would call it, a potential vacuum. What fills this potential vacuum? The tissue of the joint we will remember is elastic; it is compressible, but it is also expansible. Gas or fluid may collect there under the differential pressure, but also the tissue may expand to fill the negative space. All of the bony tissue involved is under high pressure from the stretched ligament, whose elastic tension holds them in their false position. As Dr. McConnell discovered, if all of the ligaments of a joint be cut, the lesion will correct itself. (See also A. T. Still Research Institute Bulletin No.)

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When, therefore, under the sudden spring of the corrective force the engaged point is released, the readjustment takes place under all of these elastic forces. The "pop" is in proportion to the suddenness of the release and the degree of elastic tension of the ligaments and of the elasticity of the tissues compressed.

These principles of correction may be thus summarized:

Both bones must be controlled.

To transmit force, articulations must be at the limit of their motion.

Effort must be properly focussed on lesion.

It must be so directed as to release the engaged points.

One side of a joint used as fulcrum for the other.

Elastic spring to overcome elasticity of parts.

Many operators carefully avoid the "spring" technic, finding it painful and giving a shock to the patient.

They use a technic that involves so stretching the ligaments that release comes spontaneously. If cutting of all of the ligaments allows a lesion to correct itself, so will sufficient stretching of them bring the same result. Meanwhile the patient profits by the stimulation that comes from the stretching. The choice here is between the radical technic with positive results and the gentle technic with much greater expenditure of labor but less pain to the patient, and less immediate results, with greater danger of recurrence. Probably a combination of the two is best. Our purpose at present is to build a mental picture of the mechanics of lesions and their correction, for which purpose the radical technic is described. Different description of the gentle technic is not necessary; it consists in a gentler modification of the radical technic. The principle of this gentler technic is like that of moving a heavy barrel, by very slightly tilting one side and then rolling it. With a clear picture of all the leverages, with a practiced control of all tensions, and with persevering practice, this gentler and more ideal technic may be mastered.

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## CHAPTER VIII

### Lumbar Vertebrae

The purpose of the student should be to form a mental moving picture of the normal bone and the bone in lesion.

A lumbar vertebra stationary in mid-position is balanced over the core of the intervertebral disc, the weight of the body pressing down in front of this, the pull of the muscles drawing down behind. Over this as a centre of balance, axis of motion, or fulcrum of leverage, flexion and extension occurs by relaxation and contraction of the spinal muscles, by sliding out (flexion) and in (extension) of the articular surfaces, and by compression and decompression of the remainder (front part) of the disc.

### Limitation to Motion.

Limitation to the proper motion of extension occurs from the tensing of the anterior longitudinal ligament and possibly (rarely if ever) of the disc itself; and by bony contact (through intervening tissue) of the lower edge of the upper articular process of each joint (inferior articular process of the vertebra above) with the lamina of the bone below. The capsular ligaments, loose enough to allow of free flexion and rotation, are probably loose enough to play little part here, or even to allow separation as noted below.

Further motion can occur only by separating the articular surfaces and further stretching of the anterior ligaments. This, however, can occur if the bony contact permits of sliding, the ligament acting then as a radius of the further motion, and giving rise to secondary motion. It draws down the anterior edge, allowing the whole bone to move posteriorly with separation of articular surfaces. Into the vacuum thus produced capsular ligament may perhaps be forced by atmospheric pressure, especially at the lower edge. Lesion is thus produced, which, (except in warped conditions) in all likelihood corrects itself, as the forces tending to the normal are overwhelming and as there are no forces except position helping to maintain lesion. When maintained, it is an extension or approximation lesion. Approximation lesions (except in warps and secondary to separations above or below) are rare.

Limitation to the proper motion of flexion is from the tensing of the posterior longitudinal ligament, the interspinous ligaments and the capsular ligaments, and from compression of the disc in front. The disc is the softer of these, so the chief checking influence is the ligaments behind. Of these ligaments, the ligamentum flavum (posterior surface of spinal canal) is of yellow elastic fibres, and so highly elastic, being at the same time close to the axis of motion. The interspinous ligaments are not disposed longitudinally, but pass forward from top and bottom of each spine at about 45 degrees. That is, as in all cases uniformly throughout the whole body, they lie radially to the motion of the bones they hold (longitudinally to the direction of tension, radially to the direction of motion) so that they are tense at all times; and so that at the limit of their motion, a very slight stretching will allow comparatively great further motion; with increase in tension in proportion as they are inelastic.

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Beyond this point further motion can occur in cases of violence by the stretching of these ligaments. A change in the angle of motion occurs, though to a very slight degree, limited by the shape of the articular surfaces. The upper half of the articulation (inferior articular process of the upper bone) passes beyond the edge of the lower, assumes an angle with it, and receives an indentation from its upper edge, meanwhile being driven against it with great force by the stretching of the interspinous and other ligaments, all of which force the bony contacts against each other and increase the dent, and serve to retain it in that position as a lesion. There is gapping of the lower part of the articulation, and compression of the disc.

This secondary motion with lesion we may well believe rarely occurs in the median line, although median lesions — separation lesions — are sometimes noted here; for the reason that in the median line all of the ligaments are at their most favorable angle and all acting together, and tend to prevent the occurrence of lesion. When in extreme flexion, however, some other motion, as rotation or side-bending, occurs, then these ligaments cease to act together, one or two are easily stretched, and great danger of lesion arises. Then, by the very relation of the articular surfaces, one corner or edge of one side is forced at an angle against the opposing surface, making under the heavy pressure a more acute indentation, from which it may be unable to release itself unaided.

The proper motion of rotation in the lumbar region is in reality side-bending rotation. This fact we have already noted; it is due chiefly to the action of the anterior spinous ligament which, immediately the body of the vertebra has moved from the median line, acts to produce a motion of which it is a radius; drawing down the anterior edge and transforming rotation into rotation-side bending (and we might add, flexion also). From the position of extreme extension, rotation-side bending is accomplished by lifting of the articular facet of the convex side. Since even in this extreme position — indeed especially in this extreme extension, the anterior ligament also acts, any rotation becomes rotation-side bending. The result is that the articulation of the convex side is not only lifted, but moves forward; and in the opposite one (still at lower limit of motion) moves back and twists. This brings the lower edge of the inferior articular process (upper of the two in each joint) on the convex side against the surface of that side with indentation and possibly lesion. Lesion in this position is comparatively rare except from continuous warping with weakening of ligaments; for the reason that there is not sufficient edge on the articulation, no sufficient stretching of elastic ligaments in this position to maintain the angular pressure against the surface, and such lesions usually correct themselves.

From the position of extreme flexion, rotation does not occur (except from a yielding of all elastic tissues). From this position, side-bending occurs by receding of one articular surface.

This, however, immediately becomes rotation-side-bending. This occurs by the depressing of the articular surface of the concave side, with sliding back on the concave side and forward and in on the convex side, and torsion on both sides. The least exaggeration of this motion causes a change in the angle of motion which immediately brings the lower edge of the upper articular surface on the convex side

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into contact with the opposing surface of that side, with indentation and possibly lesion. As one recovers from such a position, unless he recovers the rotation before he recovers the flexion, lesion is very likely to persist. The concave side of the lesion moves toward normal, increasing the angle and the indentation on the convex side. The weight of the body descends and fixes it thus. There is no normal tension here leading to correction which does not also serve to maintain the lesion. The majority of lesions (except warp lesions) are of this character. They may be compared quite accurately to a bureau drawer which has become jammed.

Rotation in the median position is, as said, transformed almost immediately into rotation-side-bending, through the action of the anterior longitudinal ligament. The motion is radial around this ligament, as to side-bending; as to its rotation, it is radial around a point posterior to the articular surface, perhaps to the tip of the spine itself. Examining and experimenting with the actual bones makes the forming of a mental picture of this motion easier. Across the top of the body of each lumbar vertebra, near the back, is found a shallow groove which just about fits the finger tips. This groove is curved, concave backwards. Its curve is sharpest in the third vertebra, less and less in the fourth and fifth as also in the second and first. This curved groove points fairly accurately to the centre of rotation of the vertebra above. It is the groove through which moves the core of the intervertebral disc as each bone rotates on the one below. The difference in the arcs of those grooves verifies the work done by the classes referred to above in reference to centres of rotation of lumbar vertebrae.

The cores of intervertebral discs then become important. These cores are found nearer the posterior margins of the discs. They are more solid than the rest of the disc, and act on the principle of ball bearings. They are therefore necessarily fulcra for all motions of the bodies on each other, except that of rotation, because in rotation they themselves move, making this groove. In equilibrium of the body the line of weight passes in front of them, and in the median line; and the pull of muscles is behind them, but also (through transverse processes) on either side; all acting downward; so that this core is the teter of the balance. In flexion and extension it is the teter, the axis of motion, until limitation to motion arises at some other point. In side-bending it is also the axis of motion, which passes through it antero-posteriorly, also until limitation of motion occurs at some other point; when of course that limitation forms part of the axis of the motion. The axis, that is, passes through the core and the point of limitation. But in rotation it is merely a ball bearing on which the bone rolls. The body above immediately passes from its central position over the core and tilts; hence also side-bending; but it also carries this core with it, as in a ball bearing joint (since the core is fastened to the base above as well as to the surface below), hence the rolling motion of the rotation-side-bend. But we must not forget that also the core is squeezed to the convex side by the pressure from the inclined plane of the base above; qualifying this motion; bring it about that the greatest possible amount of effective side-bending is produced with the least possible extension of muscular tissue (as universally in the body) .

In rotation-side-bending, from the median position, the articulations of the concave side slide in (extend) before those of the convex side slide out (flex). Why? This is due chiefly to the action of the intervertebral disc, which is immediately squeezed to the

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convex side as soon as there is any tilting of the surface; hence without raising the convex side, it lowers the concave side. Remember also that the muscles that maintain the balance of the vertebra are in action continuously, and any change that involves contraction or shortening of muscle is likely to occur first rather than one that calls for stretching of it. Hence again, extension occurs first. The axis of this motion becomes therefore a line drawn through the intervertebral core and the articulation of the convex side; and it swings as this core moves.

Around this axis rotation side-bending occurs first by depression of the articulation of the concave side, doubtless to varying distances in different persons and under different conditions; possibly until limitation to motion on that side is encountered; then by elevation of the articulation of the convex side; the axis now being a line through the core and the opposite articular surface. (Again note that this agrees with the results of the work done by the classes referred to, where it was found that the two articulations of the lumbar vertebrae had not the same centre, but that the centre of rotation of each was a point posterior to the opposite articular surface, approximately; wider in the lowest, less wide in the upper, coinciding opposite the eleventh or the tenth dorsal, whose discs are so thin as to preclude such motion.)

This principle, the moving of one side at a time, is vastly important in correction of lesions. It enables us to use one side as a fulcrum for the disengaging of the other side.

The actual amount of rotation-side-bending in single joints is slight. But as the normal amount of actual motion is slight, so is the amount of excess necessary to produce a lesion slight; and this motion is just as important as though it were wide.

### Mechanics of Lesions.

Limitation to this motion of side-bending-rotation of lumbar vertebrae from mid-position is from compression of the disc, and tension of practically all ligaments, chiefly the anterior longitudinal, the capsular and the intertransverse. These limitations doubtless arise all at practically the same time. We may add, perhaps, bony contact (through intervening tissue) on the concave side. Under these limitations to motion the character of it changes if further motion takes place under force, the articular surfaces assume angles with each other so that (in rotation to the right) the superior edge of the lower articular surface on the right and the inferior edge of the upper articular surface on the left are engaged against their opposite surfaces; with indentation and danger of lesion; from which spontaneous recovery is not difficult because ligamentous tension from the inter-transverse ligament of the convex side, drawing outward and downward, tends to release the catch; but which may remain as a lesion. It is when to the tangle in this extreme position some other excessive force is added, as flexion, that danger of lesion is great, and spontaneous recovery is difficult.

### Mental Pictures.

To form a mental picture of limitations in extension and flexion, the student should use the technic described in Chapter IV, p 45, slightly exaggerating the motions.

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To form a mental picture of side-bending-rotation, the student should first experiment with the actual bones, then with these bones using elastic bands in place of ligaments (although it is not possible to arrange these bands just as the ligaments in the body are arranged) ; and should then use the living body.

To form a mental picture of side-bending-rotation in the living body:

(This technic has been found to be invaluable therapeutically, especially in cases of constipation; in about 15 per cent, of the students treated thus, results were immediate):

Patient seated on table; operator standing behind; places right axilla over right shoulder of patient, grasping left elbow of patient, whose upper arm should be held about vertically ; with left thumb operator prepares to press against the right sides of the spinous processes of each lumbar vertebra in turn, beginning with the fifth.

The point in executing the movement to be described is to keep the shoulders parallel with the edge of the table (no rotation) and also with the surface of the table (no tilting) while moving them and the trunk with them to the left; so focussing all motion on the vertebra against which the thumb is pressing.

Operator now moves patient's shoulders directly to the left, allowing weight to descend on right shoulder and lifting on left through the arm; at the same time pressing with the thumb against the fifth lumbar spine so as to carry that vertebra to the limit of its lateral excursion; which requires that the right ischium should be lifted completely from the table; all of the side-bending being thus concentrated on it ; and so of each lumbar vertebra in turn.

When the limit is reached, a definite check is felt; some further pressure should be exerted to stretch the ligament. The operator will then note that the costal and transverse processes of the concave or right side have moved far forward and are approximated to each other; while those of the convex or left side are prominent posteriorly and separated.

(At the limit of side-bending-rotation, or before, there is a strong natural tendency to flex the body as a whole. Note that the limit to pure side-bending is naturally at the costal and transverse processes, at the centre of the side ; further motion is then possible only by turning one way or the other, with separation of the bodies or of the spines ; of which nature prefers the latter, with flexion.)

Now if in this position of extreme side-bending-rotation he will extend the spine, he will note that the processes of the right side retreat still further; if he flexes the spine, he will note that they reappear again posteriorly.

The student should make a number of different experiments with the motion of lumbar vertebrae under different circumstances, as for instance the following:

Patient seated on table; inclined slightly forward. Operator stands behind, passes right arm under patient's axilla and places right hand on patient's left shoulder:

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Then places thumb of left hand on right side of spines of each lumbar vertebra in turn, in such a way as to feel two at the same time; places fingers of same hand on and between costal processes of these same vertebrae.

Operator then first swings shoulders so as to produce normal rotation-side-bending, noting motions of spines and costal processes.

He then swings shoulders so as to produce rotation only, by raising up on right shoulder and pressing down on left at same time that he rotates. The total amount of excursion is observed to be very much less.

Or, operator may place knuckle of left first finger on left sides of spines, with thumb extended along right costal processes; executing same movement.

Or, operator may place his right axilla over patient's right shoulder and grasp patient's left elbow with right hand, pressing instead of lifting in producing rotation.

### Diagnosis.

If a spine is in the median line and equidistant from the spines above and below, it is hardly possible that lesion exists. For it is hardly possible that a spine will be bent in one direction and in lesion in exactly the opposite direction and to the same distance.

There exists a variety of lesions that may be called masked lesions, in which the deviation is not evident in one position, but is in another. In the sitting position it may be drawn to the median line by tension of surrounding parts, but become apparent in lying prone, or on one side. Especially may lesion be masked when lying on one side, but become quite apparent when lying on the opposite side.

When deviation is observed, laterally or longitudinally, it may be due to bent spine or other irregularity, to a very freely moveable vertebra, to compensation for some other lesion, or to lesion in the vertebra itself (lesions are always reckoned with reference to the vertebra below; thus a deviation between the third and the fourth is a lesion of the third).

Examination must then be made for other signs of lesion. These are restricted movement (not necessarily absence of movement) , tenderness, contracture and visceral disturbance. In an experience of over fourteen years I have not found these signs always present by any means, since functional compensation may have removed them; nor have I found that their absence proves the non-existence of lesion; nor have I found that their presence proves lesion, since they may all arise from reflex irritation due to strain of some function whose nerves centre at that point. The best proof of a lesion is that it can be corrected. Remembering that lesions are easy to correct (usually) and hard to create, one seems justified in trying to correct any deviation. If it resists correction that is one evidence that it is a bony abnormality and not a lesion.

Limitation to motion is the most reliable of the accessory signs of lesion. Perfect freedom of motion proves the non-existence of lesion, but practically this is very hard to determine. In most lesions, lateral deviation plus longitudinal separation plus

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limitation of motion exist at the same time, and the direction of the deviation corresponds with the character of the limitation to motion. In a third lumbar vertebra deviated to the right, there will be found separation also, as a rule; in complete flexion of the spine the lateral deviation may entirely disappear, and in extreme extension it may be aggravated. This defines the limitation to motion—the extension is limited on the right side. This combination of evidence practically proves the existence of lesion.

In examining for lesions we are limited to digital exploration. As yet no method of mensuration that is effective has been devised. The use of the tape line has been tried and has given many results that cannot be explained as yet. The tape should be fixed at the spine of the seventh cervical vertebra, and the reading at the lower margin of each spine should be recorded. The interval from each one to the one below should be then recorded in eighths of an inch, discarding the denominator. An easily read record is then obtained. This should be done first with the patient erect, and then again with the spine fully flexed. Lateral deviations are easily and accurately recorded by means of the tape in the exact centre. It is then found that the longitudinal deviations are more numerous than the lateral ones. Limitations to motion are easily noted by comparing the two records. In quite a large number of cases it is found that the interval between spines is actually diminished instead of increased in flexion — a positive reason for which cannot now be given. The difficulty with this method is that it is not technically accurate. Some study should be given to this problem. It has been recommended that examination for lesions should be made at the transverse processes rather than at the spinous processes. Except in very thin persons this is difficult or impossible on account of the over-lying muscles and fat. It also is subject to the same uncertainty that forms the chief difficulty in diagnosis by the spines — irregular transverse processes also occur, though perhaps not so frequently.

### Technic.

Scientific technic must necessarily be based on two factors; the first a scientific examination of the mechanics of the articulations and their movements and the etiology of lesions; and the second a practical study of the methods that have worked out best in practice. No theoretical science in the world is so perfect that it can come to practical success without practical testing. There is always more in the fact than can be determined in theory. Practical experience, which in this case was worked out independently of theoretical examination, has, however, worked to the same end. The two agree.

The majority of lesions of the lumbar region are warp lesions, to be cured by posture and exercise. But in this case the technic that is effective for warp lesions is also effective for the majority of lesions in the more strict sense, single acute lesions; which by contrast we might call radical lesions, major force lesions, traumatic lesions.

The problem is to disengage the lesion at the indentation, where it is caught, and to move it toward the normal. In order to do this, the problem is to so apply force and to so control the two bones involved as to move them beyond the point where they were at the moment that the lesion was formed; or by leverage to release the catch; and in such a way that immediately upon the release they will assume normal relationship.

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The majority of major force lesions of the lumbar region occur in extreme flexion with rotation to one side. The problem then is to so carry them to extreme flexion again that the rotation will be overcome; the catch disengaged, and in the same act they will be carried to a position from which they naturally recover mid-position.

Assume lesion of third lumbar, catch on right, spine deviated to right; 'Have patient seated on table, operator standing behind. Operator places "heel" of left hand against two bones in lesion, slightly below tip of spine of third; rotates patient slightly to right, so that in next phase he can rest elbow on table behind; passes right arm over patient's right shoulder, grasping left elbow, and draws patient back against wrist of left hand, left elbow descending to table and bearing whole weight; patient should be thoroughly relaxed, resting on operator's shoulder, head resting on operator's neck. Operator then lifts with both hands directly toward patient's head. Correction will usually- then occur.

Mechanics: All vertebrae of the spine are thus in extension except the ones against which the hand is lifting, which are in flexion. The traction on the spine above lifts and draws back on the third vertebra; the pressure over the right wrist throws it into flexion; the drag of weight acting through the ligaments draws the lower of the vertebra (fourth) away from it until it is straight, and the catch is released; and immediately carries the upper articular surface against the lower in such a way that normal relation is immediately reassumed and the lesion corrected.

If the lesion is very much rotated, say to the right, the operator may slightly exaggerate the turning to the right, to secure rotation of the third to the left.

This technic is available from the fifth lumbar to the mid or even the upper dorsal vertebrae, and is effective for rib lesions as well, though some caution must be employed in applying it to rib lesions in delicate persons.

Caution. The mistakes commonly made in this technic are first in drawing the patient back against the hand instead of lifting toward patient's head with both hands ; the result being that the violence of the lesion is increased. Second, the operator may unduly stretch the skin over the spines by allowing the hand to slip upward on the spine, thus causing considerable pain to the patient.

In very heavy persons some pain may be caused to the operator's wrist unless caution is employed, until the wrist has been accustomed to the strain. A second form of technic may be employed, utilizing the sound side as a fulcrum by which to release the engaged side.

Patient seated on table, operator standing behind; places thumb against prominent side of spinous process of vertebra in lesion. Assuming lesion to right, places left thumb against right side of spinous process, prepared to exert pressure toward left. Operator passes right hand under patient's right axilla and grasps left shoulder; allows patient to flex spine, leaning slightly forward, operator sustaining part of weight; presses down on shoulder until lumbar spine is bent back to full flexion. Operator then rotates shoulders to right (forward on left, backward on right), lumbar spine moving to left, to full rotation; presses with right arm to secure both full flexion and full rotation.

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Mechanics: At limit of motion, the left articular facet of the vertebra in lesion reaches a fixed point, re- strained by capsular and other ligaments, at extreme upper part of excursion, pressing against opposite articular surface in direction forward and to left. Further motion in this direction, acting against this as a fulcrum, draws right articular surface (the one in lesion) backward, upward and to left — disengages it. Operator produces such motion by further rotation with firm pressure downward on left shoulder, lifting the right if necessary; and exerting smart pressure with thumb against vertebra in lesion. Note. In order to make firm and steady the pressure with the left thumb, it is often convenient either to plant the fingers against the flesh at the proper distance, or else to anchor the knuckles of the first finger against the opposite side of the spine below, the lower of the two in lesion.

The "Corkscrew" motion may be employed in the gentler "heavy barrel" technic. It is produced as follows:

Patient seated on table, operator standing behind; places left hand of patient on right shoulder; operator places axilla over right shoulder and hand lying thereon, passes right arm under left elbow of patient, against chest, places hand under left axilla, grasping left shoulder from beneath. Thumb of operator's left hand rests against right side of spinous processes, knuckle of first finger against left side of one below, prepared to press forward and from side to side.

Operator then draws patient toward him (standing at rear and to right of patient) ; then with elbow pressing against patient's chest, presses the spine back to full flexion;; then transforms flexion into side-bending to left by pressing down on right shoulder while lifting on left, pressing also with thumb to left; then trans- forms side-bending into extension by pressing forward with thumb while shoulders are retained in mid-position; and again transforms extension into side-bending to right by lifting on right shoulder, pressing down on left, and drawing lumbar spine to right. This motion is then repeated more rapidly until it is sure that patient is thoroughly relaxed. Then turning patient gradually more and more to right to limit of flexion and rotation while the corkscrew motion is kept up, the mechanics of the previous technic becomes effective and the lesion is corrected.

Innumerable different forms of technic are in use throughout the profession. These illustrations will serve to show the application of the mechanical principles described. The student should in all cases form a moving picture of the bones acted on by the ligaments and by the forces used in correction until he can visualize the mechanical factors in correction at the time they are occurring. These things should be rehearsed until they have built themselves almost into the subconscious thought of the operator. There are enough factors in a treatment that claim the conscious attention; and all that could be should be so rehearsed that they will be easy under any circumstances. Only thus will their operation be sure.

### Dorsal Region: Movements

There is slight movement of flexion and extension in the dorsal region, but except at the lower two or three dorsals and the upper two dorsals it is very slight. With the spine in erect position and the hand on the head causing passive flexion and extension, this is felt more as an elastic yielding than as a motion; it being remembered that the

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spinous process, twice as long as the distance from axis of flexion (Articulation of rib) to articular surface, moves twice as much as the articulation itself.

The axis of flexion and extension is the head of the rib where it articulates with the lower facet of the vertebra. This was well shown by Mr. (now Dr.) Louis E. Browne, in the class referred to. The narrowness of the disc itself shows how slight is this flexion and extension, as does the fact that the articulation at the head of the rib is not shaped for such motion at all, arguing only a slight elastic yielding at the axis of motion.

Rotation of the spine as a whole occurs in the dorsal region. In extended position it occurs almost wholly in the lower dorsal and upper lumbar vertebra; in erect position in the lower dorsal; in semi-flexed, in mid dorsal; in flexed position in the upper dorsal only. The factor or at least one factor determining this may easily be shown; it is simply that when in the fully flexed position of any vertebra rotation occurs, it is accomplished by the extending of one side; that is it involves extension; and cannot occur if flexion is fully maintained. Flexion occurs first in the lower vertebrae and last in the uppermost ones, therefore rotation is lost first in the lower dorsals and last in the upper dorsals.

Movements of rotation in single vertebrae are also very slight. This is indicated by the smallness of the articular surfaces, by the way in which the inferior articular surface from the bone above overlaps at its edges the slightly smaller surface below (indicating motion restricted to the larger surface) by the smallness of the articular facet of the rib (which is the axis of flexion and extension but not of rotation and must also move in rotation) and by the limitation set by the tissues surrounding the ribs.

Nor is it probable that movements of rotation are pure, but are compounded of rotation and side-bending to probably equal degrees, especially as we approach the limits of motion. This is indicated by the costal facets and by the shape of the upper articular surfaces. Although the costal facets are so placed that they could allow a slight degree of rotation in the horizontal plane around an axis near the centre of the body, by pushing the rib down on its inferior facet; yet the place of the facets indicates motion at an angle of about forty-five degrees from the horizontal. Direction of motion being determined by the articular planes, that of dorsal vertebrae would be in the direction common to the two planes of the facets and of the spinal articular surfaces themselves, which is about forty-five degrees up and forward.

Now if we will examine the actual bones we will observe that the facets on the lower borders of the vertebral bodies, (those for the upper facets on the heads of the ribs) are the best formed and defined; they are the ones on which motion evidently occurs; while the facets on the upper borders (those for the lower margin of the head of the rib) are evidently those by which the ribs adhere to the bones (the rib belongs with the lower of the two bones; being a branch from the upper edge of each segment; as proven by analogy with vegetable forms, by the eleventh and twelfth ribs, and by the joining to the transverse process of that vertebra.) Motion occurs at both of these facets in respiration and other motions of the ribs; sometimes doubtless in motion of the vertebrae themselves. But it is evidently the facets on the inferior border that determine the motions of vertebrae. Placing the finger then in such position that it is flat against both of these articulations, (costal and spinal) it will be found that it points up and forward and out; up at an angle of about forty-five degrees in the lower dorsals,

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the angle growing less until it is almost horizontal in the third or fourth dorsal, and is practically lost on the second, the costal surface being there not a plane but often a cup-shaped surface, showing little or no motion; while on the first dorsal the articulation is altogether with the first dorsal and not at all on the seventh cervical. This angle determines the amount of side-bending, which is greatest in the lower dorsal and is lost in the upper dorsals.

The forward angle of the pointing of the finger (indicating angle of rotation) likewise changes. In the lumbar region, as said, it is backward; in the twelfth dorsal it is also backward; in the eleventh usually directly outward; in the tenth slightly forward, more so as we ascend until about the fifth, when it changes again until in the second or first it is directly out, or may point even backward; such vertebrae having no rotation at all, but only unilateral flexion and extension.

This again coincides with the work done in the classes of the A. S. O. referred to, where it was found by all students that the centres of rotation were in front of the articular surfaces in the dorsal region; were farthest away in the lower and upper dorsals, nearest in the mid dorsals where rotation was greatest and sharpest ; the center being at infinity in the eleventh or tenth and in the second or first, being for the most part near the front of the body of the vertebra in the average mid- dorsal vertebra. Except that in many spines examined the centres of rotation of the upper dorsal vertebrae- were extremely irregular, on account of the extremely slight degree of true rotation in that area. In those vertebrae whose centres of rotation are at infinity there is of course no rotation; but rotation of the trunk is nevertheless aided by unilateral flexion and extension (the articular surfaces being sloped forward). In such vertebrae it is to be noted that the rib does not articulate with the vertebra above, but has only the one facet on the body.

A curve formed by continuing the line of the pointing fingers on the two sides inward until they meet would define the arc of movement of the vertebra. This arc points up and out and forward on both sides. A further illustration of this side-bending-rotation is found in the shapes of the superior articular surfaces. Rotation up and out and forward would naturally cause the upper and outer corner of the superior articular surface to be bent forward. Examining the articular surfaces we find just this to be the case, at least in the lower three or four vertebrae, where the articular surfaces are bent like propeller blades; and this is apparent chiefly in these lower vertebrae because it is here that side-bending chiefly occurs. All motions are less in the upper dorsals; among other reasons on account of the shortness of the ribs.

The best way to fix these facts in mind is to make practical use of them. Note that a strain beyond the normal is likely to affect different parts of the spine according to direction of the force.

Strain of rotation in the erect position is likely to be felt in the lower dorsals; in the semi-flexed position it is felt in the mid-dorsals ; in the fully flexed position it is felt in the upper dorsals ; and anyone may quickly and easily test this matter in his own body.\*

The greatest danger of lesion is where the limitation to motion is greatest. It is a mechanical law that there is a point of mechanical weakness where a large part joins

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a small part; as in a nail driven in a wall, the nail will bend just where it leaves the wall. Danger of rotation lesion is therefore greatest just at the upper end of the part that is locked against rotation by flexion; lower down in extension, higher up in flexion.

To focus corrective force of a rotary nature on the lower dorsals, the upper dorsals should be kept straight, as by means of an arm under the chest. To focus it in the mid-dorsals the lower dorsals should be flexed, the upper ones extended, as in bowing of the spine while the head rests on the folded arms. To focus it on the upper dorsals, the head and neck should be used as levers, protected against injury by the supporting hand on neck, while the spine below the point treated is flexed.

Lower dorsals are carried to the limit of their normal motion by flexion-side-bend-rotation, mid dorsals by flexion-rotation, upper dorsals by rotation. Strains of a different character have a tendency to produce lesions, especially if they occur at the limit of motion.

In diagnosis, in exploring for limitation to motion, it must be borne in mind that — It must first be borne in mind that individual skeletons vary and that much research and comparative study needs to be done on this point before safe generalizations can be made. So far as such work has been done, it points to the fact that side-bending, or unilateral flexion and extension, is greatest in the lowest dorsals, that true rotation does not occur here but is greatest in the mid-dorsals, that practically all motion beyond a mere elastic yielding is often lost in the upper dorsals.

It must then be borne in mind that one finds occasionally single vertebrae that have acquired such great freedom and width of motion that they are practically never in the median line, and when apparently in lesion to one side, move as easily to the opposite side with the least effort on the part of the operator. These occur usually when there is abnormal limitation to motion above and below; and are found with greatest frequency at the eleventh dorsal, on account of the limitation to rotation in the lumbar spine which arises from the civilized habit of sitting or standing with the lumbar spine fully flexed. Rotation does not occur in the fully flexed spine, so long as flexion is maintained.

Side-bending is greatest in the lower dorsals and least in the upper dorsals, where it is practically lost.

A side-bending strain involving the whole spine will take effect chiefly in the lower dorsals. If it involve the upper dorsals, however, it is much more likely to produce exaggeration of motion and so lesion. Such a lesion is pretty sure to show itself as a unilateral flexion lesion, with rotation of the spine to side of lesion. Measurement with tape line reveals that whenever there is lateral deviation there is almost certain to be separation, with compensatory approximation above and below. Examination for limitation to motion is of very little value in upper dorsals.

Side-bending corrective force is focussed on different parts of the spine chiefly by pressure with the thumb; but also by different use of the muscles of the shoulder. Keeping the shoulders well up tenses the long muscles to the lower dorsals. Drawing the shoulders forward in mid position tenses the muscles to the mid-dorsals. Drawing

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them down tenses the muscles to the upper dorsals. Side-bending of the upper dorsals is however best accomplished through the head and neck.

Taking up the point of the movements as determined by muscles, we discover the astonishingly simple fact that the costal facets on the inferior borders of the vertebrae point always toward the shoulders; being in line with the muscles that cause their motion. Can further simplifications be discovered of this character? We find of course that the spinal articular surfaces are in line with the pull of the erector spine muscles; we find that they are concave toward the line of the centre of gravity; we note that they are directly behind the base of the bodies of the vertebrae, and perpendicular thereto.

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### CHAPTER IX.

#### Dorsal Region

##### Limitation to Motion: Lesions

The chief limitation to motion in the dorsal region is perfectly obvious — it is the flatness of the top and bottom surfaces of the bodies, and the thinness of the intervertebral discs. These do not prevent motion of pure rotation, but they do all but prevent any other kind of motion — except to slight degrees. Motion to slight degrees is all that we find in other direction. But it matters not how slight is that degree, the shape of articular surfaces is adjusted to it, and when it is exceeded, the danger of lesion is just as great as though it were wide.

Limitation to motion of extension is from tension on discs and bony contact of articular processes with bone below. Exaggeration of this motion and lesion is hardly possible.

Limitation to flexion is first the flatness of the bodies and the thinness of the intervertebral discs. Second it is the interspinous and other ligaments behind; yellow elastic cartilage where they are in line with the motion; white fibrous where they lie radially to it.

When the limitation to motion has been reached in flexion, the anterior edge of the body acts as a fulcrum and any other motion tends to gap open the spinal and costal articulations behind. But under the forward pressing weight which causes flexion, these may slide forward over the anterior edge of the one below, bringing the surface of the inferior articular processes (upper of the two in each joint) against the top edge of the surface below; with possibility of indentation and lesion. The ligaments, all tensed by this exaggeration of motion, serve to drive it with greater force against this edge and to hold it there. Lesion in the median line is not so frequent as lesions in other positions, merely because in the median line the ligaments are at maximum strength in resisting. Yet pure flexion lesions are by no means infrequent in the dorsal region. When, however, in a position of extreme flexion, other motion is added with exaggeration of motion, then is the greatest danger of lesion; because the ligaments of only one side, bearing the strain, are more stretched and allow greater exaggeration of motion for a given force, and cause engagement against a corner instead of a side, with greater indentation and more power to hold.

In pure rotation the first limitation to motion is the costal articular surface on the inferior border: which allows rotation around a centre not far from the centre of the body, for a short distance, but deflects it upward, transforming it into rotation-side-bending. The spines rotating to the right, the side-bending carries the transverse processes up on the right.

(Note that in the lumbar region the axis of rotation is behind; the bodies rotate while the spine is open stationary; rotation means rotation of the bodies to the right and side-bending down on the right. In the dorsal region this is reversed. The axis of rotation is in front; the spines rotate, the body being often stationary at its front edge; and side bending is up on the same side.)

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The limitation to motion in rotation-side-bending in the dorsal region is wholly ligamentous, unless the head of the rib may be regarded as slightly such a limitation. Probably all of these ligaments are so adjusted that they reach the point of limitation at about the same time. Pure rotation-side-bending lesions are probably therefore not so frequent as lesions caused when to extreme rotation-side-bending is added flexion. Such lesions do occur, however. The strongest of the retaining ligaments is beyond doubt the intervertebral disc, whose action is to throw the axis of rotation nearer the centre of the body ; causing on the convex side jamming of the upper articular surface against the upper and outer corner of the articular process below, with indentation and lesion, and on the concave side, gapping open; doubtless only a momentary state. When to this motion flexion is added without recovery from the rotation, it simply strains the point of contact to a point farther down on the articular surface with more distortion, greater ligamentous pressure, deeper indentation and more likelihood of lesion.

### Diagnosis

Diagnosis of lesions in the dorsal region is made in the same way as in the lumbar region.

### Technic

In the first technic described, that for examination, a corrective effect is obtained, which is not positive but is often effective in slight lesions.

Patient seated, operator stands in front; patient places hands on operator's shoulders, and head against operator's manubrium; operator reaches hands around patient and places fingers on either side of spines of vertebrae; and by pressing down, carries spine to full extension; at the same time by lifting patient's arms by means of operator's arms underneath he elevates ribs. In the lesion, the upper edge of the lower articular process is engaged against the surface of the one above throwing the latter into flexion, or separation. In this technic the fingers pressing against the articular processes below tend to carry them away from the point where they are engaged; or pressing against the spine above, tend to flatten it out, making the lower edge of the upper articulation the fulcrum for releasing the surface from its midway catch against the edge of the lower.

Note that the articular process is opposite the base of the bone, (opposite the cartilaginous joint), while in the fifth to the tenth, the tip of the spinous process is directly opposite the articular process of the next one below, so that the finger may press on both spinous process of the bone above, and also on articular process of bone below, at the same time.

In the horizontal position of the animal spine all tensions are such that the vertebrae are automatically held in normal relation, or if in lesion tend to be drawn to the normal. The following technic utilizes this principle, reproduces the tensions as in the horizontal animal spine.

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Patient lies on face on table; rises on elbows, so that upper arms are vertical, forearms lying along the table. In this position the tensions are as in the animal spine. The ribs in this position support the spine. The rib of the side in lesion belonging to the vertebra in lesion is thrust forward, and so bears a relatively heavier tension than the rest, tending to press the vertebra backward and so to release the lesion. (Whatever be the direction of the lesion, certain fibres of the muscles will be stretched, and in this position which tenses all muscles these fibres act to put strong backward tension on the rib — since all muscles attached to ribs draw toward the spine.)

Operator stands at either side of table, places thumb on articular process of lower of the two bones in lesion, pressing down (tending to directly release) or on upper of two bones, pressing down and out on spinous process, making fulcrum of lower border as in previous technic, to release the catch above. Patient is directed to let his head hang down. Operator then rotates head from side to side to the limit of motion in each direction, with extra tension down and to side if necessary, and with pressure from thumb as required, until lesion is felt to be released.

If extra leverage with the head is necessary, the operator may brace the patient's shoulder on either side against his abdomen to prevent pulling patient so that upper arms are not vertical. It is an important point to keep the arms vertical.

If patient's shoulder-blades come so close together that ribs cannot be reached, operator may press patient's shoulders to side, uncovering ribs of that side, until he is able to apply thumb to lesion.

Caution. The head in such technic should be kept low, and the face should be turned slightly to the side to which the head is being carried — the face should go first, in either direction; for if not the effect of the tension is on the vertebrae of the neck, in a position that is practically abnormal for the neck — extension and rotation. With the face slightly turned in the direction of the pull, the effect is to cause side-bending of the opposite side well down in the dorsal region, with tendency to release the catch.

This technic is available in some patients through the whole dorsal region, but is less likely to be effective in the lower three and the upper two, where indeed it is rarely effective. It is effective also for rib lesions. It is especially valuable in asthmatic patients.

This same principle may be applied with the patient supine, but requires some strength of fingers.

Patient supine on table, operator stands at either side; crosses arms of patient over breast, arm nearest the operator being below, other above (otherwise the patient's elbows will be in line with the sternum of operator, whereas with near arm below they are on opposite sides of manubrium as operator presses breast against them in next phase; the elbows in this position present a broad surface for pressure of operator's chest); operator draws patient's arms taut down against patient's chest so as to bring pressure against ribs, and to tense pectoral muscles; operator then applies his own chest to patient's elbows ; not too low — about the second costal cartilages, pressing down slightly ; lie then passes his two hands around patient's body and applies them to lesion; with knuckles resting against table and fingers raised against lesion, he

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exerts firm pressure upward against lesion or bone below, or both. Then with his breast he makes a quick and firm pressure against the elbows in the direction of the lesion or slightly above, while maintaining firm upward pressure with fingers. The effect of this is the same as above — it disengages the catch by carrying the lower of the two bones away from the upper, or by making a fulcrum of the lower border of the upper articular surface.

Some practice is necessary to use this technic to the best advantage. Properly used it is one of the most effective. It is effective in some patients as low as the eleventh dorsal and as high as the third. In adjusting the lower lesions the elbows should be carried farther down on the patient's chest and the direction of pressure of the operator's chest is lower. In adjusting the upper vertebrae the patient's arms and the pressure of the operator's chest are more nearly vertical. This is especially valuable in anterior upper dorsal warps.

Caution. In some patients the coracoid processes are long and the arms in this position exert smart pressure against them so that the technic is very painful. In such patients this technic should not be used or should be used with proper caution. Sensitive shoulder muscles also may cause considerable pain and this also should be guarded against. In patients with valvular lesions it is contra-indicated.

This same principle but without use of the shoulder muscles may be used with the patient seated; operator standing behind; passes arms under patients arms and clasps hands against manubrium drawing patient back against operator's chest; then lifting and drawing quickly backward on manubrium, patient being completely relaxed, the lesion is released through pressure of the ribs and drag of the rest of the vertebral column. This technic is available in the upper two or three dorsal vertebrae. It is necessary to be sure that the pressure of the clasped hands is against the ribs belonging of the upper of the two bones in lesion, and that the contact with operator is below that point.

Caution. This technic too vigorously applied has been known to injure the sternum, or the cartilages of the ribs.

The spines of dorsal vertebrae extend sharply down and somewhat back, varying in the different regions (more sharply back in the upper and lower dorsal, more sharply down in the mid dorsals). Pressure to the opposite side on a spine rotated to one side therefore tends to carry the articular surface down on the affected side and up on the opposite side, thus increasing the articular surface back on the affected side against the tension in the engaged point; but tends also to draw the fulcrum of the sound side, and so to release it. Technic which offsets the first of these effects leaves the second of them effective in releasing the lesion.

Patient seated on table, operator standing behind, passes arm under patient's arm on affected side and grasps opposite shoulder; presses with thumb against prominent side of lesion ; executes a modified corkscrew motion to secure relaxation of patient; then carrying trunk to the limit of rotation so that ligaments and articular surface on opposite side are all tense and so create a fulcrum, he lifts and draws back on near shoulder and draws forward on opposite shoulder, while pressing with thumb against

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lesion. If this is not effective, he may while holding all in tension thus, carry patient first to full flexion and then to full extension, and repeat until lesion is overcome. Release occurs in full flexion plus rotation.

The technic for the upper three dorsals is more difficult than that for the rest. Here motion is slight, and lesions frequent; and here the shoulder muscles have little value. Recourse is usually had to the leverage of the neck.

With patient seated, operator standing behind, thumb is placed against prominent side of spinous process of vertebra in lesion; patient's head is drawn forward to full flexion and to side opposite to side of lesion, stretching ligaments of side in lesion; is then swung without releasing flexion to side of lesion, to limit of motion, then pressure down and back is added. This tends to separate articular surfaces, aided by pressure of thumb. Or pressure of thumb may be against articular processes of vertebra below; or thumb may press against spinous process of vertebra in lesion, knuckle of first finger against opposite side of spinous process of vertebra below. Holding thumb and finger in this position, the head may be swung from side to side always in flexion to limit of side-bending, until lesion is released.

For lesions that resist these corrective measures, a technic that involves side-bending only may be employed. Patient lies on side on table, lesion side uppermost. Lifting patient's shoulders from table, operator places on table under patient's shoulders his knee and thigh, using the leg nearest the foot of the table, and laying it flat against table on outer side of thigh (assuming lesion to right, patient lying on left side, he places his left leg on table) ; then lowers patient across thigh so that leg fits into axilla, patient's arms being up and forward, out of the way. Across this fulcrum he presses patient's head down to limit of motion, stretching ligaments of lesion; then lifts head up to limit of motion (always remembering to keep face toward side of bending) with pressure against prominent side of lesion, repeating with wider stretching of head and heavier pressure (within limits) and if necessary with greater and greater degrees of flexion, or extension, until lesion is felt to be released. In this technic the rib braced against the thigh aids in fixing the vertebra below and in focussing the corrective force.

This technic is available from about the seventh dorsal to the first dorsal. With traction upward instead of downward it is effective for lesions of opposite side (to left). It is available also for many rib lesions.

## CHAPTER X.

### Twelve and Eleventh Movement

The eleventh and twelfth ribs are simply joined to the pedicles of their respective vertebrae, posterior to the bodies, at some distance from the transverse processes, which are very short. They stand as it were erect, without other bony support or limitation.

In these two ribs all movements are possible, limited only by ligaments and muscles that attach to them. Of these the capsular ligaments are the most strict, but have no effect on the varieties of motions possible. Ligaments doubtless attach to the transverse processes, and should be studied. The intercostal fascia is poorly represented. The most effective of the ligamentous limitations, however, is this intercostal aponeurosis, which in the twelfth rib extends down and in to the costal process of the first lumbar, and above, up and out to the eleventh rib. It draws the rib down and in, from the middle third, and up and out from the spinal end.

### Lesions

Any movement of a character sufficiently extreme to carry the base away from its articulation on the pedicle may create a lesion. The tensions that hold the rib to its base draw not directly to that base, but quartering toward the spine. When strained beyond the normal articulation with the base, these tensions so draw it against the articular surface that in trying to re- turn to normal a wrinkle may be made, which wrinkle may hold it as a lesion.

The lesion may be in any direction from the base. The most usual direction is upward and forward, produced by blows from behind and below (almost the only blows that reach it) or by wrenches in which the shoulder is twisted backward on that side. In this movement the tension of the abdominal muscles acting mostly on the tip, draws down and forward, while the ligaments to the eleventh rib, together with the intercostal muscles, draw upward near the head. The combined tensions gap open the upper part of the articulation, twist the rib, slide it upward in the twisting, and leave it as a lesion.

### Diagnosis.

Diagnosis of lesion of this rib is made by comparison with the opposite side, with ribs above, with the average normal, and by sensitiveness and visceral disturbance traceable to it.

For these ribs, particularly the twelfth, exact technic is perhaps the most difficult of all parts of the body, on account of the absence of bony leverage by which to draw the rib away from its point of engagement.

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### Technic

Patient kneels on table, feet over edge, and sits back on heels; clasps hands behind neck. Operator stands behind and to side of lesion. Assuming right twelfth rib to be in lesion — operator passes right hand under right axilla and places it over clasped hands of patient; places left thumb on rib as near to head as possible; between it and the eleventh if lesion is upward; below if lesion is downward. Operator then swings patient's spine to right, so that he sinks off from seat on heels to right; supporting weight with right hand and arm under axilla; keeping neck as near the median line as possible. In this position the spine is bent to the right to the limit of its motion, the twelfth rib is drawn up at its outer extremity by the intercostal muscles tensed by the raising of the arm; the intercostal aponeurosis below, acting on the centre of the rib, acts as a fulcrum, and the thumb pressing forward, outward and downward, moves the head to its normal seat.

The same principle may be applied with patient seated on table. Operator stands behind. Patient places left hand behind neck, operator passes left hand under left axilla and places it over patient's hand on back of neck, forearm supporting axilla. With right hand he presses forward on eleventh dorsal vertebra until spine is in full extension; then with right thumb on head of rib as above, he produces side-bending to right, retaining neck as near median line as possible, focussing motion at the twelfth rib. To this complete extension and complete lateral flexion, then some rotation is added until the lesion is felt to be released. If not released, operator may then press downward on neck, carrying spine suddenly to flexion, while maintaining side-bending rotation and pressure with thumb; and may alternate extension and flexion until correction is made.

The same principle may be employed with patient on hands and knees.

In all of these forms of technic deep inspiration may be of some assistance. In deep inspiration the intercostal muscles are tensed, drawing up and to the spine, and the diaphragm is also tensed, drawing up and on the tip of the rib and transversely across the body.

The technic for the other ribs in general may be used for these ribs.

### Tenth to Third Ribs: Movements

In inspiration the ribs turn slightly on the transverse processes, and slide forward on the lower and backward on the upper facet against the bodies of the vertebrae. From extreme expiration to extreme inspiration the total of motion is rarely over two inches at the tips of the longest ribs, and in some of this at least the vertebrae themselves share; a maximum of two inches at the tip of the rib means very slight motion indeed at the transverse processes and facets; even the slight apparent motion being diminished by the motion of the vertebra itself and the yielding of the elastic cartilages and ligaments.

In flexion and extension of the body the ribs move as in inspiration and expiration.

In side-bending of the body each rib moves with the vertebra to which it belongs, the vertebra above sliding on the superior facet of the rib. It may even press the rib down

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on the concave side, the rib sliding down and out on its inferior facet, and out on the tubercle at the transverse process ; doubtless this motion is in all cases exceedingly slight; but it explains the discrepancy between the centre of rotation of the articular processes and that of the costal facets.

In this motion the tips of the ribs remain relatively stationary on both sides, being fastened together in front, unless there is inspiration at the same time; while on the convex side the extreme lateral part in the axillary line moves relatively down (unless there be inspiration at the same time) and on the concave side, up ; with corresponding turning at the transverse processes. In rotation side-bending each rib moves with its vertebra; transverse process of the vertebra moves up and out and forward on the convex side, carrying with it the rib; but the ribs are all fastened together in front by the cartilages attaching them to the sternum; so that the ribs on the convex side must separate in the axillary line; but since the spine turns relatively more than the ribs, these must slide upward on the transverse processes; and on the concave side the reverse; giving the downward motion to individual ribs as noted in preceding paragraph. Any confusion of thought that arises here may be clarified by recalling that the tubercle-transverse process joint is concave on the transverse process, convex on the tubercle; so that, as in the shoulder, motion down of the shaft means motion up in the socket. Since this is just the point where lesions occur, the picture should be clear.

### Lesions

Limitations to motion are the ligaments of the joints, and the intercostal aponeurosis, drawing down and in below and up and out above, with a slightly greater distance from the spine on the lower side; so that the general tendency is to upward luxations of ribs. This is particularly true of the human subject, standing erect with the full weight of ribs and muscles bearing downward on ends of ribs. (This is the reverse of the general direction of pressure in the animal, in which the pressure from weight of viscera carries ribs down and forward, that from muscular effort toward the head). Lesions may, however, be either up or down, at the tubercle. Lesions of the head, if they exist, are indistinguishable from those at the tubercle.

The intercostal muscles, along the full length of the rib, act in lesions so as to distribute the tension. Certain fibres will be over-strained and others relaxed, those between remaining normal. The latter should be found at the juncture of the middle third with the anterior and posterior thirds, which are therefore apparent centres of rotation.

The intercostal muscles so act, however, only when on tension, which is not the usual state in the erect trunk of the human subject. The position of a rib in lesion is therefore determined usually by the position of the tubercle and of the head and tip — when up at the tubercle its lower edge will be exposed behind, its tip will be drawn back and depressed. When all of the intercostal muscles are on tension it tends to correct the lesion.

To become familiar with the motions of ribs, have patient seated, operator standing behind; place thumbs of both hands on corresponding ribs of two sides, thumbs as near the spine as it is possible distinctly to feel the bone ; place fingers on margins of

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same ribs, as far along as they will reach. In this position have patient inhale and exhale, and go through various movements; trying to distinguish the bone from the contracted muscle. Then do the same thing with passive movements. Assume position to give the cork screw movement; place thumb and fingers on rib as above; execute cork screw movement and various other movements with the patient completely passive. It will be discovered that the movements of ribs are quite complicated. It is probably best to focus the mind on what is happening at the transverse process and the position of the vertebra, tracing back from the points where the fingers lie to those points with the imagination.

To develop an efficient technic it is not enough to have done this once, but requires that it be done long enough to become almost subconscious; and it should be rehearsed again with each case that presents any difficult features.

### Diagnosis

Diagnosis of rib lesions is best made where it exists —at the juncture of the rib with the transverse process. The rib is not quite a continuation of the process, but extends out from its upper half in the lower vertebrae, its centre in the mid dorsals, and its lower half in the upper dorsals. It will be remembered that these facets are inclined, not flat with the spine; that they incline upward in the lower, forward in the mid, and downward in the upper vertebrae. Lesion will therefore carry them in these respective directions; in the lower chest, they will be less prominent posteriorly if the lesion is downward, more prominent if the lesion be upward; the reverse in the upper chest, and neutral in the middle; except that the curve of the neck of the rib acts to bring the angle to greater prominence in any lesion, from second or third to ninth or tenth ribs; and that approximation to the rib above makes a rib seem less prominent. Failure to form a mental picture of this curved neck, in those ribs where it exists, may be responsible for much confusion in diagnosis.

To examine these points in the upper ribs it is necessary to draw the shoulder blade aside.

Secondary deviation may be found along the shaft of the rib in lesion, but this may be masked by the tension of muscles, especially in inspiration. In general, a rib that is up at the transverse process will be down in front, its tip pointing at a greater angle; its inferior border will be palpable behind, and it will be not parallel with the ribs above and below. If the lesion be downward at the transverse process, its tip will point more up than its fellows, its inferior border behind will be half concealed and its upper border may be palpable.

If the vertebra to which it is attached is in lesion, upward on the right, then the right rib will be raised as the transverse process is raised, but will turn on the process and assume a position as when it itself is in lesion upward. On the opposite side, the reverse. If actual lesion then occurs between rib and transverse process, this tends to offset the deviation.

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### Technic

Assuming a lesion of the eighth rib upward on the right. Patient is seated on table; places right hand on left shoulder; operator stands behind, facing right; places left axilla over patient's shoulder and hand thereon, passes left arm around body and under patient's elbow, places fingers on the eighth rib in front of the axillary line; places right thumb on eighth rib as near the transverse process as possible, the fingers as far along as possible. Exerting slight pressure on the rib in all of these directions, he then executes the corkscrew movement a time or two, then bows the spine convex to the right to complete side-bending of the eighth segment, at the same time rotating to left to complete limit of rotation; and alternates bowing to This technic is available from the twelfth to the fourth side and rotation until the lesion is felt to be released, ribs.

The effect of this technic is as follows: The pressure with the right thumb and fingers carries the rib away from the transverse process enough to overcome the catch or wrinkle that is holding it in lesion; pressure by the fingers on the front end down in and centrally, overcomes the resistance of the intercostal muscles and, acting through the curved spring of the rib, still further aids in carrying the rib from the transverse process (pressure back and in on the front ends of ribs makes a fulcrum of the thumb in the back, and tends to gap not only the articulation at the transverse process, but also that at the head of the rib). The movements then act to tense all muscles, to gap open the joint at the top, and with the pressure of thumb to carry it to normal.

It is impossible to distinguish lesions at the head — if indeed such lesions exist — from those at the transverse process; and the technic seems to be the same. In any case in all of the most successful technic for ribs, this element of pressure on both ends is evident. As for instance the following:

Patient seated, places right hand on top of head (highest point). Operator stands behind, passes right arm under patient's axilla, supporting it, places hand on top of patient's hand on head; places left thumb on rib as near transverse process as possible; presses to right and forward with thumb while carrying vertex to left and slightly back, with lifting of axilla, to full limit of side-bending convex to right and of extension of segment in lesion.

The effect of this treatment is as above, except that in place of pressure by the fingers backward on the front end of the rib we have traction backward and upward through the pectoral and intercostal muscles.

Caution. The neck should not be turned sharply nor bent sharply, as is the natural tendency; it should be bent as little as possible, the focus of motion being on the lifting of the ribs and the bowing of the spine. The head should be slightly turned to right to increase separation between transverse processes.

This technic is not strongly corrective, but is mild and soothing for nervous cases. It is excellent for relaxation in the upper dorsal region.

Many forms of this technic are in use, the patient prone or supine or on side or against door jam, using the arms in different ways; and doubtless each of them has its advantages which vary in different cases. In all, caution must be used not to exceed

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the normal limits of motion of the shoulder joint itself, which is much more sensitive than most other joints of the body — protected by more sensitive nerves because of the some- what greater danger of straining it. For instance in this:

Patient supine; operator stands at side of lesion; assuming eighth rib of right side in lesion, stands at right side; places fingers of right hand under angle of eighth rib, ready to press upward and toward patient's head; grasps patient's right wrist with left hand, carries it directly up in the axillary line with slight pressure backward, to the limit of motion, while the patient inhales a deep breath; at the same time pressing upward and toward the head with the finger on the affected rib.

The effect of this position of the arm is to carry the rib to the upper limit of motion on the transverse process, while the front end is held down, controlled by the tensed serratus magnus muscle; this gives it therefore an angle, at that top limit of its motion — causes it to assume as nearly as possible the position of the lesion, or the position it was in when it became a lesion, while yet all of the surrounding tissues are exerting on it tension to the normal. The deep inhalation helps in this effect. Slight lifting with the finger is thus often able to release it from the catch.

Holding all in that position for a brief second while the ligaments stretch, all is then reversed; the right hand is brought forward, in front of shoulder and carried to full extension over the head; the pressure of the finger on the rib is changed to lift the rib toward the feet; the breath is released all at once. This tends to raise the front end of the rib and lifts the tubercle on the transverse process over the catch and toward normal. This is one of the oldest forms of technic. Its chief drawback is the strain upon the shoulder.

This technic may be used with the patient prone, the table supplying the pressure on the front ends of the ribs as in the previous technic; or with a pillow placed against a door-jamb and the patient's breast pressed against the pillow; or with an assistant pressing on the front end of the rib ; or, less accurately with the operator's knee against the back end of the rib, the fingers moving the front end, the other hand moving the patient's arms.

### First and Second Ribs: Movements

The motion of these two ribs is much slighter than that of the others. The motion of the sternum is forward, and up; but the excursion of the lower part is much greater than that of the upper part, leaving very little for these first two ribs. Beside this they have a slight wing motion, under the traction of the scaleni muscles, opposed by the intercostals; little more than a ligamentous yielding.

### Diagnosis

On account of the thickness of the over-lying muscles it is very difficult as a rule to examine effectively these two ribs except at the sternal ends. Unevenness on the two sides in front argues probability of a lesion, but to know which side is in lesion, one must rely upon relative sensitiveness. Lesion upward at the transverse process draws

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the sternal end backward, making it seem smaller than its fellow, and making it also sensitive; lesion downward, the reverse. About one inch of the first rib may be felt beneath the collar bone. By drawing the shoulder blade away and slightly lifting it, in thin subjects the spinal ends may sometimes be felt; but they bend almost directly forward from the transverse process, leaving little surface for examination and little certainty therein. With patient lying on side and shoulder blade lifted, the thumbs may find and examine one side at a time.

### Lesions

As in the other ribs, lesions at the transverse processes cannot be distinguished from those at the head, up and forward, down and back if slight ; but the curve if the latter exist. Lesions at the transverse process are up and forward, down and back. They seem more prominent if up, on account of the spacing, less so if down.

### Technic.

Assuming right first rib to be downward on transverse process; patient seated on table; operator stands behind; places right foot on table and places knee under patient's right axilla, arm hanging loose; presses down on arm to carry shoulder blade away from spine and to put upward tension on subclavius and pectoralis minor muscles; swings knee with patient slightly to right to secure full extension of ribs ; places right thumb against the angle of rib where it leaves transverse process, endeavoring to get beneath it, between it and the second rib ; places left hand on patient's head and carries to left to limit of motion to produce tension on scaleni muscles; in this position turns face first toward left to lift transverse process and produce an angle between it and the rib, then to right and backward to carry transverse process backward away from rib, changing the angle. With gentle exaggerations of these tensions the rib may be brought to normal. If necessary swing head and neck in extreme side-bending from left to extreme right; repeat until lesion is reduced.

A slightly different use of the pectoral muscles may be made with the patient supine; operator draws patient's right arm across breast, high up ; places his sternum against elbow, ready to press down; places left hand under first rib, knuckles against table, fingers bearing up against rib ; with right hand carries head to left side, then to right; gentle exaggeration of all of these tensions will tend to bring the rib to normal.

Patient may be seated, elbow against operator's sternum, technic as above.

If lesion is upward, it is a simple matter to exert pressure from above and with technic as above, to carry it downward to normal.

## CHAPTER XI.

### Cervical Vertebrae

Examining the actual bone we observe that the base of cervical vertebrae is prolonged downward and forward into an anterior lip; that this makes the base of the vertebrae not flat, as in the rest of the spine, but curved; and that this curve prolonged backward is continuous with the articular surfaces. This is true of all except the atlas and occiput.

Experimenting with the actual bones we observe that in flexion the body of the vertebra slides forward over the one below in the arc of this curve; and that if it does not do so, if, that is, the bodies retain their vertical relation with each other, a gap is made between the articular processes.

We observe also that in complete extension the inferior edges of the articular processes of the sixth and seventh cervical vertebrae fit into indentations in the bone below that fit them more or less exactly; that the superior edges of all articular processes fit into the space between the transverse and the articular processes; that the spines themselves, which are here often bifid and concave below, fit over each other. In this respect different spines vary very markedly; but as a rule the arrangements as above are found to obtain.

These arrangements serve to reinforce the cervical vertebrae in extreme positions, except in extreme flexion, and in side-bending, where one side only is protected.

Placing the thumbs on the tips of the spinous processes of the cervical vertebrae in some living subject, the fingers on the anterior borders of the costal processes, and asking the patient to turn the head from side to side, we observe that retraction on the concave side completes itself before forward motion (flexion) of the opposite or convex side begins. Since all motions are produced by contraction of muscles, it is therefore natural that movements of approximation under muscular action should occur first before movements of separation based on leverage action begin. Compare with this the movements of lumbar and probably of dorsal vertebrae, commented on in their respective chapters.

Reproducing these motions in the actual bones we observe that the extension or approximation of one side implies necessarily a reverse motion of the other side around this disc as an axis; but that since there is at the same time rotation backward following the arc of the base of the vertebra, the forward motion on the convex side is offset and cancelled. The axis of the rotary part of this motion is, for each side, the opposite side; the axis of the flexion-extension part is below the body of the intervertebral disc, the centre of the curve of the base. This motion continues until the grooves of transverse-articular processes are in contact (through intervening tissue) with the superior edge of the articular processes below on that side, that is, are interlocked. This point of contact then becomes the axis of further motion, that is, the axis of rotation shifts to this side, and the opposite side moves forward, following again the curve of the base of the bodies. In the cervical column as a whole, these points of contact form a flexible but non-contractable pole, which bends to the concave side as more motion is produced, but does not further shorten.

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Examining again the actual bones we note that the superior surfaces of the bodies are prolonged upward at the sides to form lateral lips of considerable height so that the top surface, concave upward, and the bottom surface, concave downward, give the effect of two hands half clasped.

These lateral lips we find to be covered with the sort of smoothly polished bone that is peculiar to articular surfaces. We sometimes find also on the lateral edges of the bone above indentations for these lips, and again, to a less degree, the same sort of polished bone. Evidently these lips are integral and important parts of the joint. They are discovered to be the homologues of the heads of the ribs. The friction and pressure that led to this quasi-articular surface occurs at the limit of the first phase of rotation, when the approximation of the concave side is completed; and the friction contact continues while the extension of the convex side is progressing. There is pressure against this point.

### Lesions

Lesions of cervical vertebrae are found to be in all directions: bilaterally posterior, unilaterally posterior, directly lateral, and unilaterally anterior, rarely bi- laterally anterior. In the bilaterally posterior it is evident that both articular surfaces have become separated from those below; a primary lesion of one side leading to a secondary gapping of the opposite side also, as in sacral lesions.

Unilaterally posterior lesions are the most frequent. There is not found to be necessarily a corresponding anterior displacement of the opposite side ; more often the reverse. The point of engagement is in some point of bony contact, as that of the lateral lip on that side. A flexion lesion of the opposite side may bring about a separation posteriorly on this side, with engagement of the transverse process against the superior edge of the articular process below. The mechanics of these so frequent lesions is not perfectly clear. It may be necessary to abandon the bony contact theory and to adopt a view of the mechanics of these lesions based on passing the dead-centre of ligaments, or on the much slighter retaining power of simple friction, effective only because the tension of ligament is radial to motion.

Unilaterally anterior lesions, if maintained by points of bony contact, must be maintained by a catch of the superior border of the articular process of that side against the surface above, with flexion of the vertebral column. There are no other points of bony contact in anterior lesions.

Directly lateral lesions, the least numerous of these, are maintained evidently by a catch of the lateral lip against the tissues of the base of the bone.

### Diagnosis

The spinous processes are utterly unreliable for diagnosis in the cervical region. In seated position, it is extremely difficult to secure perfect relaxation of all muscles. Patient supine, operator seated at head of table; places fingers of two hands broadly

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under two sides of neck of patient, lifting slightly until neck presents an arch similar to that when standing. Finds posterior border of articular processes, being careful to avoid lateral ends in order not to bruise the cervical plexus; passes fingers from below upward, noting relation of each with one elbow.

The seventh cervical has been called terra incognita, (Fiske) situated deep in the mass of the shoulder muscles and being difficult of examination both in front and in back. The literature of the profession shows a dearth of lesions of the seventh cervical, which is probably due to failure to examine or to detect them rather than to great strength of this articulation. Because of greater difficulty in examining this segment it should be given greater care.

The axis stands normally somewhat more prominent posteriorly than the other cervical vertebrae. The atlas is rarely found to be in the median line with the axis, rotation here being extremely easy; deviation rarely means more than a difference in muscular tone.

To examine for anterior displacements, lift the tissues and the sterno-mastoid muscle with the thumb, and place the ball of the thumb flat on the front of the costal processes; carefully avoiding the lateral edges, for fear of bruising the delicate nerves there. Begin with the first dorsal if possible; examine the relation of each costal process with that of the one below. The costal process of the sixth cervical carries the carotid tubercle, which makes it somewhat more prominent than the others, and in some cases very much more prominent; it will be mistaken for a lesion by inexperienced students. In some anterior lesions the tissues and the longissimus colli muscle will be lifted and tensed by the lesion, making a tented condition which masks the lesion and deceives the examining thumb. Only patient practice and concentrated attention makes perfect.

In the upper half of the neck it is necessary to push the sterno-mastoid muscle out and below instead of lifting it above the examining thumb.

To examine for lateral lesions, place the fingers on the lateral aspects of the transverse processes, being careful to keep them on the posterior and outer corners and to avoid the cervical nerves emerging from the groove between costal and transverse processes and inclining forward. Examine the relation of each vertebra with the one below.

Examination for movement of cervical vertebrae may be made in the same positions, the head supported between the forearms and moved as desired.

### Technic

For posterior lesions; patient supine, operator standing at head of table; places proximal joint of first finger behind and below prominent portion of lesion, other fingers of that hand supporting neck; face being in median line; carries face and neck to the side of the lesion, without turning; that is, in lesion posterior to right, carries head to right, side-bending neck without turning face; to limit of motion, until all of the tissues of the left side are on tension; head being not raised but on level table without pillow. In this position the left side of the neck is flattened out and under tension; the right side is arched forward. Maintaining pressure against the lesion, an angle of bending is

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made here, the pressure lifting the lesion slightly forward. When all is ready, the operator then turns the face to an angle of forty-five degrees at the same time drawing back slightly, and pressing with the finger across the lesion in the direction of the patient's nose — parallel, that is, to the plane of the articulation. In the average lesion, a very slight pressure is sufficient to reduce.

At the moment of reduction the arch is drawn by the pressure of the finger into two straight columns; the bones below are drawn taut and straight, holding the lower of the two bones in lesion; the bones above are also taut and straight, but at an angle with the lower bones, bent across the pressing finger. The complete extension of the left side makes it serve as a fulcrum.

Caution: The reduction of cervical lesions is always attended by a conscious shock which is always un-pleasant and often insupportable to the patient. The word care was invented to apply to technic of cervical lesions. Preparatory stretching is especially advisable here. Aside from the tensing of the ligaments on the opposite side, which must be maintained throughout, all motion must be focussed on moving the bone in lesion, by means of the leverage of the tensed ligaments and the pressing finger, to the limit of motion in the plane of its natural motion; and all attention must be focused in the psyche of the patient to avoid shock. The force used must be so graduated as to go no further than the point of correction. Indiscriminate "cracking" of the neck without a definite planning for the correction of a lesion is a danger and often a damage to the patient, and should be regarded as little short of criminal.

For correction of anterior lesions; patient supine, operator standing at side of head, same side as lesion; assuming lesion anterior on right, stands slightly to right of patient's head; places palm of left hand beneath occiput, holding head as low as possible, without pillow, face in median line; then carries head to left to limit of motion, without turning; or even rotates face slightly to left; with right thumb operator presses down gently on prominent portion of lesion. When all is ready, operator first relaxes pressure to left, by a fraction of an inch, then without lifting occiput, carries it with quick motion to limit of motion to left with slight extra pressure, at same time turning head, occiput to left, face to right.

The effect of this technic is as follows: carrying head to limit of motion to left locks all of the processes on that side against further motion, making that side the fulcrum for any further motion; at the same time the ligaments of the right side are all tense, tending to separate bones in lesion; allowing face to turn back to right as neck is sharply carried to limit of motion draws back on right transverse processes of all cervical vertebrae, fulcrum being opposite side, but especially on one in lesion, that being farthest from normal anteriorly. Since all are separated already by tension, the quick motion usually suffices to release the catch and carry the vertebra to normal.

For lesions directly lateral; the catch being on prominent side, between lateral lip and tissues of base of bone. Assume lesion to right; patient supine, operator standing at head, places proximal joint of right first finger against right side of vertebra below, and left forefinger against left side of bone in lesion; side-bends to right, stretching tissues of right side until catch is released by exaggeration; then reverse fingers, against right side of bone in lesion and left side of bone below, inserting finger so far as possible

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between vertebra in lesion and one below; then reverses position of neck, drawing across fulcrum of finger on right; as in technic for posterior lesion, and repeats until lesion is reduced. Flexion may be used before reversing position of neck, to make a fulcrum of posterior ligaments.

### Atlanto-Occipital Joint: Movements

The scientific designation for lesions of this joint is lesion of the occiput. But in ordinary conversation the term atlas lesion is usually employed, and serves; for lesion between atlas and axis is rarely more than a functional change of position, secondary to uneven tension of muscles; and the least unevenness postulates rotation here; true lesions are rare here on account of the odontoid process; and in any case can be only rotations. Posterior atlas means therefore necessarily a lesion of the atlanto-occipital joint.

The atlanto-occipital joint is composed of two parts, an anterior and a posterior; usually there is a division between them. The posterior part is a modification of the articular surface proper; the anterior is a modification of the costal articulation.

The articular surface of the lumbar region is likewise composed of two parts, the articular surface proper being the part flat toward the spinal column, the costal element being the part perpendicular thereto, the two making the curve of the articulation. The costal element moves farther forward as we approach the dorsal region, until it is found at the posterior corner of the bodies, still forming the lateral protection of the joint. In the cervical region it forms the lateral lips of the superior surface. In the atlas it forms the anterior half of the superior surface. The two together form a cup-shaped surface with a symmetric curve.

The atlanto-occipital articulation is thus a shallow ball-and-socket joint. The axis of all motion is the same — the centre of the sphere of which these four surfaces (two on each side) form four parts. All motions are possible therein. Of these the chief is the nodding motion, the second is the rotary motion, limited by the contact of the transverse processes with the occipital bone. The nodding motion (flexion and extension) is limited by the contact of the anterior and posterior arches with the occipital bone; but as there is neither body in front nor process in rear of the atlas, this motion is freer.

To examine the occiput in relation with the atlas, the proper point to examine is the relation of the posterior border of the transverse process with the posterior border of the mastoid process of the occiput; which should be almost in line; the margin of the atlas a trifle posterior to the mastoid line, in the average person (the mastoid line being a continuation of the posterior border of the mastoid bone).

There is no change of motion beyond these points of contact, unless there is sufficient force to separate the whole articulation. There are no bony edges or prominences to come into contact with surfaces and make indentations. Lesions nevertheless exist. For the mechanics of these lesions we shall have to assume either a dead-centre or a friction action, as commented on in cervical vertebrae. Or these may be warp lesions, from relaxation of some ligaments or contracture of some muscles. Ligaments, acting

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radially to the motion, do not here draw the articulation back toward the normal but easily allow the maintenance of a warp lesion, even perhaps allowing the wrinkles to form and maintain lesion.

Of muscles between the atlas and occiput there is only one in front, and a small one as well, whereas behind there are several large and well developed muscles. Moreover, the special senses of the face protect the front of the head from violence as from strain, whereas the back of the occiput is more subject to abnormal strain than any other part of the body, except perhaps the tuberosities of the ischii. Lesions of the occiput are therefore ninety per cent anterior, or more, (posterior atlas) and ten per cent posterior, or less (anterior atlas). The technic for anterior occiput (posterior atlas) and for rotated occiput is the same. In rotation, the posterior arch of the affected side is treated; in the other, one side at a time is treated.

### TECHNIC

Assume atlas posterior on right. Patient supine; operator stands at head of table; turns patient's head to left side and flexes it, focussing motion on atlanto-occipital joint so as to gap open right side and bring arch of atlas into prominence on that side; inserts fingers or thumb as it were between arch of atlas and the occiput until they come into contact with the arch, pressing between the two but strongly forward, then, keeping the face turned to the left, and maintaining pressure on atlas, draws the neck back to limit of motion to right, until all articulations on left are tensed; then with slight but quick further turning of the head with extension, the bone is lifted into place. The mechanics in this technic is the same as in posterior cervical lesions

Directly lateral displacements of the atlas are on careful examination found to be really approximations on the opposite side; in an atlas apparently displaced to the right, the left transverse process will be found drawn close against the underside of the occiput, as by the spasm of the rectus capitis lateralis. The displacement to the left is an appearance, due to the effort to bring the head to the median line. To correct this lesion the tense muscle must be relaxed. The tension may be then reduced by the above technic applied to the prominent side.

For occiput-posterior (anterior atlas) lesions; patient supine, top of head slightly beyond top of table; operator places one hand under chin and other under occiput and lifts, holding face upward until occipito-atlantal articulation is in full extension and the weight of the body is dragging downward on the atlas; then carrying the head from side to side, focussing motion at the atlas, he endeavors to gap open first one side and then the other, until the lesion is reduced.

The same technic may be applied with operator half seated, thigh across head of table, patient's occiput on thigh, lifting under chin and rotating.

### Sensitiveness of Joints

There is a very good natural reason for the extreme sensitiveness of the joints of the body, especially those of the cervical region, and especially in lesions. In the ligaments

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of the joints are developed nerves whose function is to protect the joints. Just as the eye is automatically closed by its nerves when some object moves rapidly toward it, so are the muscles of the joints automatically contracted by these nerves of the joints when the joints are threatened. Hilton's law states that "the nerve that supplies the joint supplies the muscles that move the joint, and the skin over the insertion of the muscles" i.e., the skin against which pressure would threaten the joint. The nerve irritated by the strained ligaments is the nerve that contracts the muscles to protect the joint.

In lesion, the tension of these ligaments is already abnormal, except so far as compensation has been made. In them therefore this sense of threat to the joint is already excited — the fear or "dread" as it is usually called, is barely below the plane of consciousness. When the corrective effort is made, this fear or dread is acutely stirred.

The cervical region is more exposed than any other region of the spine. Nature has therefore made this sensation more acute here. By reason of the nearness of the ear, the shock of correction is carried with great acuteness to the ear, and the unpleasant sensation is redoubled. Care is therefore necessary, especially in treating the neck. When a patient is lost because he "could not stand the treatment," he could not have been more truly or completely lost to the profession if he had died.

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## CHAPTER XII

### Other Joints

#### Mandible

Lesions of the jaw bone are well known to the laity as well as to the professions. The mechanics of these lesions will serve as a very clear illustration of the lesions of other joints less well known. They occur when the jaw has been opened beyond the limit of its normal motion, has invaded new territory, become entangled in the tissue there, and going back tries to carry this with it; making a wrinkle and being held there by it. It may even be that it passes beyond the dead centre of the ligaments that hold it, so that their tension now holds the jaw out, instead of holding it in. This mechanical principle should be studied in connection with all lesions.

Irregularities in the movement of the jaw, falsely called lesions, may be due to irregular contractures of the muscles that move the jaw. Thrusting the jaw forward on one side, one observes that only one tooth touches the jaw above; contractures of the muscle that produces this motion will bring about this result and other such results in varying degrees. Thickening of the tissues of the joint also may give the appearance of slight lesions.

The technic for true lesions of the jaw bone is in principle the same as in other lesions. Using one side as a fulcrum, the other side is lifted over the catch; or putting a fulcrum (a cork or spool) between the jaws, pressure is exerted on the tip so as to stretch the tissues and lift the bone over the point engaged.

#### CLAVICLE

The motion of the sterno-clavicular joint is wide as to direction, narrow as to range. It bends forward or back or up as the shoulder blade is driven forward or drawn back or up; it rotates as the shoulder rotates. It may slide in and out on the manubrium. The size of the end of the bone indicates the amount of pressure it sustains, and the size of the ligaments indicates the amount of tensile strain they bear.

Warp lesions of the clavicle are very frequent. Real lesions doubtless occur, but it is not easy to distinguish between the two.

#### Diagnosis

Diagnosis of lesions of the clavicle is made by comparing the two sides, and is by no means positive. The two sides differ much in size. It may be assumed, however, that the less prominent side is in lesion if either side is. There are few forces drawing the clavicle forward.

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### Technic

Patient supine. Operator half sits on corner of table facing foot of table, with thigh resting on it opposite patient's shoulder; lifts patient's shoulder of affected side on to thigh so that shoulder-blade rests on thigh; presses down on shoulder or arm, to stretch ligaments of clavicle. Then placing fingers under clavicle and lifting he draws elbow backward and up to limit of rotation in that direction, and then forward and up and out, and down, using thigh as a fulcrum. Clavicle is thus lifted forward.

Caution. The tissues under the clavicle are very sensitive and easily bruised. It is necessary to find the point at which pressure with the fingers will cause least pain. This point is usually at the juncture of the inner third with the middle third. The fingers must be neither pressed too far in — barely enough to produce upward pressure — nor lifted with too much power. The leverage over the thigh, the drawing of the joint out, up, and rotating it backward, does most of the work of restoration.

Lesions of the cartilages of the ribs are found. These cases are probably surgical.

Lesions of the acromial end of the clavicle are occasionally found. One end of the joint may be used as a lever to adjust the other, and then the technic reversed if necessary. The articulation is parallel to the saggital axis of the body, at right angles to the articulation at the sternal end, to permit those motions of the shoulder-blade not permitted at the sternal end.

### Technic

Patient seated, operator standing behind, puts foot on table and knee under patient's axilla, moves knee with axilla away from body of patient until part of weight is resting on knee and there is tension away from median line (the knee under the axilla presses equally against the humerus, tending to gap lesion and against scapula, tending to close it; and to pry open merely shoulder joint). Lifting on shoulder and shoulder-blade gaps acromio-clavicular joint. If posterior end is in lesion, turn knee to point toward median line, carrying with it scapula. This makes a fulcrum of anterior end and gaps open the posterior end. Then pressing down on acromial process or clavicle as needed, move arm and scapula as needed to reduce lesion. If anterior end is in lesion, turn knee to point outward from median line, so as to gap anterior end, and press down on acromial process or clavicle as needed with rotation of arm and scapula to reduce lesion.

## BICIPITAL TENDON

The long bicipital tendon is often found to have slipped from its groove, stretching or rupturing its retaining ligaments, and lying close to the coracoid tendon of the biceps.

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### Diagnosis

Inability to raise the arm in front or behind back or laterally, beyond a certain point; soreness over bicipital groove; relaxed state of outer half of biceps muscle.

Differential diagnosis: This condition must be distinguished from inflammation of various portions of the shoulder, and from rheumatoid neuritis, which commonly shows itself first in this area and simulates this lesion often very closely. Other symptoms of rheumatism, or of diseases allied to rheumatism, aid the diagnosis.

### Technic

The problem is to bring the groove as close to the present position of the tendon as possible, to lift the tendon into the groove, to hold it there by fixing the shoulder in an inverted position until the tissues have resumed their normal tone. Patient seated operator standing at side, grasps arm at elbow, forearm flexed to relieve tension on biceps; lifts arm to about forty-five degrees, rotates forearm down as far as possible, then with fingers of other hand locates tendon and lifts into groove, then rotates arm backward with forearm lifted. An adhesive bandage may be applied to hold the shoulder back and the arm everted as much as possible, and kept there for a week or ten days, longer if the lesion has persisted for some time.

## FEMUR

### Diagnosis

Dislocations of the hip and of other joints of the extremities are surgical cases, and are well known and thoroughly described. The principle of correction is traction. A point in the diagnosis of dislocations of the hip is well worth while here. Patient supine, an assistant standing at foot of table grasping toes prepared to rotate them out and down, then up and in (both feet out and down at the same time); operator places thumbs on anterior superior spines of ilium and lays hands over greater trochanter; as assistant rotates toes, each greater trochanter describes an arc whose centre is the centre of the acetabulum in normal hips. This arc is very quickly determined by the curve of the palms. Its position with reference to the anterior superior spine is instantly defined. In dislocations of the hip, the trochanter describes an arc which points immediately to the position of the head of the bone. The normal arc is slightly more down than up. If the position of the head is on the dorsum of the ilium, the arc will be altogether up and in; if the position be in the thyroid notch, the trochanter of that side will be correspondingly lower than its fellow, and the rotation will be up and in. If the arc be shorter and more sharply curved than its fellow, it points to a fracture of the neck or a tubercular destruction of the head of the bone. As soon as the arc is defined under the palm, the position of the head and the length of the neck is instantly defined.

Lesions of the ligamentum teres are believed to occur.

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The tendon becomes curled the wrong way and cramped on itself.

The diagnosis is obscure; a catch in walking; pains on the inner side of the knee without other lesions of the hip joint (the tendon is a development from the transverse ligament, and originally connected with certain muscles of the thigh, whence probably the pain in the inner side of the knee).

### TECHNIC

The problem is to stretch the ligament in all directions, relying on the tendency to the normal to restore it to normal position; is therefore to carry the head of the bone around the rim of the acetabulum at the limit of normal tension, from the anterior edge of the notch, the lower anterior corner, up, back and around and down to the other side of the acetabular notch. If this does not give relief, rotation in the opposite direction may be tried.

Patient supine; thigh is raised to forty-five degrees, abducted, and leg is also abducted; this brings head of bone to anterior edge of notch; leg is then adducted; this brings head to anterior edge of acetabulum; foot and knee are then adducted together; this carries head to almost the top of notch; foot is then abducted as knee is lowered always at limit of tension centrally; this carries head around upper third of acetabulum; maintaining foot in abduction, the knee is then carried up, out, down, and to normal position.

### Sesamoid Bones

Lesions of the sesamoid bones under the big toe are found. Diagnosis rests on pain, cramps, and shallowness of the corresponding side under the first joint of the big toe.

### Technic

The problem is to locate the bone, relax the tendon, pull it down to the level of the joint, slide it into place and hold it there while the ligaments regain tone.

Sharply flex toe; rotate affected side down; move to opposite side with traction; assisting the sesamoid bone with fingers if possible. Adhesive tape or plaster casts may be used to maintain fixity as long as seems desirable.

## CHAPTER XIII

Curvatures, Group Lesions, Warps

### CURVATURES

That curvatures of the spine are due primarily to dynamic and not static causes may be proved in the following manner:

Patient prone; operator lifts legs (holding above knees) to angle of thirty or forty degrees; places heel of hand against convex side of curve and presses toward concave side while rotating raised legs from side to side in wide sweep. This technic if properly done will change the one long curve into a series of short ones; or may completely reverse it. There is the same total amount of curvature, but instead of being one long curve it is a series of short ones. This is not possible in all curvatures, is easiest in those involving the lumbar region and is no longer possible after structural changes have been caused in the bones.

Curvature may thus be due not to contracture of muscles of one side, either convex or concave side, but to shortening of the muscles of both sides, until they are shorter than the spine; or else to swelling of the discs until the spine is longer than the muscles. (Burns, A. O. A. Journal, July, 1917.) In order to get the greater length of bone within the limit of the lesser length of muscle, the spine curves on itself. The etiology of this muscular shortening is doubtless the same as that of neuralgia, etc., the one motor, the other sensory. Curvatures may also arise from unilateral contractures.

Having determined this etiology, it then follows as a matter of course that there are similar conditions involving lesser parts of the column. These we find in great abundance. The chief seat of these changes and the smaller curves that they give rise to is the fourth dorsal segment. This condition is so frequently found that it might almost be said to be typical of most of the spasmodic disorders and most of the sensory as well, of many of the disorders of internal secretion and disorders of the stomach and the brain. A large field; and yet I feel sure that it will be broadened rather than narrowed as experience accumulates. The condition it gives rise to should be called technically a curve, even though it may not take the shape of a curve; this to make a necessary distinction between those conditions due to muscular spasm or disc changes, and those due to acute lesions or to weakenings (warps) as well as from conditions like Potts disease.

These conditions may appear anywhere in the spine.

They are most frequent at the fourth dorsal, as said, where the distortion they produce may be a curve, three or four vertebrae long only, or may lead to acute lesion of some one point, as the rib, or to other forms of distortion. The next most frequent site of them appears to be between the third cervical and the occiput on the left side — and these occur almost invariably in connection with strain or disorder of thyroid function. The effect of this contracture, if mild, is merely to cause lesion of the third cervical; but may go so far as to squeeze atlas and axis some distance to the opposite side, the right.

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In other cases, the rectus capitis lateralis on one side alone may be involved, approximating that side and separating the opposite side.

The next most frequent sites are in the neighborhood of the eleventh dorsal or the eighth dorsal. As all of these points are specific centres for organs of internal secretion, the close connection of such conditions with strain of these organs is evident. They may occur at any point, however.

### Technic

The technic of these conditions is first the correction of the primary condition, and second the persistent passive stretching of the contracture itself, which may be aided by posture, even posture enforced by straps, casts, etc. The Lovett technic may be used. See also Ashmore's Osteopathic Technic.

### Group Lesions

It is in the handling of group lesions that the highest diagnostic skill of the operator is displayed. It is often impossible to distinguish group lesions from warp lesions; and yet the distinction is highly important. Warp lesions may be made to correct themselves by change of habits and by exercises, though this process is made a hundred times as rapid by assistance of the operator. But group lesions are like the log jams in

Northern rivers. Unless the key to the situation is discovered, and corrected, the whole condition will recur; the operator may correct the secondary lesions as many times as possible, they — or others — will recur in time.

Group lesions must also be distinguished from lesions due to spastic conditions of parts of the muscular column, or thickening of discs, i.e. curves.

The general principle of group lesions is perhaps most easily seen in case of lesion of the sacrum (or as it is more often called, lesion of the innominate) . The sacrum sinking forward on one side offers a tilted base for the vertebral column above it. The body of the fifth lumbar sinks on the inclined plane, and its spine is usually found deviated toward the same side (since the centre of rotation is posterior to the spine, the spine will be deviated to the same side as the body of the vertebra, though to a lesser degree). The whole lumbar column is thrown off of its normal balance, toward the side of the lesion; and the effect is transmitted through the lumbar articulations which are strong laterally, to take effect on the first articulation that lacks this lateral strength, the eleventh dorsal; whose articular plane is not antero-posterior, but transverse. The eleventh and twelfth ribs may then become involved in the tangle, which may continue to spread indefinitely.

But though compensation is thus made in part for this unbalance, yet it is evidently not completely made; for according to Dr. F. C. Morris, lesion of the atlas almost invariably accompanies lesion of the sacrum — a thing not necessarily significant at first sight, but becoming significant when we learn that the deviation of the atlas is always on the same side as the sacral lesion — that a sacrum anterior throws an unbalance upward

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through the spine whose last effect is the throwing anteriorly of the occiput of that side — called a posterior atlas on that side. He further states that unless the sacral lesion be corrected the atlas lesion will recur.

Dr. Edyth Ashmore, examining the vertebrae of human skeleta in museums, found that evidence of lesion could be read in the articular surfaces. Studying this evidence, she found that lesions alternated through the spine. A lesion to the left of, say, the seventh dorsal produced a compensatory lesion to the right of the sixth, to the left of the fifth, of lessening degree, to the right of fourth, etc.

Examination of spines in the classes of the A. S. O. referred to above disclosed the fact that this alternation ran not only upward, but downward as well; also that whereas usually the alternation went from one vertebra to the next, yet often lesion was great enough to cause two vertebrae to deviate to the opposite side, the next two to the same side, etc. ; or in rare cases, where the rhythm of the compensation was greater than one and less than two, the deviation would be irregular. Obviously it would be an error to correct any but the first of these, until after the first had been defined and corrected. Until one's conception of the mechanics of the spinal column has become sufficiently clear from long practice, one's only guide is the relative soreness of the various joints — not a perfect guide — and his knowledge of specific centres.

Rib lesions are held by some to be always necessarily accompaniments of vertebral lesions. This I believe to be an error, though perhaps a justifiable one. Deviation of the rib belonging to a given vertebra is necessary if the vertebra is in lesion ; and by this deviation strains of various sorts are set up through the muscles and ligaments connecting that rib with adjacent parts, with resulting secondary deviation. But these deviations are compensatory, or at best secondary, and their correction must follow that of the vertebra, never precede it. That lesion of ribs may occur independently of lesion of vertebrae is, I believe, an accepted principle.

In warp lesions, secondary warps are the rule.

From any structural deviation in the body secondary and tertiary and still further changes are apt to arise; are almost sure to arise in time. It is a principle of mechanics that a strain will diffuse itself until it finds equilibrium. In the self-adjusting structure of the living body, such a tangle may spread very widely. But the activity of the said body may even cause a continuous aggravation of a primary slight disorder without limit.

### WARPS

#### Warp Lesions

By warp is meant deviation due to habitual posture or exercise in different occupations; not necessarily involving fixity or acute lesions, but tending to produce both. They are easily corrected but quickly recur unless their cause is removed. They are of the greatest variety, but the most typical is the posterior sag of the lumbar spine due to the habit of sitting long hours over school desk or books. Probably ninety per cent, of educated human beings suffer from this deformity. In the formative years, the period of growth, the body is peculiarly liable to warps from posture. These may in time correct

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themselves, under changed habits, but they do not do so in all of that ninety per cent, by any means; and in any case they leave a weakness and a tendency to recurrence. But in many cases they produce acute lesions and even structural changes that are permanent.

It is impossible to overestimate the amount of damage that this fault in our educational methods does to life and health. Too often it is a case of education versus health or even life. It is usual that by such in- conspicuous but omnipresent factors the greatest total of damage is done. It is so in this case. Children were not meant to spend interminable hours over books during the years when they should be training the sub-conscious mind in the geometry of the moving hand and the swinging pendula of the limbs, etc. that great source and background of all of our conscious thought.

The effect of such a warp is to produce limitation to motion in various directions, and so to increase the likelihood of lesion at either end; also to bring focal strain on some point near the centre thereof, with similar increased likelihood of lesion. The posterior lumbar sag, for instance, may reach as high as the eighth or seventh dorsal; and at that point, or wherever the upper limit of the sag happens to be, is usually found a lesion; due to the fact that the spine in the flexed position of the warp has lost its lateral flexibility; concentrating a strain of that kind on the joint at the end of the warp. The same thing is true of the lower end, which is almost always the fifth lumbar, hence the very great frequency of lesion there.

The way in which warps are produced is most easily seen in the upper cervical segments. Here warps are produced by posture in sleeping; and it is usually possible to tell the position in which a patient sleeps from the position of the upper cervical vertebrae. Thus in sleeping on the back with the head raised on a high pillow the occiput is drawn forward, and the atlas is found prominent back of the mastoid line. In sleeping for long hours in this position the ligaments become stretched, and the muscles of course relaxed; and the bones become displaced simply in the direction of the strain. They tend to recover as soon as normal use and normal position is restored, but when the same strain is repeated night after night they become established in the false position.

Thus gradually assumed, there is less irritation from the immediate lesion itself than in the case of an acute lesion; but diseases are in fact found to arise from it, and to be corrected by the correction of the dis- order. Warpings of the body are so many times more numerous than acute lesions that probably a greater total of ills arises from them.

The same technic that is available for acute lesions is available in warp lesions, insofar as they affect single vertebrae; but warp lesions usually cover an area rather than a single segment, and must be treated accordingly. Any technic that offsets the false position is available, unless acute lesion has occurred. For flexion warps the proper technic is extension, etc. It is best applied first passively, and then in the form of regulated exercise.

In dealing with inanimate objects, fences, wheelbarrows, machinery, it is comparatively easy for the mind to grasp the mechanical principles, and to follow them successfully through their changes.

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But in dealing with the human body it is not thus easy.

In the first place, the mechanical parts are concealed. In the second place they are extremely complicated; practically all mechanical principles apply at all points.

In the third place there is much individual variation.

In the fourth place, it is a living human body lying there, possibly in state of extreme suffering; and this does in fact make much more difficult, and sometimes extremely difficult, the matter of concentrating the mind on the purely mechanical factors in the condition. Yet on the physician's capacity to so concentrate may depend the life of that person.

It is quite necessary then that the faculties dealing with the mechanics of the body be trained to the last possible degree, until knowledge and technic are almost unconscious — until perception has become almost an intuition.

# OSTEOPATHIC TECHNIC

## CHAPTER XIV

### Causes of Osteopathic Lesions

The causes of Osteopathic lesions is a subject for principles rather than for technic, except so far as it relates to recording and to prevention, and as it aids in forming a clear picture of the mechanics of lesions.

The causes of Osteopathic lesions are the thousand forms of violence and strain to which the human body is subjected — to which indeed man subjects it. Compared with animals these are as a thousand to one. The business of the animal is to protect itself from such things, and except in the comparatively rare occasions of its fights it does so. The business of the human being on the other hand is to harness and control the forces of nature, and the stress of this control rests finally upon the mechanisms of his body. Nor is her body exempt, for the stressful contact of human life with the forces it controls has led to the great development of the human brain, with a consequent and necessary enlargement of the female pelvis, to admit of its being born; which enlargement is out of proportion, mechanically, is a mechanical weakness with increased danger of lesion, and at a point that is the mechanical axis of the body and more subject to strains than any other part. Probably more than half of the women who have been examined by osteopathic physicians in the last half century have had lesion of the sacro-iliac articulation.

Comparing the mechanisms of the animal body with those of the human body, we find further reason for the large number of lesions found in the human body. In the prone position of the framework the force of gravity acts at one angle; in the erect position at ninety degrees from this angle. The joints, the stresses, the weights and pressures in the animal body were adapted for the horizontal position, in which they have the greatest amount of protection that is possible along with the necessary motion. In the erect position the angle is changed enough to destroy completely many of these protective devices. For instance the articular planes of the spine and those of the transverse processes for the ribs are flat to the direction of gravitation in the horizontal position, while in the erect position they are parallel to it, and much more exposed as a consequence. The sacro-iliac articulation also is not adapted for bearing the weight of the body and all of its muscular efforts as well, but a large — in fact the larger — part of this in animals is borne by the forelegs: yet in the human subject this is first subjected to extreme torsion from the erect position, its thrown off its balance by the tilting of the pelvis, and then is forced to bear the strain of the erect position and of all the effort put forth by arms and trunk as well.

And the human spine is derived from the animal spine. Undoubtedly compensation is made for this change to the erect position — the adjustment of structure to function is an automatic thing in higher animals — but also that adjustment is never complete. The ages of heredity are magnificent as compared with the race history of the human family. Each individual passes again through an epitome of the evolution of its race, re-enacting its race history, structurally as well as otherwise. And though each individual is also re-created by its parents, under the influence of their environment and efforts, yet the balance struck between the forward reaching heredity and the

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backward reaching re-creation is much nearer the present than the past. The mechanical devices of the human body are still weak with reference to the erect position, the position in which it mostly receives its strains and shocks. For a further illustration, again comparing the animal with the human spine, we find in the latter the joints of the lumbar region extended to the limit until they are in effect telescoped, while those of the dorsal area are correspondingly flexed — constantly in a state of semi-flexion, as compared with the horizontal animal spine bearing its weight transversely. In these positions it is put through an immensely wider range of motion and under immensely increased mechanical strain.

This is the background against which must be drawn the picture of the causation of mechanical lesions in the body.

There is always a force greater than the power of any structure to resist. Even in animals osteopathic lesions are found in plenty, as shown in the reports of the A. T. Still Research Institute. In human beings they are merely more in proportion, as his mechanism is somewhat perverted, and his use of it violent.

We think of these forces of disorder as being of a violent character. And indeed the most serious lesions are caused by external violence. But there is also much internal violence, and there is also the prolonged warping force, whose effect is slow but none the less serious; whose total is, as a matter of fact, probably greater than that of the other two combined. To these must be added forces that weaken the mechanism itself.

We may classify the sources of lesions therefore as :

External violence.

Internal strain (muscular).

Gradual warp.

Pathological weakness.

In reference to external violence, it proves to be not easy to get a clear record of the cause of a given disorder. These do not occur in the presence of the physician; often they occurred years before. All that he can note is the effect. Classifying of these accidents and shocks with a view to prevention is not possible yet. We find a rather curious thing, namely, that people do not often remember even the serious accidents that are responsible for the more serious of these disorders. The reason for this is doubtless that they have not been taught to associate disease with disorders, i.e., with such accidents. That which is a daily observation with the osteopathic physician is as yet a novel and a strange doctrine to the people in general.

The greatest number of violence lesions comes probably from falls; next ranks accidents of various kinds, and then blows, as blows on the neck. A rather frequent cause of lesions is the playful habit of pulling a chair from under someone about to sit down. In the resulting shock the sciatic ligament is tensed by the position so that the elastic yielding of the sacrum is less, the spine is strained forward compressing the discs so that the full unrelieved shock from the descending weight of the trunk comes against the sacro-iliac joint. This is especially liable to produce serious lesion if one

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side strikes first, as the descent of the opposite side then brings strong leverage action to bear on the articulation. The suddenness of the shock will the more easily cause a lesion, just as the quick pressure is more effective in correction, because there is less time for the distribution of the pressure through the elastic medium of the tissues; which in the one case acts to cause, in the other to correct, the lesion — according to the direction of the force.

It is the sudden, violent shocks that cause the radical lesions. Let us make an examination of the mechanics of the joint in relation to such violence.

In the first place we have solid structures, bones, bound together by flexible material; and these solid structures move on each other. They move on each other, and they remain in contact while doing so. In such a case one of two things must necessarily be true of that flexible material which holds them together — either it must be elastic, or it must be fastened at the centre of motion of the bone that moves, and move radially as it moves. Otherwise no motion would be possible without tearing the material. Both of these things are true, as it happens. There is one kind of ligament that is strong and very slightly elastic, which acts radially; and another kind that is quite elastic, not radial in its motion. Also it is evident that this binding material does not keep the two bones from passing beyond their normal limits of motion — it merely holds them at a constant distance while they do so. It is not their function to limit them otherwise. That they do so limit them is due to the fact that beyond the point of normal motion the surface of the bone is no longer smooth or no longer permits of radial motion. Beyond the limit of normal motion therefore the angle of the surfaces to each other is changed, and the function of the joint as such is destroyed. It is under those circumstances that it remains in false position as a lesion. It may be very lightly held at first, but the factors that hold it as a lesion are likely to increase as time goes on and it is uncorrected; for it seems to be the fact that recent lesions are far easier to correct and remain corrected more easily than those of some standing.

It is the muscles, which act for the most part parallel to the plane of the joint surfaces, that should constitute the protection of the joint against lesion. Muscle is really a powerful thing. Consider the leverage of the elbow through which the biceps acts — attached about an inch from the centre of the joint, or fulcrum, the lever is from fifteen to eighteen inches long; to lift ten pounds in the hand requires about one hundred and fifty pounds of force when the forearm is horizontal. So of the other bones in the body in proportion to leverage. Their power is adequate to protect joints normally.

It is when they are overpowered by the other leverages of the body itself or are taken off their guard that lesion is mostly produced, or when co-ordination of the body's movements is faulty or slow.

It can be seen from this how necessary it is to have the patient relax when correction is attempted. With relaxation complete, the correction of lesion is often unbelievably easy with proper technic, except in long standing or in extreme lesions.

The theory of the immunity of drunken men from hurts in falling is probably incorrect, when it states that this is due to his muscles being all relaxed. It is difficult to relax voluntarily — it is the business of muscles to contract to protect joints. What does

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happen is that the muscular reaction is slow, so that the shock of the fall is widely distributed — as it would not be if the muscles were completely relaxed, nor of course if they were violently contracted under the influence of fright. The falling of a dead body differs by immense degrees from that of a drunken man. In stage falls also there is probably never complete relaxation — it would probably be found impossible to drill the nervous system so thoroughly as to make it possible; but it is possible by training to overcome the element of fright which brings on over-contraction with increased danger, and to secure enough relaxation to allow the distribution of the shock.

In the matter of the prevention of lesions in falls and accidents therefore the proper thing would seem to be first never to allow a joint to be moved to its extreme limit, and to keep the position and motions of the body always securely under the control of its muscles.

Direct blows on joints are responsible for lesions of ribs quite frequently, of the cervical vertebrae at times, and of the sacrum rarely. Any severe shock will, however, be distributed through the body, decreasing as it spreads, until it finds articulations whose planes are parallel to its force; then if sufficient force is left, lesion may be produced.

By internal violence is meant contracture of muscle under some pathological force. As said, this contractile force may be very great and may last for long periods. With such a contracture existing in some muscle, then even normal movement of the part may cause it to overpower the muscles opposing it on the opposite side of a joint, and to produce lesion. A familiar instance is the ordinary "crick in the neck," in which certain cervical muscles are contracted under the shock of cold, by nerve shock reflected from the thermic centres in the cervical cord; at the lower end of this contracted muscle lesion of the rib to which it is attached will commonly be found.

The subject of warp lesions is a very vast one. Probably every occupation that is at all monotonous or mechanical has its typical warp. Very great benefit would come to the public from a statistical study of this matter with a view to prevention. Many of these have been commented on. Most important of these are the sitting position, and the position in sleeping. High heels exact a toll in human life and health whose total would be astounding could it be reckoned. The high heel takes tension off of the rear thigh muscles, and so allows the pelvis to assume a steeper angle; throwing the sacro-iliac ligament off of its plumb, leading to lesion of this joint; stretching the anterior spinal tissues and telescoping the articulations in the rear. It is not uncommon to find the spine bent into a series of antero-posterior curves, with lesions at various points.

These may be corrected but will appear at other points in a short time if the deformity of the shoes is not corrected.

The mechanics of the warp lesion are practically the same as those of the major force lesion. Instead of the sudden violence overcoming the protective action of muscle and ligament there is the gradual stretching of them. The mechanical positions and relations that are assumed are the same except that there is less tension in the stretched ligaments; less indentation; greater ease in correction at first ; but there is probably much less tendency to spontaneous correction.

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When, however, a lesion resulting from warp has stood for some time it is probably quite indistinguishable from a major-force lesion.

The border-line between a normal state with muscles relaxed at the limit of motion of any joint, and a warp with stretched tissues, is very faint. So also is the border-line between a warp and a warp lesion in which normal position is not assumed for mechanical reasons. The latter distinction is not important in technic.

Weakening of the ligaments of the whole body occurs in conditions of thyroid insufficiency. Weakening of ligaments of individual joints is likely to occur in connection with vasomotor disturbance reflected from some internal abuse; in which case it occurs around the specific centre for that organ and is due to the inflammation congestion and swelling of the ligaments.

There are certain points of natural mechanical weakness in the body. Every mechanism has its structurally weakest points. Mechanically weak points exist wherever a small part joins a large part. Such points are found in the human body at the juncture of the spine with the pelvis, with the reinforced chest box, at both upper and lower ends, and with the cranium.

Mechanically weak points occur where the angle of motion changes abruptly. These are found at the sacro-lumbar joint, at the eleventh dorsal, the seventh cervical (heavily reinforced) at the axis and atlas.

Mechanically exposed points exist at the ends of the attachments of large muscles or of any muscles subject to strain, as those of the shoulder, the scaleni, the pectoralis minor.

Danger points exist where articulations are small and motion slight, when strain, even well distributed strain, includes them; as the upper dorsals, the last ribs.

Physiologically exposed points exist at the centres for organs frequently strained or abused, as the organs of internal secretion; these are the third cervical, the second to fourth dorsal, the seventh and eighth dorsal, the eleventh dorsal.

A physiologically weak point exists in the sacro-iliac joint in females near parturition, for the ligaments are functionally congested and softened to make dilatation and adjustment easy.