On curvatures of the spine : their causes and treatment / by Richard Barwell.

ON

CURVATURES OF THE SPINE;

THEIR CAUSES AND TREATMENT.

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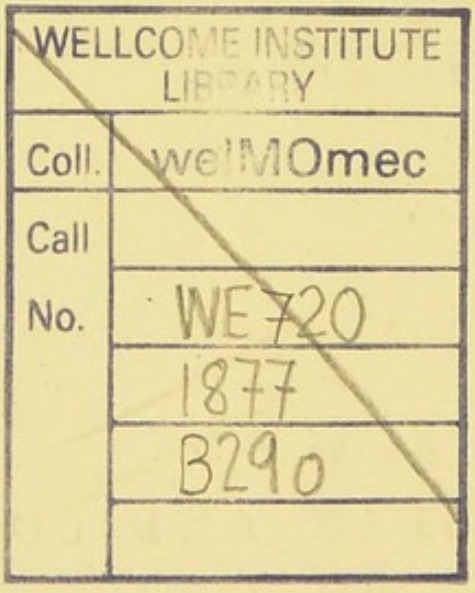

PREFACE TO THIRD EDITION.

The fact that a third edition of this little work is called for cannot be otherwise than gratifying, since it shows that the principles therein advocated are gaining ground, and establishing themselves with the profession. These principles, which also pervade other of my works, viz. that on Clubfoot, and to a certain extent that on Joint Diseases, may be thus epitomized. A large number of deformities depend on muscular conditions: their cure, therefore, is better and more perfectly effected by causing the muscles to act aright than by preventing their acting at all.

The present edition has been revised and slightly modified; certain forms of bandage

not previously depicted have been added; and certain phases of distortion have been more fully described. The delineation, therefore, of Lateral Curvature, its origin and treatment, is complete in itself; nor do I think that anything of importance has been omitted.

A chapter on a new method of treating Angular Curvature has been added. Its inventor, Dr. Lewis Sayre of New York, to whom I wrote on the subject, was good enough to respond by sending me a fuller narrative of his procedure than is contained in his work on Orthopædic Surgery: he will, I am sure, pardon a few minor modifications in the management. My experience, though extending only over a few months, has been very extensive, and enables me to say, without overstepping the limits of due and proper caution, that this plan offers the one desideratum so long sought—a means of enabling persons suffering from spinal disease to sit up,

instead of lying in bed; to take a healthy amount of exercise in the open air, instead of being dragged about in a wheel-couch; and to get well with as little, instead of with as much deformity as possible.

RICHARD BARWELL.

32 *George Street, Hanover Square,*
June 1877.

PREFACE.

ALTHOUGH it be unadvisable that an author should in a preface argue the necessity of reading his book, he may nevertheless be permitted to state why it has been written. In the present plethora of medical literature no one should publish unless he has something to say which he believes to be more than a mere repetition of what has been said in another form,—something which he believes to be both new and useful. The reason of my having such faith in the ensuing pages may be thus stated.

Having failed to find in books a satisfactory theory of those conditions which produce lateral curvature, it naturally appeared that

in all the works, English and Continental, which I studied, and whose name is legion, there was something defective, for they gave, to my thinking, no explanation of certain essential peculiarities of that deformity. Endeavouring to carry further their line of reasoning, the same gap or the same impassable barrier presented itself. It then appeared that, to carry out my desire, I must work for myself. To do this I first examined a great many normal backs under different conditions, measuring and calculating different movements and varying postures, both at rest and in exercise. The results of about twenty months of this labour are given in a few lines of the ensuing pages; at the same time, dissections and examinations of normal and morbid specimens, as far as my opportunities would permit, were carried on. Having completed these studies, I turned to living spinal curvatures, and investigated their condition with the insight which my studies of the norm had

afforded. This work also occupied a considerable period, during which time all theorizing was avoided until a large mass of facts was collected, until these facts presented me with a causation which I could trust, and until experience led me to a treatment calculated to remedy its effects. Although, then, a great deal has been written upon the subject of lateral curvature of the spine, I yet hold myself justified in adding another work to the list; because the views which I have been led to form account for those essential characteristics which have been hitherto left unexplained, and because the treatment which I advocate is certainly less irksome, and will, I firmly believe, be found by others, as by myself, more efficacious than that which has hitherto been pursued.

It only remains for me to say that the substance, or, as it may be called, a summary, of the ensuing pages, appeared in 'The Lancet' during the latter end of the last and the

beginning of the present year. Perhaps may be partly due to that form of publication a certain mode of arrangement which, though not quite logical or orderly, will, I think, conduce to the more easy comprehension of the doctrine which I desire to teach.

RICHARD BARWELL.

32 *George Street, Hanover Square,*
26th May, 1868.

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CHAPTER I.

THE NORMAL SPINE.

THE treatises which I have published on Diseases of Joints, and on Clubfoot, &c., will probably lead those of my readers who are acquainted with their contents to expect in the ensuing pages a somewhat analogous mode of dealing with deformities of the trunk. This, I believe, will be found to be the case, not only in my endeavours to assign the malady to its real cause, but also in the *direct* method of treatment advocated. It may be permitted me to recall the fact, that in my writings on the subjects first named I have insisted on the necessity of going beyond the mere forcing of immobile parts into a position, which they must either retain, with permanent immobility or abrogate with resumption of motion—that

I have especially advocated treatment during the continuance of functional movement in such manner as to prevent destruction of joint structures, more especially the fatty and the fibrous degeneration of muscle, so certain to attack those organs while retained in forced repose—and that in doing this it has been my task to point out some muscular functions and actions hitherto overlooked or insufficiently considered; but upon which the persistence of the malady nevertheless depends.

Contemporarily with my investigations on joints and limbs, I began to study English and Continental works on the spine; and soon became involved in a haze of difficulties and a fog of contradictions—since of all the irreconcilable theories on the causes of lateral curvature, not a single one of them, nor all put together, account for the peculiarities of the disease.* These peculiarities are so constant and so remarkable as to

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* Of course we must here except the curvature of rachitic origin, and those resulting from internal inflammations. I am speaking only of lateral curvature as a primary disease.

inspire a true and instinctive feeling, that if they be left unexplained the disease itself is not understood. At the risk of forestalling points that must be examined hereafter, it will be necessary to mention the three most important characteristics of lateral curvature, and to contrast them with the explanations hitherto given. These are torsion of vertebræ,* predominance of dorsal curvature to one and the same side, with tendency to affect chiefly almost exclusively the female sex, and among these hardly any but women of Europe and the United States — especially of the Northern States. It would make this work utterly unreadable to mention all the theories that have been formed to account for these conditions; but it may be possible to do them full justice, without boring the reader, by classifying them into spastic contraction, debility and paralysis of spinal muscles, paralysis of respi-

* That is to say, each aberrant vertebra is twisted horizontally, so that the anterior surface of its body looks to the convexity, the tips of its spinous processes to the concavity of the curve. The degree of curvature corresponds accurately with the amount of torsion

ratory muscles, over-action of the right arm, uneven distribution of the weight of the trunk —the weight of the heart hanging on the dorsal, that of the liver on the lumbar spine —disease and deformation of vertebræ and of intervertebral substance.* Now the difficulty with all these is as follows: they none of them account, or indeed attempt to account, for rotation. If any one of these theories, except the over-action of right arm or weighting by heart and liver, were correct, the dorsal curvature must of necessity be as frequently to the left as to the right. The theory of over-use of the right arm, even were it for a moment tenable, should make the affection more usual in men than in women. The different weighting of the column by liver and heart should, if it were the efficient cause, render lateral curvature a constant and usual condition, equally common in both sexes. Thus, as we examine each and every of these

* I believe every theory will be found to range itself within one or the other of these classes—overweight of head being accepted as equal to debility, —lack of nutrition as equivalent to disease.

theories, we find one or more of the characteristics in the disease unexplained; and as these points are not accidents, but essentials, the disease as a whole is not elucidated.

I believe that, in the course of the ensuing pages, I shall be able to give a satisfactory explanation of this perplexed subject, and to show how, upon a correct pathology, a more efficacious and less irksome or injurious treatment is to be adopted than the present prevalent method of screwing the spine into iron splints. To do this fairly we must take up the subject from early physiology, since by that means alone can we determine what forces act, and how they act on the vertebral column.

The bodies of the twenty-four bones composing the spine are placed alternately with intervertebral ligaments, so as to form a continuous column, which, lying within the abdomen, within the chest, and behind the gullet, tapers with slight modifications from below upwards to the point upon which the head is pivoted. The vertebræ, separated from each other in front by the remarkably

elastic intervertebral ligament, only touch at the back of the spinal canal by the small facets on the articular processes, one on each side. Each bone therefore rests upon its fellow by a tripod, between the feet of which lies the axis of motion, and here the vertebral canal perforates the bone. Movement at the articular surfaces takes place by the gliding action common to these and all arthrodial joints; the movement between the bodies is produced by compression, stretching, or twisting of the intervertebral substance, which is thick enough to suffer these alterations to a very great extent, and elastic enough to recover them completely.

In most mammalia whose station is horizontal and whose femora lie at an angle with the axis of the body, the spine is nearly rectilinear or but very slightly curved. The spine of the infant too is intrinsically straight in all directions; while so very young as to be kept always recumbent, the back, perfectly devoid of any inherent bend, merely follows the curves of the surface upon which the child lies. The thighs are kept flexed towards

the abdomen ; except at the occasional moment when the child "stretches" the limbs are never held straight. The pelvis is nearly horizontal, *i.e.* the brim of the true pelvis projects at little more than a right angle from the lumbar spine. When the infant sits up on the nurse's arm the back bends in one single antero-posterior curve, concavity to the front, the pelvis maintaining the same relative position.

When, however, the child begins to walk a change takes place in all these postures. The thighs must take a new position, and lie in a line parallel with the body's axis. In doing this they drag on all the muscles passing from the anterior part of the os innominatum to the femur—on the iliacus, rectus, pectineus, and others; the pelvis, yielding to these forces, must necessarily receive a downward slope, and the sacrum must project backwards. The psoas, made tense by the same force, draws the loins forward, while the mass of lumbar muscles enforces that bend of the lumbar region necessary to compensate for the pelvic obliquity, and to preserve the body in æquilibrio. It seems at first sight well to say that

the dorsal bend is produced by the necessity of balance; but it will, on consideration, be seen that there must be muscular force to place the passive bones in the position which permits balance. This force is supplied by the abdominal muscles, which, passing from the pelvis to the walls of the chest, are rendered tense by the new posture of the former and the descent of the pubic bones above described. On the front of the dorsal spine are no muscles,—for if any were so placed, their action through the vertebræ upon such long levers as the ribs would destroy that regularity of movement necessary for healthy breathing. Therefore each pair of ribs is not moved by muscles acting on the fore part of the spine: on the contrary, nearly all motion of that portion of the column is confided to muscles attached to the ribs.

The flexion backward of the cervical spine, also necessary for balance, is produced by the tension, employed for keeping the head erect, of those muscles which are attached to the occiput, as well as of those attached to the vertebræ themselves. I must here make an

observation on the position of the head in man, and the small size of the ligamentum nuchæ, which is especially placed in animals to economise muscular power. Although the weight of the head is in man considerably forward, yet very little muscular power is required to keep it upright. The disposition of the upper part of the trapezius muscle, running from occiput to acromion, is such that a small part of the weight of the shoulders is quite sufficient to counterbalance the forward tendency of the head; the muscle is not fatigued thereby, since no contraction, further than mere tonic tension, is necessary to permit the weight of the one part to act on the gravity of the other.

When the adult or adolescent stands erect, with the weight evenly distributed between the two feet, the antero-posterior curves of the spine are three—cervical, dorsal, an lumbar, which alternate in direction; they may be thus expressed:

Cervical—convex in front, 28 degrees of a circle of $6\frac{5}{8}$ radius, begins at the odontoid process, and ends at middle of 2nd dorsal vertebræ.

Dorsal—convex behind, 42 degrees of a circle of $12\frac{2}{8}$ radius, begins at 2nd dorsal, ends lower edge of 11th dorsal.

Lumbar—convex in front, 80 degrees of a circle of $5\frac{3}{8}$ radius, begins middle last dorsal, ends lower edge last lumbar.

The chords of these arcs lie in one continuous line, which is the perpendicular of the crooked column; or, to put it in other words, a perpendicular drawn from the tip of the odontoid process impinges on the vertebræ above-named, and forms the chords of the vertebral curves. This line, traced onwards beyond the lumbar vertebræ, falls at right angles on the centre of a line drawn from the middle of one acetabulum across the pelvis to the other. Thus the weight of the body falls upon the strong transverse arch formed by the thick ilio-pectineal line, and thence is transferred to another transverse arch constructed by the necks of the thigh bones.

A considerable portion of the lateral springiness of the trunk is produced by these transverse arches: one foot, *i.e.* one buttress, can be

raised from the solid ground, and slung as it were upon resilient muscular power.

The above-mentioned incurvation of the spine has generally been considered and described as an essential characteristic of the column; but this is far from being the case; it is simply a condition forced upon the bones by the human erect posture, and is essentially one of effort. This is proved by the congenital form of the spine, which is straight, by the fact that in lying down to sleep—even in sitting at ease—these curves, especially the lumbar, and to a great extent the cervical, are obliterated, and the column assumes simply one curve (concavity in front) from the last lumbar to about the fourth cervical vertebra. I cannot but think that the brothers Weber were, in their estimates of the dimensions of vertebræ, misled by their ideas of what ought to be the case, rather than guided by accurate measurement. They assert that the bodies of vertebræ vary in such wise (to put the matter shortly), that they are in all cases thicker on the convex part of the curve. Herr Hirschfeld, of Prague, a most accurate

observer, could find no such variation; nor have I, in my measurements of a great many spines, been able to discover such differences as the Berlin anatomists have described.*

Again, if the vertebræ did really vary thus in thickness, the spine would maintain those curves during recumbency, and the infantile column would be bent. Moreover, the spine when erect would lose that mechanism of exquisitely counterbalanced springs which I am about to describe.

When the recumbent or sitting individual, whose spine, either nearly straight or forming a slight long bend, rises to his feet, the column changes its form in the manner described, and certain connecting structures are compressed or stretched. Let us first take those connected only with the bodies of the

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* It appears to me that the great elaboration and abstruse appearance in calculation of arcs and sines have caused this learned work ('Die menschliche Gehwerkzeuge') to be accepted with too little examination. I have, in another publication ('A Treatise on Diseases of the Joints'), shown that the great power which these authors attribute to a supposed articular vacuum is quite unfounded.

vertebræ—viz. intervertebral substance, anterior and posterior ligament. Imagine first the bones and the interposed substance piled one above the other, forming a straight line, with the ligaments in front and behind equally tense. Now bend the column forwards: the front of the intervertebral substance becomes compressed, the anterior ligament relaxed; while at the back the intervertebral substance is thickened, and the posterior ligament stretched: thus, in both back and front aspects of the column, there is attempt to restore the straight condition. But, besides these, we must consider the parts connected with the processes, which, especially those attached to the arches, are extremely elastic, and so arranged that they constantly, by their retractile power, tend to draw the back parts of each bone nearer together—*i.e.* to make the spine concave posteriorly. Thus they are, at the loins and neck, at ease in the erect posture; the posterior muscles are there extremely strong: in the back they are tense, and always endeavouring to obliterate the dorsal curve, and in that part

the muscles behind the column are comparatively very weak. Let us consider these conditions, first, in extremes: suppose the individual stoop or bend the trunk forcibly in any direction; there are always on the convex side ligaments stretched, on the concave, substance compressed, both endeavouring to restore the straight line. Next, suppose the individual, seated as man usually sits, with the lumbar curve obliterated, the dorsal one nearly so; imagine him starting up, and the spine assuming its curves—that is to say, all these ligamentous aids to motion, all these alternations of tenseness, are called into play; the spine becomes a series of springs, which set each other, allowing the brain to ride as in a well-hung carriage, and giving to the figure, expectant or in motion, that lithe activity which could never have been produced if the bones were a series of wedges such as the Webers describe.

Finding, then, that the normal antero-posterior bends do not result from the form of the bones, but are superinduced upon the previously straight spine simply by muscular

force, I wished to determine, firstly, the amount of influence such muscles exercise, or, in other words, the degree of mobility, which the spine, under ordinary circumstances, possesses; secondly, the particular muscles producing the movements in question; thirdly, the mode in which the usual movements of the body or limbs affected the spinal column.

In order to determine the capability of rotation in persons unaccustomed to gymnastic performances, I contrived a means of attaching a light upright rod to the upper end of the sternum and chest in such-wise that it should be quite uninfluenced by any movement of the shoulders; but should only and accurately follow the movement of the sternum from side to side. The upper end of the rod is, by jointed attachments, placed in communication with a dial-index. The person to be examined is seated on a chair, the pelvis well fixed, and, for greater security, the knees grasp between them a wooden pillar or bulkhead, so that all twist of the pelvis is impossible. This instrument then will exactly indicate the amount of rotation of the loins and back, the neck not

being included. A very general amount of this rotation is between 30° and 40° to either side. Occasionally one comes across persons who can only turn 25° each way, but it is more usual to meet with those whose power exceeds 50°. I myself can turn 56°. One of my subjects, seventeen years old, could turn 62° to each side—that is, more than one-third of the circle.

If we assume that the power of rotation is equally apportioned between the first dorsal and fourth lumbar vertebra (the last has no power of rotation, in all probability), it would be distributed amongst sixteen bones—that is, each would revolve upon the other, 7° 75′.*

I tried also to measure the lateral curve which the spine without absolute effort could assume, but found it impossible to do so on the body itself. I therefore had photographs taken

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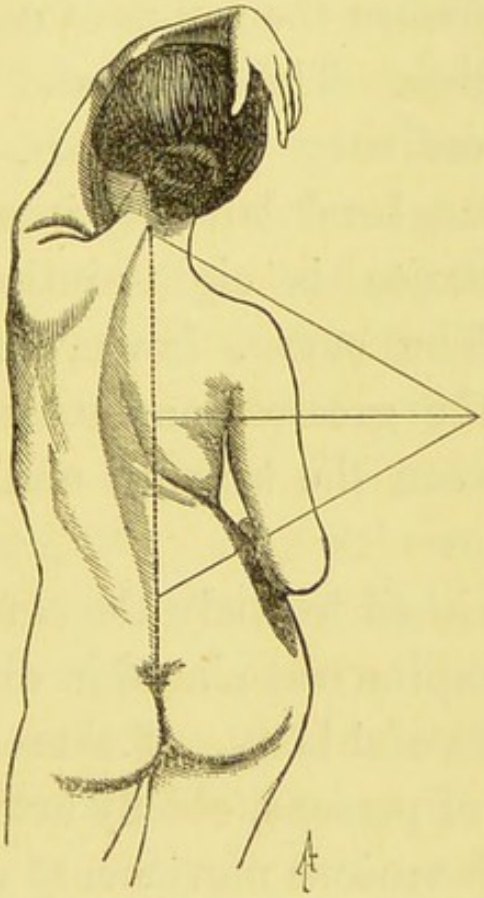
* I have found that authors mention different parts of the spine as enjoying most freedom of rotation, their deductions being drawn from their ideas of the limiting powers of the articulating processes. My belief, founded on many observations on the living, is that the freedom of movement is pretty evenly distributed.

of a few people, chosen not from those whose spines were very flexible, but from those whom it was most convenient to photograph. One of these persons, a woman aged thirty-two, placed with the left shoulder against the wall,

Fig. 1.



was directed to bend the spine to the right as much as she could without strain. On the photograph of this position the transverse axis of the pelvis was drawn, and a line at right angles to it marks the straight position of the

spine: the curve from the top of the sacrum to the vertebræ prominens was then measured; its length was 13·5 lines; the radial distance (we will suppose the curve circular) amounted to twelve lines. On the body of the patient, the length of the spine itself was eighteen inches, therefore the radius of curve measured sixteen inches. The dorsal and lumbar spine, then, in ordinary individuals, and without exertion, can bend laterally in a curve whose radial distance is eight-ninths of its own length. The curve, however, is not quite circular; the greatest amount of bend takes place between the seventh and tenth dorsal vertebræ.

I also wished to study the conditions under which the spine was placed in different actions of the limbs and body. I therefore procured a number of persons, chiefly artists' models, to go through various movements with the back naked. It does not seem advisable to transcribe here my voluminous notes of these experiments. Suffice it to say that in walking, sitting down, and rising again, and lifting even small weights, the spine bends from side

to side. As might be expected, motions of the arms and shoulders influence chiefly the upper part; movements of the lower limbs, especially if the pelvis itself move, chiefly the lower part, of the spine. The former movements only affect the column when either powerful or prolonged: for instance, a pound weight may be held in the hand outstretched without influencing the spine for a certain time, but when fatigue commences the column bends; a greater weight will at the moment of lifting cause bending of the column, produced in both instances by the spinal muscles which lie at the opposite side to that which carries the weight. Any movement which shifts the weight of the body from one leg to the other causes lateral flexion of the lumbar and lower dorsal spine; for instance, walking, especially ascending a staircase, causes deviation to the right and left, in some persons as high as the seventh dorsal, in others only to the tenth dorsal vertebra. Whenever the weight or movement be such as to cause more than the slightest lateral bend, either in back or loins, the other portion of the spine, loins,

or back, as the case may be, assumes a curve in the contrary direction ; of this I shall have to speak more fully in the sequel. With every lateral movement a commensurate amount of rotation is combined; it does not appear possible to bend the spine sideways without at the same time rotating the vertebræ to a certain extent.

These experiments and measurements prove the normal spine to be capable of considerable lateral flexion, and of a great amount of rotation. I would desire to lay stress upon these results, because the whole plan of treatment, the whole prognosis of deformity, not at the spine only, but also in other parts, depends upon correct appreciation of its origin and production. All noncongenital deformities which arise and progress slowly, and which are not due to organic disease of bones or joints, consist throughout their earlier stages of undue persistence of a posture which is in itself normal. At first, by voluntary effort of the local muscles, this position may be changed, even reversed. When the posture has been maintained a certain time the

muscles of the part can no longer entirely abrogate it—some external force, either of the surgeon's or of the patient's hand, is required. Soon after this the position becomes exaggerated—it goes beyond that which the part can normally assume; still for a time replacement can by some external assistance be attained. After a still further interval neither intrinsic nor extrinsic force can put the bones into the natural medium position. I propose to term these conditions respectively, habitual posture, permanent posture, malposture, first phase of deformity. A second phase of deformity still exists, that, namely, in which long persistent malposture and the subsequent changes have produced alteration in the shape of the bones and of the articular surfaces. The length of time required to establish appreciable change in these harder parts of the body varies chiefly with the age at which permanent malposture commenced, and also in a less degree with the amount of malposition established.

This last phase is, save in very early life,

incurable.* The fourth condition (first phase of deformity) is curable in its earlier periods, before it has continued long enough to produce considerable shortening of ligaments. The three first conditions are always amenable to treatment.

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* I do not intend to say that it cannot be benefited.

CHAPTER II.

CAUSES OF DORSAL CURVATURE.

EACH group of vertebræ—viz. cervical, dorsal, and lumbar—may be affected by circumstances which produce in them a persistent bend or curve to one side. But when the first of these regions is the seat of such disturbance the malady is termed "wry neck," and, its production being peculiar, it is not included in the term of lateral curvature. The dorsal and the lumbar region only, consisting of seventeen vertebræ, are therefore to be included in the consideration of this malady. Let us commence with certain definitions and explanations, which will make our subsequent work easier.

A curvature is named right or left according as the convexity of the curve looks to the one or other side.

In every curvature the aberrant vertebræ twist, so that the anterior faces of their bodies look towards the convexity of the curve, the spinous processes to the concavity.

It very seldom happens that the spine assumes one simple lateral curve in the same direction from end to end.* On the contrary, there are at least two, in opposite directions; the upper one is called the dorsal, the lower the lumbar curve: dorso-lumbar would, however, be the more correct term, since it occupies the two or three lowest bones of the back, as well as those of the loins. Of these two curves, one is directly caused by some external circumstance; the other is only an indirect sequence, being produced by the necessity of restoring the balance disturbed by the curvature first set up. Hence the one is called primary, the other secondary or compensating.

The terms primary and secondary must be understood as referring only to the sequence

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* Nearly all the examples I have seen of this condition were manifestly hysterical.

of causes; for, since the necessity of balance produces the secondary curve, it must arise simultaneously, or nearly simultaneously, with the primary one.

When more than two curves appear they are called multiple.

We will first consider curvature primarily dorsal as the more frequent and more important form; and in doing so must bear well in mind the three coincidences already specified—namely, torsion of vertebræ, predominance of dorsal curvature to the right side, preference of the disease for the female sex. These peculiarities have not as yet been satisfactorily accounted for, and, since they are essential characteristics, I must beg the reader to dismiss as untenable any theory—my own among them—which does not fully explain their occurrence and their constancy.

The vertebræ and the ligaments of the spine are passive, and of themselves motionless objects. If any disease or alteration of shape caused them to deviate or to twist, such malady would after death be very apparent, and would long ere this have been distinctly

described in morbid anatomy; but it would be highly improbable, if not absolutely impossible, that the same side of the vertebræ, and the same numerical vertebræ, should be so constantly almost exclusively affected, that the curve always influences the same bones. That is to say, in a double curvature a straight line from the last cervical vertebra to the middle of the sacrum will cross the S shaped curve once at the ninth dorsal vertebra, a few lines below or above its spinous process, and this whether the two curves be extreme or slight. Therefore those who ascribe these curves to a primary disease of bone or ligament are bound to give some pathological history of such malady, and to show cause why it should affect not only particular bones, or intermediate substances, but certain sides of these particular parts, with such remarkable constancy. We must then look outside the spine for the causes of its curve, *i.e.* to the forces which normally bend the spine in different directions, viz. to the muscles. The muscular group classed together under the name of erectores spinæ, being situated along

and parallel with the column, can have very little or no influence in rotating the dorsal portion of the spine.*

In the course of making the experiments detailed in the foregoing chapter, I was anxious to find what those forces might be which produce that normal rotation of the column whose amount I had so carefully measured. Somewhat unexpectedly, I found that rotation of the vertebræ in all the upper part of the column is effected by the serratus magnus, which when thin persons are under observation stands out during such action strongly and sharply. Let the reader consider the anatomical relations of this part. Two muscles (rhombodei major and minor) arising from the spine at the root of the neck and top of the back are inserted into the base of the scapula; from this point the serratus spreads out fan-

* On the lumbar vertebræ, as we shall see in the sequel, their influence in this direction must be considerable; if, however, dorsal curvature were attributable to this group, it is impossible to find any reason why it should so constantly affect one and the same side, and a group of vertebræ, nor why it should so predominate in one sex.

shaped, to be attached to the ribs from the first to the ninth inclusive. For the particular

Fig. II.

Rotating Action of Serratus.

action in question these muscles may be regarded as one broad fleshy layer, which, arising from the upper part of the spine,

sweeps round and embraces the back and sides of the chest; and in this view the intervening base of the scapula is to be considered merely as an intersection, like the semilunar lines in the abdominal rectus. This muscular arrangement acts at great advantage in turning the upper part of the body on the pelvis; its base of attachment to the spine is small, its leverage short, that to the chest very large, and in contracting it draws the ribs of the side backward. Each rib, having attachment to the body, and also to the transverse process of vertebræ, becomes thus a lever of the second class, whose power arm is the length from the muscular attachment to its head, whose weight arm is the distance from head to tubercle; it is indeed a crow-bar very powerful to twist each vertebra on its own axis. This function of the rib is attested by the fact that when the serratus ceases to be inserted, the spinal attachment of the rib no longer affords a purchase for such action. In losing the double conjunction to body and transverse process, the lower ribs abrogate the arrangement of fulcrum and weight necessary to lever-like

action on the vertebræ, and at the same time the serratus ceases to be attached to the ribs.

Now, let us consider the action of the serratus under another point of view. It has already been said, that only a very small portion of the weight of the shoulder is supported by the upper fibres of the trapezius, otherwise its action on the head would have to be counteracted by other muscles, which would greatly interfere with the freedom and mobility of the head and neck. Therefore the upper angle of the scapula hangs to the spine by its levator muscle; but the outer angle, the shoulder-joint and the arm, are supported by the serratus, which, drawing the base and lower angle of the shoulder outwards and forwards, keeps the outer angle (acromion and shoulder) upwards and backwards. The weight, therefore, of the shoulders, and of the arms falls, through the medium of the serrati, upon the ribs, and this weight tends to keep them back—equally, of course, on both sides of the chest if the arms be of equal weight.

The most important function, however, of the serrati is respiratory; they lift and draw

back the ribs on each side of the chest as far as the freedom at the joints permits, thus enlarging the cavity of the thorax. In forced inspiration this action is very marked; but man during quiet breathing hardly uses the muscle at all, his respiration being chiefly abdominal; woman's ordinary quiet breathing is, on the other hand, very much more pectoral, her chest and bosom rising constantly with each inspiration, even during sleep. In woman then, more than in man, the ribs are drawn backwards in inspiration—an action which would be equal on both sides of the chest if both lungs admitted the same quantity of air.

The hypothetical sentences at the end of the last two paragraphs are of importance. The arms are not of equal weight, nor are the lungs of the same size. A boy or youth, however, uses free exercise, swings his arms as he walks, and lolls and lounges about in all conceivable positions, thus giving variety to the manner in which the shoulders are supported; and, above all, he breathes chiefly by the diaphragm. The girl or young woman

takes less free exercise; in walking she lets the arm hang almost motionless from the shoulder, sits decorously upright, so that the weight of the arms hangs all day long, through the medium of the serratus magnus, on the ribs; and, far more important, her breathing is chiefly pectoral. Now let the ribs be regarded, in the manner above described, as powerful levers, which, under the sway of the serratus, can rotate the spine should the one muscle act more powerfully than its fellow; and consider the girl thus circumstanced, with the right arm heavier than the left, with the right lung more capacious than the left, and it will be seen that the serratus of the right side, being more weighted and in stronger respiratory action than its opponent, must of necessity rotate the vertebræ to the left side. This explanation will at once account for the rotation of vertebræ, and its prevalent direction. Moreover, a crucial proof, if I may use such a term, is found in the fact that European women, who by tight clothing round the waist and abdomen increase their tendency to

pectoral respiration, are the frequent subjects of lateral curvature; while among Hindoos, Arabs, and others who use a loose form of dress, such deformity is all but unknown.

It will, of course, be remarked that in this explanation I entirely change the sequence of causality. It is usually stated that the spine first curves laterally, then rotates, and in this latter movement, by dragging with it the ribs, deforms the chest. I affirm that the ribs are primarily drawn backwards, and, acting as levers, twist the vertebræ, which in consequence deviate from the right line—according to a simple mechanical law, and yielding to the new direction in which the erectors of the spine now act; for in this rotated condition straightening the spine curves it naturally to the right, and in lateral curvature much of the sideways distortion is in reality displaced extension.

This theory is very strongly supported by the result of disease, for when part of one lung becomes, from some local affection, unfit for its function, the ribs covering that portion cease to move, and are uninfluenced by those par-

ticular serrations of the muscle. Therefore the corresponding ribs of the sound side bulge backward, and the cognate vertebræ become crooked. This is not produced by contraction of the lung on the diseased side (there is frequently rather swelling than decrease in bulk), but from inaction of the serratus over the affected spot; the opposite parts of the muscle therefore on the sound side must twist the vertebra, since their action is unbalanced on the morbid side of the chest. So accurate is this correspondence that we may fix upon the part of lung most affected, by noting the ribs which protrude on the sound side, and the locality of the spinal deviation. In curvature from consumption we find nearly always a high short dorsal curve, as in a patient recently sent to me by Dr. Cotton; in pneumonia the curve is low and long, as I have had more than once occasion to remark in cases at the Charing-cross Hospital.*

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* By no other method can we account for the fact that in pleurisy, when the size of the contents on one side of the chest is increased, and afterwards, when, the lung being bound down by adhesions, their size is

The etiology of the weight-bearing curve is also borne out by pathological facts. A man, after amputation of one arm, acquires by the action of unequal weight a certain amount of lateral twist, sometimes sufficient to constitute a noticeable deformity. When therefore a girl carries a weight constantly on one arm, its power in contorting the spine becomes considerable, and we occasionally find nurse-girls become very crooked from such cause. In these cases the lumbar muscles on the other (the left) side of the spine are found very much developed in consequence of increased action counterbalancing the burden carried.* In such cases the compensatory lumbar curve is established simply for the sake of balance; not so the secondary curve in cases arising from respiratory causes. The two forms are

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diminished, we still have curvature in the same direction—*i.e.* from the diseased side; the ribs on that side ceasing to move on respiration.

* This condition must be distinguished from mere bulging of the parts through backward projection of the transverse processes, as will be shortly explained.

distinct, not only in causation but in form, and in the action of subtending muscles.

If the two causes (one-sided pectoral breathing and the influence of weight) be combined, as is frequently the case, their distorting power is very great; but the former is undoubtedly the more influential, and is continuous both night and day. European women, as above stated, increase this peculiarity of thoracic breathing by wearing tight petticoat-strings, corsets, and belts round the waist; also many plump girls, in desire to restrain any unsightly, however blameless, enlargement of the abdomen, frequently compress that part with belts or corsets, and thus, by almost entirely checking the respiratory movements of the abdomen, place themselves in a position of dangerous facility for acquiring dorsal curvature.

This leads me, even at the risk of future repetition, to consider the grave cause of objection to the "spinal support" of orthopædy.

It is easily perceptible that there is great difficulty, or rather impossibility, in fixing

around the pelvis a steel hoop so immovably that a lever springing therefrom can make effective pressure on a protuberant portion of the spine or ribs. In order, however, to render the pelvic hoop of a spinal support as little movable as possible, straps and bandages fastened upon the instrument encircle and are tightly laced upon and around the abdomen. We have, however, just seen that excessively thoracic breathing of women (since the right lung is larger than the left) is the real and efficient cause of dorsal deformity. Such exaggeration of woman's natural character of respiration is produced chiefly or entirely by tight swathing of the abdomen; for where this form of dress is not used, as in hot climates, lateral curvature is a very rare deformity. It is hardly necessary that I should ask the reader to compare the cause of lateral curvature with its prevalent treatment by an instrument, which in every possible way adds largely to the very root and origin of the malady, by preventing abdominal movement in breathing. Nor need attention be called to the singular fact that tight rigid

stays have always, with justice, been regarded as productive of lateral curvature; yet as soon as a girl shows any inclination to that deformity, she, under such treatment, is fixed in stays, more tight, more heavy, and more onerous than the most tyrannous devotee of a barbarous fashion could invent. Yet we must, in justice, state that in a certain small number of cases these instruments have produced benefit—namely, in such as are caused, not by the more usual respiratory conditions above mentioned, but in that far smaller number produced by distribution of weight always to one side of the body. In such cases the good is effected by the crutch-handle, which relieves the serratus magnus of the weight of the right shoulder. This may, however, be effected, in the cases where it is desirable, by means far simpler, and which do not produce such restraint and so many evils.

The production of the secondary curve (lumbar) is somewhat different in each class of case; for though, in either, two groups of muscles are called into play, viz. spinal and

abdominal, yet the degree of their participation is not the same in both.

Let us first consider the formation of a lumbar curve consecutive to a weight-bearing dorsal curvature. A weight carried on the right arm alters in the figure the place of the centre of gravity; and in order to bring this within the points of support, the body is thrown over to the left side; the spine forms at first one simple curve to the right. This, as I have found by experiment on a number of individuals, is always the first new posture of the column, unless the weight be considerable in proportion to the person's strength. If the object be very heavy, or if the time for supporting it be prolonged, the spine, instead of bending thus simply, will form two curves; the upper one to the right will increase, and will be supplemented by another contrary curve in the loins.

Now, while the spine is straight as in infancy, the erectores spinæ muscles are placed at a mechanical disadvantage for moving the bones in any direction, since a cord running parallel to and in close contact

with a straight staff has less power in bending that staff than if it ran in any other direction. When, through the actions described in the former chapter, the column assumes its antero-posterior curves, the influence of the muscles is improved, as far as backward and forward movement is concerned; but still remain—since the column in a lateral direction is straight—in a disadvantageous posture for producing sideways movement. But when the spine, weighted as above described, has become crooked (and this first step is chiefly through the medium of abdominal muscles), the erectores are in a better position for the above action, and of course have most power over those vertebræ which have chiefly deviated from the right line. We therefore find, in all lateral curvatures of weight-bearing origin, a line of strong muscular development running from the back of the ilium to the most aberrant vertebræ. This line is marked in proportion to the weight carried and to the rapidity with which the curve is formed. I must, however, warn the unaccustomed observer against mistaking the projection formed

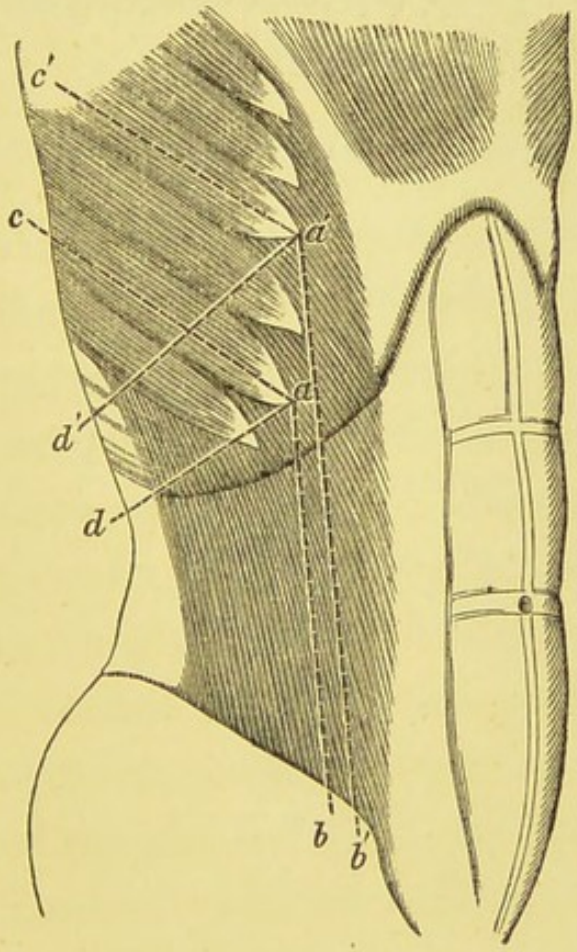
by prominent transverse processes in a rotated lumbar spine for muscular enlargement.

The production of the compensating curve in the much more frequent cases of respiratory origin is very different. In normal breathing inspiration is produced by descent of the diaphragm, together with relaxation of the abdominal muscles and protrusion of the belly. When such movement is restrained by any pressure over the abdomen, this relaxation is prevented, but the same cause does not prevent—indeed it rather abets—constant contraction of the abdominal muscles. The spine, however, twisting to the right, relieves the tension of the left side, while that on the right is increased, not merely by this twist, but by the respiratory elevation of the ribs. Thus upon these right ribs two forces act at an angle to one another: one from the pelvis drawing them down, the other from the spine drawing them upwards and backwards. These forces balance each other, since during life there is no alteration of the costo-spinal angle; but the pelvis, in its relationship to the trunk, is a fixed point, the spine a movable one. Hence,

although the former force does not change the posture of the ribs on the spine, it draws ribs and spine *en masse*, *i.e.* the whole trunk down to the right hip-bone, causing the loins to bend chiefly at or near the second lumbar vertebra. The lower ribs of the right side are therefore found very much nearer to the eritta ilii than those of the left—indeed, in severe cases they are in contact; in exaggerated ones they overlap and inclose the upper lip of the haunch-bone. If we consider this subject in a more mechanical point of view, the problem may be placed thus:—Upon each rib two forces act, at an angle to each other, and the resultant movement must be in a line within the angle. Since the rib itself does not move on the spine, the forces are even, therefore this line of motion must bisect the angle; and, of course, the point of movement must be where that line intersects the next joined part of the body. The annexed rough diagram represents, on the right side, the lines of force of the serrati and external oblique with the bisecting lines of movement. Now, if these measurements be made on the subject, and

the lines carefully drawn, it will be found that they all converge to a space between the first and third lumbar vertebræ. Hence,

Fig. III.



a b, and *c' a' b'*, the angle of serratus and lateral oblique at seventh and ninth ribs; *a d*, and *a d'*, the bisecting line.

in cases of respiratory origin, unless far advanced, we find on the left loin no line of strong muscular development such as is present in the weight-bearing curve; but on

the right side we find exaggerated muscular marking about the side and flank, with—what will most strike the unaccustomed observer—a twisting of the umbilicus. These diagnostic signs will require especial consideration in the sequel.

CHAPTER III.

CAUSES OF LUMBAR CURVATURE.

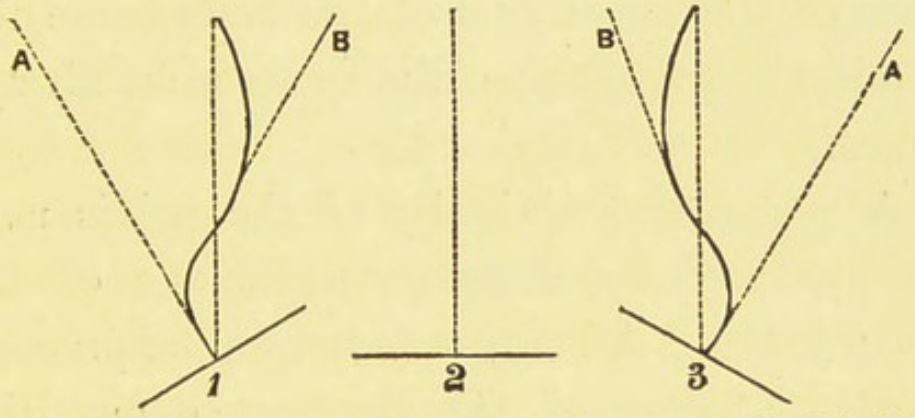
In order to trace the simpler etiology of lumbar curves, I would remind the reader of those parts in the first chapter which refer to the normal movements of the spine in different actions of the body. The erect human figure has but two points of support, and in locomotion the weight is thrown alternately from one to the other: thus a certain shifting of the centre of gravity takes place, so as to bring it over the right and left foot by turns. Such movement occurs even in walking along level ground; and, besides this, the pelvis twists a little with every step, so that first one side and then the other is advanced, and the side projected forward is at the same time lifted. These conditions necessitate certain movements of the spine, which may be felt, as

before stated, in some as high as the seventh dorsal, in others only to the tenth or eleventh dorsal. The highest movements of the column are, *cæteris paribus*, to be found in women, a fact which is, I believe, attributable to their greater breadth of pelvis.

Since the actions of limbs and pelvis alternate, so must the spine move from side to side, producing those undulating curves of graceful action which the Greek sculptors so wonderfully understood. These, I say, take place even in walking over a level space; they are, of course, increased in such actions as ascending a staircase, or more unevenly, but to a larger extent, in passing over broken ground. Such curves (without, however, the pelvic twist) can be well seen in the back of one sitting on a prancing horse or sailing over a chopping sea, but are most thoroughly to be observed by seating an individual, sideways and barebacked, on a plank contrived to rock on a fitting support placed under the centre of gravity. An observer standing behind the subject of experiment will see alternating undulations of the spine, as

depicted in the accompanying diagram. If the whole spine remained at right angles to the pelvis when its transverse axis became oblique (1 and 3, A A), the line of gravity would fall outside the support; therefore the

Fig. IV.



2, The horizontal position. 1 and 3, Rocking to right and left. The dotted lines, A A, the direction of lower lumbar vertebræ. B B, The direction of dorso-lumbar spine. The central dotted line, a perpendicular. The dark lines, curves of spine.

spine bends to the side. Moreover, since the centre of gravity lies so low in the body, this bend must be sharp. If the upper part of the trunk followed the direction of the loins (1 and 3, B B), the balance would be over-corrected; hence the dorsal portion must assume a contrary curve. These movements, though owing to the necessities of balance, are, of course, produced entirely by muscular action.

Thus it is evident that any position which throws the transverse axis of the pelvis out of the horizontal position forces on the spine certain curves, and such will be the case whether such disturbance be merely momentary or of longer duration. If therefore any state of the lower part of the body cause the pelvis always to slope, the spine must always curve.

A permanent obliquity of the pelvis may be produced by a rickety condition of the lower limbs. All surgeons in hospital practice must be aware of the frequent deformities entailed by such malady. One or both legs may be varous or valgous; one may be affected with the former, the other with the latter distortion; and in all such cases the level of the pelvis is disturbed, since it very rarely, if ever, occurs that both limbs, even if they have the same morbid curves, will suffer in the same degree. This is, I believe, the reason why rickety scoliosis is so incurable; for the vertebræ themselves are very seldom affected by rickety disease; in bad cases, however, the pelvic bones are considerably involved,

and become themselves misshapen, besides standing aslant on their supports.

The same effect may be produced by disease causing a contracture of the hip-joint, a stiff knee, or lame foot; all such conditions may, it is evident, produce a slope of the pelvis to the lame side and a counterbalancing movement in the upper part of the body, which causes the spine to bend at the loins. There thus arises lumbar curvature towards the lower side of the pelvis; at first this curvature only exists while the bone slants, *i.e.* while the patient is erect; but after a certain lapse of time muscles and ligaments adapt themselves to this posture, and the curve becomes fixed.

But an obliquity of the pelvis is, occasionally, much more frequently than will be readily believed, owing to an absolute difference in the length of the lower limbs. I can scarcely expect that my experience in these matters will be at once accepted without further test, but the result of any investigation I am ready to abide. I have found that an inequality in the length of the lower extremities is not uncommon in persons affected with lumbar

curvature. There are great difficulties in the way of statistic accuracy in this matter, because the people who pay most attention to deviation of form belong to the upper ranks of women, so that accurate measurements are obviously objectionable. Nevertheless, I have three cases of lumbar curve in the female, in which I detected and measured this inequality; they amounted, respectively, to $2\frac{1}{2}$, $1\frac{1}{2}$, and $1\frac{1}{4}$ inch from the top of the great trochanter to the lowest tip of the external malleolus; two in lads, the one amounting to a little over $\frac{3}{4}$, the other to $\frac{1}{2}$ an inch.* In two of these five cases there had been, in early life, some short phase of pain and lameness which, barely remembered by the parent, might point to hip disease—in one a condition which appeared more like a transient attack of infantile paralysis; in another, the

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* These two occurred among four male lumbar curves which came under notice in a space of three months. It will be necessary to refer hereafter to the circumstances which in examining the patient would lead us to suspect this condition. Here I must limit myself simply to its description.

story resembled that of femoral embolism; but these memories from a far-off date furnish no very reliable basis.

But besides these cases absolutely measured and noted, I have seen a vast number of others, equally strongly marked, and equally indubitable, that have not been traceable to any disease or injury of bones or joints, nor to other specific cause.* The shorter limb is not in these cases thinner or less well-nourished than the other; the patient and her friends are unconscious of any such defect, since the condition produces no lameness. Nevertheless, when it is once pointed out by the method described at p. 122, no doubt can for a moment be entertained on its existence. As a rule, the inequality merely affects the limb itself, so that when the patient sits down all obliquity disappears; but I have seen two patients who, even while sitting on a level seat, had one ilium higher than the other, thus showing that the pelvic bones were also of

* One of the most severe spinal distortions produced by very great difference of the lower limbs was sent to me by Mr. Lansdown, of Clifton: it occurred in the person of a youth aged 14.

uneven growth. In neither of these cases could any cause be traced. One of these, sent me quite recently by Dr. Hammond, of Preston —a young lady only eleven years of age has in standing the left ilium $1\frac{1}{4}$ inch higher, in sitting $\frac{3}{4}$ inch higher than the right. The case is also exceptional as to the side, for, although a longer right limb is by no means uncommon, it is rare to find the inequality reversed.

I cannot determine which of the limbs is in fault, nor whether the error be redundant growth of the one or deficient growth of the other. The fact, that in a greatly overweening majority of cases the right is the longer limb, points to an origin independent of injury or disease, and to simply an exaggeration of that law of development which makes the right side of the body larger and more potent than the left. I believe—but in this any accuracy is obviously impossible—that the condition is more common with girls than with boys, although a goodly number of the latter have come under my notice.

I now proceed to relate two cases of excessive difference in the length of the limbs,

partly as curiosities, partly because from one of them my illustration of this form of pelvic obliquity is taken.

Case I.—Margt. E., æt. 15, came to me, at the Hospital, with a scalded foot, which would not heal; the sore was painful and very obstinate. I found peculiarities of the limb, both as to size and circulation, which led to further inquiries.

The mother, an intelligent woman, says the girl has never been ill—except from measles, hooping-cough, &c.—never lost the use of the limb, never had a fit till a few months back, when some seizure, apparently hysterical, caused a short alarm.

A fortnight after the birth of the child she observed that one leg was smaller than the other; she called the attention of both doctor and nurse to this fact. Nothing was done, and the disparity has gone on increasing. There was never any loss of power. The girl is marked with the dark blotches called portwine stains—not, as is usual, confined to one or two places, but over the whole body.

12th March, '69.—The girl is largely developed, and fat; the left thigh and buttock are, perhaps, unusually big for a girl of fifteen. On the right side these parts are small. Measurements as follows:

	LEFT.	RIGHT.
Length from trochanter to foot ..	35	31
„ of foot..	9½	8½
Half-circumference of pelvis, at level of great trochanter	18	15

	LEFT.	RIGHT.
Top of thigh	21¼	16¼
Middle thigh	18½	13¼
Knee	13	10½
Calf	12	9

Case II.—John H., aged 13, came to me on account of severe lameness; on examining, I found the left leg smaller than the other. There is no hip disease, and no paralysis; the lad seems very healthy.

The history of the case is all but valueless. The father (his mother is dead) remembers that, when the boy was about 2½, he had an attack of illness which lasted four days, with pain in the leg, or legs, but he does not know if the limb lost power; in fact he knows nothing about it. We can only say now that there is no sign of disease in hip or knee; the foot is small, and rather valgous. Measurements:

	RIGHT.	LEFT.
Whole limb*	30	24½
Femur	16	13
Tibia	14	11½

Now, in both these cases it is evident that, when the patient stands upon the two limbs, with the knees straight, the pelvis must be excessively oblique; hence, to preserve balance, the body must be thrown over to the high

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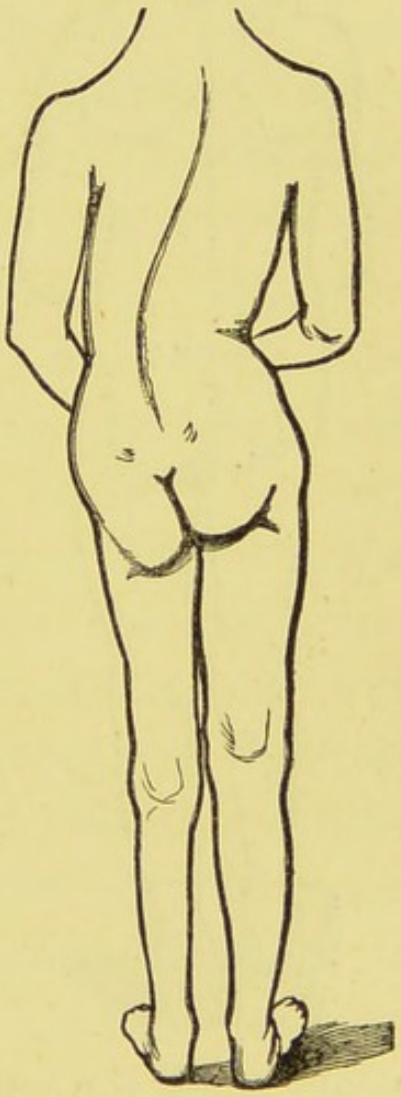
* These are taken from great trochanter to external malleolus.

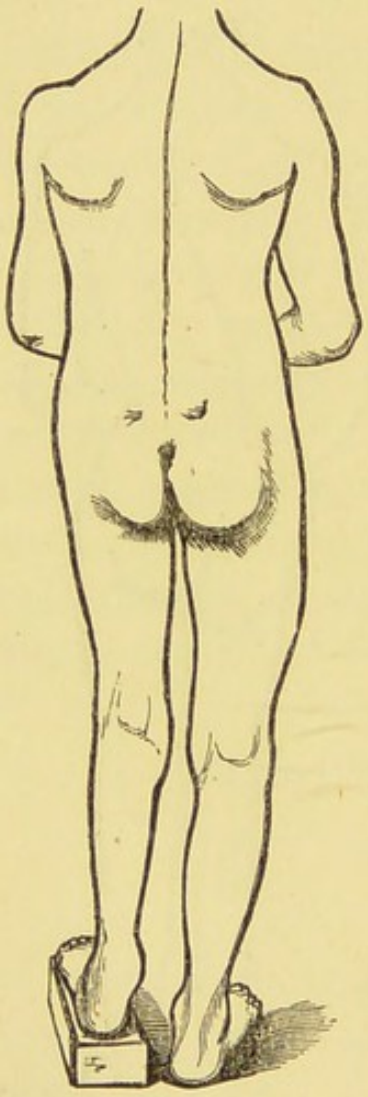
side—in other words, the spine must be crooked, the concavity towards the high side. The annexed plate (*Fig.* V.) represents the condition in the case of John H.; that on the next page (*Fig.* VI.)—in which the lad stands with the short limb supported on a block, thick enough to make up the difference—shows that there is no permanent curve of the spine — since, when the pelvis is horizontal, the back is straight. The former plate, where the two feet are on a level, shows how obliquity of the pelvis forces the spine to curve. It will be readily understood that, while such great disparity in the length of the limb is rare, a difference small enough to produce no appreciable lameness, and therefore overlooked, yet large enough to cause spinal deformity, may

Fig. V.



well be more common. It must be remembered, too that, when one limb is smaller than another, it is also weaker; hence the patient is sure to stand chiefly on the longer leg, and render the tendency to curve still more potent.

Fig. VI.



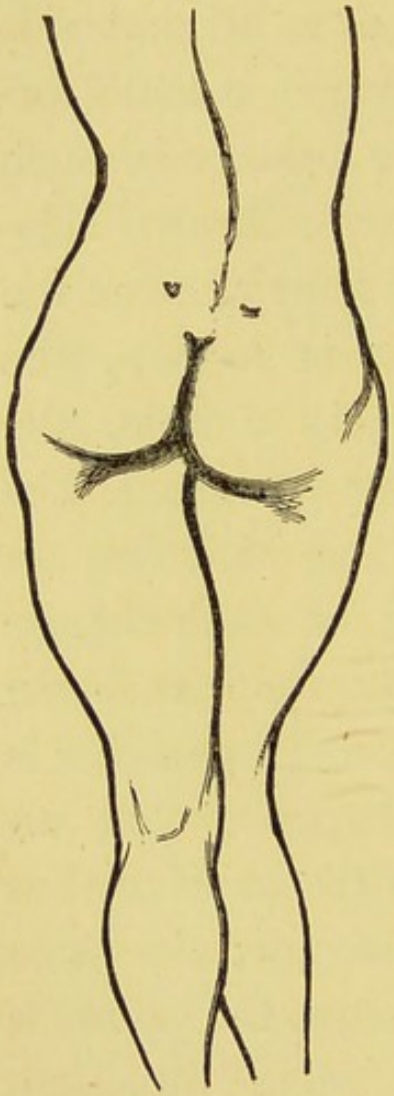
Such condition—a difference in the length, or a lameness of a lower limb—produces an obliquity of the pelvis, which we can detect when the patient stands as erect as possible before us. We will call it "permanent obliquity," to distinguish it from another state, about to be described, which we will name "habitual obliquity" of the pelvis, and which disappears when the patient is made to stand erect (both feet together, and the knees straight).

All observant people are aware that they seldom see an individual (unless it be a soldier

on drill) standing with the weight equally distributed on the two feet, and the body straight. There is always a tendency to throw the burden chiefly upon one foot, and to bend the other knee, so as to let that side of the pelvis droop and advance a little forward. In order to preserve balance in such position, the body is, of course, thrown sideways, to bring the centre of gravity over the weight-supporting leg—that is to say, the spine is curved laterally. As a rule, the attitude is constantly being reversed, the weight supported now on one foot, now on the other, the spine bending on each change in a contrary direction, so that an even balance in its muscles, bones, and ligaments is produced. But, again, it happens that an occasional individual will get the habit of thus using one leg almost exclusively; the same side of the pelvis always droops, the spine is constantly curved in the same direction. Generally, with this overweening habit, there is some other fault involved; for instance, twisting the unengaged thigh inward, and throwing it in front of the other. This trick,

which is especially injurious, I have found not infrequent; so much so, that when I am presented with a primary lumbar curve and can detect no *permanent* pelvic obliquity, I lie in wait to catch my patient in that or some analogous posture. All tricks of this sort are more common among girls than boys, partly because the concealment of female attire masks such malpostures from surrounding friends, while a creature in trousers would be laughed or scolded out of such an attitude before it had time to do harm.

Fig. VII.



In all this latter class of cases the pelvic obliquity is merely *habitual**—that is,

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* Whenever one limb is shorter than the other the patient is sure to stand habitually on the long one, and to let the short one with that side of the pelvis droop;

according to our definition (p. 56), it disappears when the patient stands in drill posture; but these faulty attitudes influence the spine in a mode which requires fuller explanation. In the earliest part of the case, and when the awkward trick has lasted but a little time, the spinal curvature disappears when the patient is placed truly erect, and when she lies down. A little later in the progress of events, the curvature does not disappear in the drill posture, but does vanish when the patient lies prone. In a still further advanced condition, neither erect nor recumbent position annuls the curve. Such peculiarities of behaviour divides lumbar curvatures naturally into three stages.

There is no doubt whatever that by far the larger proportion of lumbar curves is produced by pelvic obliquity, permanent or habitual; but there are a certain number of cases in which I have been able to detect

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therefore when either permanent or habitual pelvic obliquity has been diagnosed the other form must also be looked for.

no such condition, although studied with an amount of care which has almost precluded the possibility of error. In such cases there has always been some uterine disturbance (amenorrhœa, or dysmenorrhœa), combined with what may be called uterine irritability. The connection between the one condition and the other is necessarily involved in obscurity, increased by the fact that in advanced lumbar curves the uterine functions, originally normal, often become disturbed. Under such circumstances, can we consider menstrual difficulties occurring shortly after puberty the efficient cause of a lumbar curve which follows closely on the primary disturbance? I believe we must do so, unless we discard many cases which appear to leave no alternative; and in such view must ascribe an ill-regulated and one-sided action of muscles to irritation of the uterine and ovarian plexus communicated to the lumbar nerves. It is also very probable that the sufferer from such disturbances seeks relief in some abnormal attitude;* for one very

* Ovarian irritation, perhaps even hyperæmia, produces an uneasiness which probably causes the one-sided

frequently finds in these cases a condition, which is absent in the curves from pelvic obliquity ; viz. that besides having assumed a lateral inclination, the loins have lost a good deal of their normal antero-posterior bend.

With every lateral bend of the spine, whatever be its cause, a commensurate amount of rotation is combined (p. 20), whose direction is such that the anterior faces of the vertebræ always look to the convexity of the curve. A former chapter showed us that in dorsal curvature rotation is the primary movement, and the cause of the lateral bend; it is produced by muscles which may be named extrinsic. In lumbar curves the mechanism is somewhat different; for when the pelvis is oblique (as in 1 and 3, *Fig.* IV.), it becomes necessary to the preservation of balance that the body should bend to the high side. Of

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attitude above alluded to. This explanation is consonant with the fact that these conditions are always, or nearly always, unilateral; whence also the nervous irritation communicated upwards to lumbar nerves would be only on one side.

the muscles which effect this movement, two (quadratus lumborum, and psoas) have great power over the spine conferred on them by the situation of their distal points of attachment at a considerable distance from the column. The sacro-lumbalis, also arising some distance away, exercises its great influence through the medium of the ribs; while the longissimus dorsi, on the transverse processes, comes more fully into play when the previously named have already curved the spine.*

The annexed diagram shows, in the form of plan, the action of these muscles (except the psoas). It will be seen that, besides impelling the column towards their points of attachment, each muscular slip draws down the rib, and the transverse processes of each side, thus tilting each vertebra upon the one immediately

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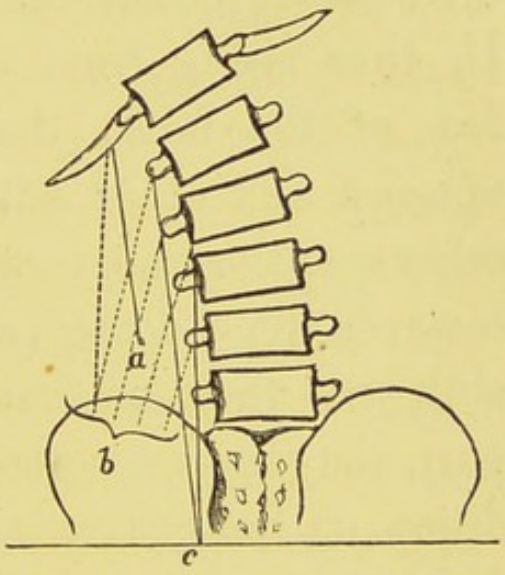
* The external and internal oblique, although they greatly aid in balancing the spine upon its base the pelvic bones, have, I have found, very little influence in the production of a primary lumbar curve, which contrasts markedly herein with secondary curves at the loin (p. 44 et seq.).

below it, compressing that side of the inter-articular cartilages, and making them a series of wedges.

If these forces acted on a column originally straight, no twist between each bone would occur; or, again, if their force were exerted along the chord of curvature in a bent column, that power would merely add to flexion, and in the same direction. But the position and the direction of ribs and transverse processes is such that the muscles act on points quite outside the chord of curve, and both outside and behind the point of rotation and flexion for each vertebra on its fellow. Therefore the spine must, of necessity, twist—or, in other words, every lateral bend of the lumbar spine must be combined with rotation.

Fig. VIII.



a, Sacro-lumbalis. *b*, Quadratus lumborum. *c*, Longissimus dorsi.

It cannot be too strongly impressed upon

the minds of those unaccustomed to examine these cases that the rotation always takes place so that the fronts of the vertebræ face towards the convexity of the curve: in consequence of this the transverse processes on that convexity may be felt with more or less distinctness according to the amount of bend. In thus rising from the depths to the surface of the loins, they lift with them the muscles and other soft parts; while on the other side the transverse processes sink deeply towards the abdomen, and the lumbar muscles sink with them, so that losing their hard support, they become soft and doughy. This condition on the convex side has been mistaken for violent or spastic contraction of muscle; and the view has led to sundry infelicitous errors in theory and practice. For instance, these muscles have been cut; and, singular to relate, M. Guerin, who originated this operation, has cut muscles sometimes on the convex, sometimes on the concave side of the spine with, according to his published writings, equally brilliant results: indeed, this operation has been revived at one of the many special

Hospitals. Unfortunately, the strong condemnation passed upon it by a commission of the most celebrated Parisian surgeons has not deterred orthopædists from this justly condemned procedure, whose future fate—foreseen with only too great facility—is already written in the pages of the past. While subcutaneous myotomy and tenotomy were still new, its employment was in Paris transferred from the limbs to the trunk, and a certain number of cases suffered under the knife; while the debility thus induced permitted the scaffoldings to work with greater ease, the operator, and perhaps his patients, buoyed themselves with hopes that a cure was hatching—the cases were published with considerable parade and flourish, and a few more induced to undergo myotomy. Then came a time when some ventured to express distrust of these results. That feeling gradually gained ground, and soon it was found that at a period when, if a cure had been effected, the patient might have dispensed with mechanism, a stronger support instead of a slighter one was needed: the back became weaker, and

collapsed when the irons were removed; at last it was scarcely able, even with strong instruments, to uphold the trunk at all. Then these cases were not so much paraded; the Academy pronounced a condemnation of the procedure; and the whole thing has been quietly interred, until in these latter days, when its ineffectual ghost haunts us once again.*

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* It is believed that, since these lines first appeared, the practice has been again abandoned, probably because our too facile prophesy has been fulfilled.

CHAPTER IV.

DIAGNOSIS OF DIFFERENT CURVES.

We have seen that a broad and marked distinction between a curve primarily lumbar, and one primarily dorsal, lies in the fact that in the former a prominent hip, in the latter a prominent shoulder, is first observed; that is, such changes of form are the most marked symptom of each malady. Thus, though a dorsal curve very rapidly, perhaps instantaneously, calls forth a lumbar, and the primarily lumbar is closely followed by a secondary dorsal, yet the peculiar first alteration remains characteristic till, at all events, a late period, and not unfrequently throughout the case; and this peculiarity is not the lateral sinuosity of the column, but the twist backwards of parts on the convex side of the spine, or, if very early in the case, on the side which will become convex.

Thus, if the surgeon be about to examine a patient with the desire of finding out whether or no the spine be crooked, he will be judicious in directing attention rather to the parts above named than to the line of the spinous processes, for the following reasons: When, in the commencement of the malady, the vertebræ begin to deviate, they do so in two manners—rotation and lateral movement. Now, the tip of the spinous process—which, until there is considerable displacement, is the only bit of the vertebra we can feel—is that very part which in rotating moves most away from the side towards which lateral displacement tends—that is, the rotation of the spinous process to the left compensates for a certain amount of lateral deviation to the right; therefore there is a stage in the condition, when the tips of these processes will lie in a perfectly straight line, although the vertebræ will have been considerably displaced. But, if we direct our research to the parts at the side of the spinal ridge, we find that these, be they ribs or lumbar transverse processes, have been so displaced that, under

good auspices of lighting, the eye will detect the want of symmetry, or a practised hand will distinguish the variation of level, hardness, &c. Some stress is laid upon the mode of lighting, because in an ordinary window light any horizontal gradual protuberance or undulation can hardly be detected; but, with a perpendicular light, the shoulder in the one class, the hip, or rather haunch, in the other class of curve, receives on its prominence a strong ray, and throws a long shadow under its elevation. I have the advantage of possessing two consulting-rooms, and have found that an amount of torsion so slight as to be not at all, or only doubtfully, perceptible in the one light was unmistakably evident in the other. The fact of asymmetrical shading of the torso must provisionally be considered as sufficiently indicative of a spinal curve. We shall speak of more conclusive symptoms in the sequel.*

After having decided on the existence of a spinal curve, the next points for determination

* The reader is referred to two plates at pp. 79 and 90 for such instances of asymmetrical shading of the figure.

are these: firstly, is it primarily dorsal or primarily lumbar? and, if the former, to which class of dorsal curves does the distortion belong? The former question must be answered by observations concerning relative protuberance of the hip or of the posterior pectoral walls. I will describe the differential diagnosis as shortly as possible, since the peculiarities of each case must be again discussed in their special description. The mere projection of the scapula is comparatively a late symptom in dorsal curve: previous to its appearance a certain bulging beneath and inside the angle of the blade-bone becomes evident. In lumbar curve, the lateral projection of the hip—that which alters the mere outline of the figure—is later than a posterior projection of the innominate bone, marked by protuberance backward of the parts lying just outside the sacro-iliac joint; while the figure above this, viz. at the loins, though it may not have altered to the view, will be found by touch harder on one side of the spine than on the other—a difference resulting from the unsymmetrical positions of

the transverse processes, not from muscular transformations. These conditions will be the chief or only ones apparent when a patient who has not any or only habitual pelvic obliquity is placed in drill posture: when the patient has permanent pelvic obliquity one crista ilii will be found higher than the other. Diagnosis of disease is simple enough, if strongly marked morbid types be assumed; the skill of an observer is shown in his power of distinguishing, in early stages, typical conditions, which, though present, are still only slightly developed. Now, in all cases of commencing dorsal curve, the mere lateral undulations of the bones of the spine will not afford any ground for diagnosis between that form of distortion and a curve primarily lumbar; but the variations in collateral parts give ample means for distinguishing the forms, under such conditions as I have named. In the very earliest stages, the costal prominence backward of a dorsal curve is unaccompanied by any pelvic change; and, in any equally early stage of lumbar curve, the variations in form about the iliac and lumbar regions are combined with

no pectoral alteration; but these, with certain other symptoms hereafter described, will indicate the presence of a lateral curve, lumbar or dorsal, before the line of the spinous processes has deviated to any appreciable extent. In later stages a curve primarily dorsal will be accompanied by lateral prominence of the other hip, but never by the peculiar backward prominence above described.

The diagnosis between lumbar and dorsal curvature being now formed, it will be desirable to point out the peculiarities of each; and first of the dorsal curve.

The backward projection of the scapula is, I have said, a rather late symptom, and it will be well to explain its occurrence. The first motive of a dorsal curve is, as has been shown, over-action in one serratus—*e.g.* the right, which draws back, and a little upwards, the ribs; it follows that inequality in the walls of the chest will be an early sign. Moreover, since a slight twist in such short and such well-covered bones as the vertebræ can hardly be detected, but becomes very evident in such long levers as the ribs, it

follows that, although from their anatomical connections both parts must rotate at the same time, yet the ribs by their length will act as indices, and enable us at once to detect an amount of rotation not evidenced by the shorter bones. In their backward progress the ribs begin to press upon the soft parts between them and the scapula, which all yield, to a certain extent, before the pressure becomes sufficient to raise the shoulder-blade itself: thus in the earlier stages the scapula may still be in normal position. Be it also remembered that the shoulder is very movable, and it frequently happens that in making examination of a young woman we shall find, in spite of all possible care to keep the arms in position and the back upright, that sometimes one, sometimes the other blade-bone will project more than its fellow, on account of some irregular action of muscles induced by the exposure to the air of parts usually covered, a sense of shyness, or impress of the surgeon's finger.* Such impress is necessary:

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* In the last chapter of this treatise the posture of

for, while examination by the eye is highly essential, we must also use touch; feeling not only for the projection of the ribs, of transverse processes on the right side, and their depression on the left, but also for the line of the spinous processes. It will hardly be necessary, in this advanced stage of our investigations, to repeat that the axis of rotation lies just at the posterior margin of the vertebral bodies, and that the tips of the spinous processes being twisted to the left may still be in a straight line, although the spine itself will have deviated considerably to the right; but it will be well to point out a peculiarity which, as far as I know, has not been noticed. There is in the skin of the back a mesial line, or broad raphé, very plainly marked by absence of hair follicles and gland-ducts, and by the opposed direction of those structures on each side. This line, while the back is straight, lies over the spinous projections; but when these latter deviate, they glide beneath the skin, and may wander

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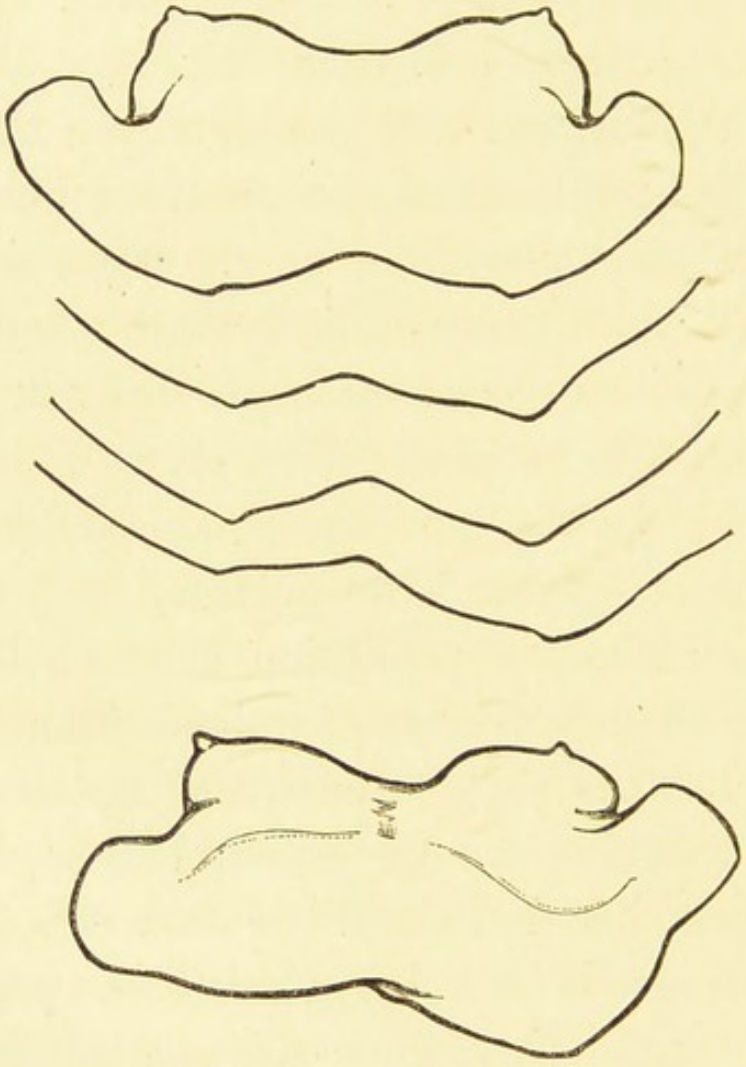
the scapula, and its value in diagnosis, is more fully described.

considerably from the mesial line without drawing the raphé with them. Therefore it is not sufficient to examine by sight alone, for the superficial marking will be sure to mislead the eye as to the position of deeper parts. If the case be advanced beyond the very earliest stage, the surgeon will be able to feel the tips of the spinous processes on one side (under the circumstances postulated on the right side) of this line; and about an inch further outward the transverse processes begin—as the curve advances—to be perceptible, or, at the least, there will be the hardness produced by their retrogression towards the surface.

This backward projection of the ribs can also be advantageously examined from above thus: Let the patient be seated on as low a chair or stool as can conveniently be employed, and lean her head a little forwards. The surgeon stands over her, closes one eye, and, placing the other some distance above the vertebra prominens, looks down the spine as along a gun-barrel. He will then see in a straight back the line of the spinous processes as a groove, or as a slight elevation, according

to the *embonpoint* of the patient, and on each side the rounded eminence of the erector spinæ, partially covering the backward

Fig. IX.



Diagrams of Rotation.

projection of the ribs; beyond this is the scapula. Now if the back be straight—so straight that not even any rotation has taken

place—the two sides will be symmetrical as in the first diagram of *Fig.* IX. If there be the beginning of deviation, the symmetry will be imperfect, as in the second outline, and in further advanced cases the two sides will be utterly unlike; the one flat, or an absolute hollow, the other a projection. Further out than the ribs is the base of the scapula, and the positions of these two bones are likewise plainly unsymmetrical, the one looking directly—too directly—backward, the other looking outward. The annexed series of diagrams illustrating these conditions are carefully taken from nature, as different cases presented themselves, and are a selection from those of my sketchings which would best illustrate progressive changes from the healthy spine to very considerable curvatures.

Although it is desirable to avoid examining the front of the figure as much as possible, yet it is well to know the changes which take place. These are very early, and, since they depend upon torsion to the right side, are very simple. In normal conditions a straight line—a piece of cord, for instance—

laid upon the middle of the first sternal bone, and passed between the thighs, should bisect the breastbone, the xiphoid cartilage, and the umbilicus, running over a well-defined abdominal raphé. In lateral curvature, a line similarly placed on the upper piece of the sternum, and held in the same way, no longer coincides with these mesial parts of the body; but the breast-bone slants away from it to the right, the xiphoid cartilage and the umbilicus lie altogether to its right. The part most deviated is the tip of the ensiform cartilage: thus the cord forms the base of an obtuse triangle, the sides which subtend the blunt angle being formed by the mesial line of the sternum above, and by the linea alba of the abdomen below. Coincident with this deviation are certain changes in the apparent size of the left and right chest: we have seen that the right ribs are drawn back, and the vertebræ, by their rotation, throw the left ribs forward; therefore, viewed from the front, the chest presents an appearance just the contrary to its aspect from behind—viz. the right side appears small and shrunken, the left

prominent and on a plane further forward than its fellow.

Fig. X.

The patient had a far advanced respiratory curvature; for which she had worn instruments of considerable weight for some years. Note the absence of any projection of lumbar muscles on the left side; the line of light running from the ilium is simply the edge of the body and of the hollow from sinking forward of the ribs; it springs from the ilium far outside the erector spinæ.

A great aid to diagnosis, or rather, let me say, a reliable means of confirming or negativing conclusions drawn from subtle changes of form, is to be found in the rotation measurer, which I have already described. After having studied the results of experiments with this instrument on the healthy subject, I expected, when first applying it to patients, to find that rotation to the side towards which the spine curves (let us suppose the right) would be greater than in the opposite direction. I soon found, however, that this notion was directly contrary to the truth: rotation to the right side is decreased; while to the left that power is relatively, I believe often absolutely, increased. The reason of this is not far to seek: it lies in the facts that the bones have already performed a certain part of their possible rotatory journey to the right, and the chief muscle for this action (serratus magnus) has done a large portion of its possible work. Torsion to the left, on the other hand, replaces the bones and ligaments, and the muscle itself is not merely in a state of quiet, but is in such a position as renders the range of its

action larger than usual. Accordingly, in all cases of lateral curvature, the index of my instrument indicates to right and left a difference in degrees, whose number corresponds with the extent of the curvature. A small margin of difference often, indeed generally, occurs in perfectly straight spines; but this surplusage is nearly always to the right, and does not exceed five degrees; such difference, especially in that direction, may be discarded.*

Since, then, the rotation measurer marks a greater or less amount of difference as the case is more or less severe, the instrument becomes of great value as an index of success in treatment; since if the patient be improving the discordance diminishes, and increases if she be getting worse. Thus I shall in the sequel mark the progress of certain

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* We must here except the cases in which the ordinary orthopædic supports have been worn. Spines subjected to that treatment are unusually stiff, and the muscles much wasted, so that they rotate but very little and unevenly; therefore no information can be gained from their action.

related cases by a diary of rotation, to show the precision of its indications.

When the mere existence of a dorsal curvature has been detected, we must then, in order to apply treatment aright, distinguish the class of curve to which the case belongs, and must primarily divide these distortions into two sets—the curve from respiratory causes, and the curve of weight-bearing origin.

In the *Weight-bearing* class of cases I have observed but one sort—it is that which has been already in part described. The curve occupies the upper three-fourths of the dorsal region, and the return for the compensatory curve commences with the lower fourth. A straight line—a silken thread, for instance—stretched between the last cervical vertebra and the middle of the sacrum crosses the double curve *once* at the ninth dorsal vertebra. The most aberrant bones are the fifth dorsal to one side, the second lumbar to the other.* A well-marked rounded eminence of muscular contraction runs upward from the back part

* These numbers may not be absolutely rigid, but are remarkably uniform.

of the ilium to the most aberrant vertebra. Most of these curves are to the right; but as *all* respiratory curves, lung-disease being absent, are to the right (save in the very exceptional instances of visceral transposition), a curve primarily dorsal to the left, if the breathing apparatus be sound, and if the heart beat on the left side of the chest, may be certainly set down as weight-bearing. There is to be traced in almost all of these cases some history of hard work, generally at an early age, as constantly carrying an infant or other weight, &c. By far the larger proportion of this sort of curve belongs, therefore, to the working class. They are less frequent, and for that and other reasons less important, than the respiratory curves. They are also more easily cured if the individuals can so far alter their habits as to relieve the overworked muscles. This concession is, however, in that class of persons, with difficulty obtained.

Of the *Respiratory Curves* there are two sorts: the one arising from external causes, restraint of abdominal breathing, and even

certain bad habits; the other originating in some malady of the lung and appendices. This latter class of cases is not only very interesting, but of great moment, and it will be well to draw attention strongly to certain important features, especially in that view of the lung malady on which, as a surgeon, I am authorized to speak—viz. of the form, state, and position of curves which should lead us to anticipate internal disease.

Respiratory curves of external origin are always (save in the extremely rare cases of transposed viscera) to the right; they occupy, like that from weight-bearing, the upper three-fourths of the dorsal spine, and the point of greatest aberration falls on the same vertebræ. It is barely possible to distinguish between the two classes by the mere form of the curve alone; yet, since differences exist in its aspects, and as certain extraneous characteristics are obvious, the distinction can always be made. The upper limb of the curve is more marked, the lower less so, and both are less straight—that is to say, suppose the fifth dorsal vertebra at a given distance of lateral deviation, in the

weight-bearing curves, the lines of spinous processes running upward and downward from this vertebra are almost straight, so that it seems to be in an angle; in the respiratory form the curve, though equal in amount, is more evenly distributed over the nine upper dorsal bones. There is no line of strong muscular development running up from the back of the ilium; the secondary curve is, in proportion, less severe.

Curves of internal origin assume a variety of shapes from the gradual long curve, occupying all, or nearly all, of the dorsal region, to the well-marked short and sudden aberration of two or three vertebræ occurring anywhere between the first and the tenth. These latter, particularly if they be high, are generally connected with tubercle of the lung. Pneumonia induces, as a rule, the low long curve which, even when the functions of the lung have been restored, continues for a long time, perhaps permanently, after the attack has passed off. Pleurisy produces several forms of curve, but chiefly a high curve, longer and less sharp than the consumptive curvature.

But very severe pleuro-pneumonia, with empyema, causes as a rule a long curve, which occupies the whole of the dorsal region. In my second chapter I hinted at the etiology of these deformations; they do not arise from contractions on the diseased side; but from the fact that when any portion of the lung becomes unfit to perform its office, or when disease renders such performance painful, the rib or ribs over that part of the organ cease to move, while those on the other side continue, under the sway of the serratus, to act unopposed upon the vertebræ, and twist them round. If we consider the great power of the ribs as levers, the length of their power-arm, the shortness of their weight-arm, we shall comprehend the sensitiveness of the spine to their action.

In the course of these papers a cause which is often given for dorsal curve has been omitted—viz. "*position*;" and this has been done because *position* of the spine itself—*i.e.* different habits of sitting or lying—does not often in my experience produce this deformity. Position of pelvis and thighs is, as we have

seen, the efficient cause of curvatures primarily lumbar; position of the ribs of those primarily dorsal. The shoulder and arm are, as a rule, in such varied movement that curvature very rarely depends on their posture; nevertheless, I shall immediately give a striking example to the contrary.

In considering the causes of these changes producing dorsal curve, we must dismiss from our minds all inconclusive and unsatisfactory theories concerning its origin in spastic contraction of muscles—in paralysis of respiratory function, in softening or inflammation of bones, intervertebral substance, &c., and accept entirely the simple, and, as it appears to me, adequate doctrine taught in these chapters—that in the sequence of causes for dorsal curvature torsion precedes lateral deviation—that none of the spinal muscles proper are capable of producing such rotation; but that the lever-like arrangement of the ribs, enabling the serrati to turn the trunk in either direction, gives to those muscles, when unilaterally and unduly exerted, the power of inflicting on the vertebræ a permanent twist,

which of necessity is followed by lateral deviation. Perhaps, however, some of my readers, unaccustomed to watch the power of muscles in producing deformity, will scarcely estimate the extreme sensitiveness of the spine to the exaggerated action of one serratus. Let the following case illustrate this point:

Case III.—Mr. ——, aged nineteen, came to me on the 9th of February, 1867, with a far advanced dorsal curve to the right. He was by no means weakly, but on the other hand muscular, being used to strong exercise, more especially with the dumb-bells. Rotation was very marked, the ribs and the lower angle of the scapula projecting very much backward: but there was something very peculiar in the distortion; it bore, markedly, all the characteristics of a weight-bearing curve, with the exception of its most prominent feature—the strong development of the left sacro-lumbalis and longissimus dorsi. It is true that he confessed to using the dumb-bells rather more with the right than with the left hand; but in all my previous cases I had always found such or similar work produce with the curve the muscular elevation so often mentioned. The condition was, to my mind, so anomalous that I re-examined all my minute records, my photographs, and my theory of lateral curvature. On his second visit I observed this peculiarity of attitude: he

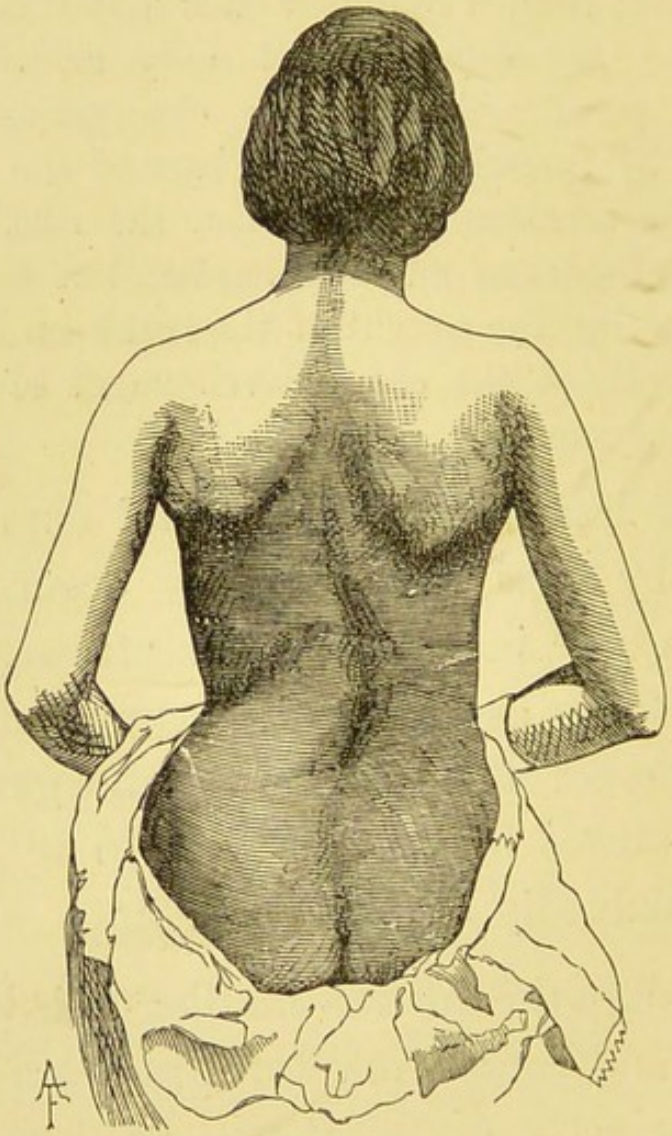
always stood with the right hand placed far back on the hip or on the loins, and threw his elbow as far back as possible. I kept him with me as long a time as I could spare, and standing as much as possible. He maintained constantly this attitude; and, on questioning him, I found it was habitual. Thus, then, was my difficulty not only solved, but a singular proof added to my observations. This position, by throwing back the base of the scapula, caused the serratus to drag upon the ribs, and not only the absence of an extra burden, but the fact of his supporting the weight of the trunk on the right hand, precluded the extra development of the left erectores spinæ.

A few less well-marked dorsal curves, produced by position, doubtless occur — such postures, for instance, as semptresses, book-stitchers, &c. assume, cause occasionally long and slight dorsal deviations; but the generality of curvatures owing their origin to posture are undoubtedly lumbar.

Although the differential diagnosis between lumbar and dorsal curvature has been shortly and succinctly given, it will be desirable to recur to certain of the signs of the former curvature, and to enforce the distinction more concisely. As the primarily dorsal curve com-

mences above, in posterior procession of the ribs, so the primarily lumbar curve begins in a similar displacement of other parts, viz. of certain

Fig. XI.



portions of the pelvis. Let us, *exempli gratia*, assume that the curvature under examination be lumbar to the right—that is to say, such

a curve is about to appear; but, long previously to any absolute change in the spinal bones, we observe an alteration in neighbouring parts, revealed, as already stated, under a perpendicular light. In all these cases it is of the utmost importance to obtain the earliest reliable diagnostic sign of the morbid condition, and I would strongly impress upon my readers that the mere lateral protrusion of the hip, whereby the deformity is first recognised by parents, dressmakers, or other unskilled observers, is in reality a late symptom. A peculiar backward projection of the pelvis, *i.e.* of the haunch, or, to be more precise, of the parts just outside the sacro-iliac joint, on the side towards which the spine is about to, or has become convex, is the earliest symptom; when no permanent pelvic obliquity exists. If permanent obliquity of the pelvis be present, this condition, the cause, appears before its consequence. In either case, the next earliest symptom is increased hardness and projection of muscles on one side of the spinous processes, and decrease of these qualities on the other.

CHAPTER V.

SIGNS OF CURABILITY.

BEFORE passing on to consider what sort of treatment will best befit the conditions whose origin has been in the foregoing chapters explained, it will be well to examine what circumstances would in any given case lead us to view it as curable or the reverse. To gain a clear insight into these peculiarities the reader must dismiss from his mind all those inconclusive theories which have been already shortly examined. It has been shown (p. 4) that the origin of lateral curvature cannot possibly be in diseases of vertebral bodies, nor of intervertebral substances, neither in weakness, nor in spastic contraction of spinal muscles; since, under such circumstances, we should find preference of this malady neither for one side nor for one sex.

Nevertheless an advocate for cutting the spinal muscles has recently insisted on this theory, because he has found in certain autopsies the *erectores spinæ* of one side degenerated. He appears to forget or ignore that all muscles, partly or entirely thrown out of gear and out of use, are by the imposed restraint subject to fatty or to fibrous degeneration, according as the abnormal position produces tightness or looseness of their fibres. It is not enough, when conducting an autopsy, to observe a change; it is also necessary to distinguish between primary and secondary metamorphoses, and to know the difference between cause and effect.

The preponderance of muscular action on one side of the body, which produces dorsal lateral curvature, is not an action morbid in itself, like a spastic or convulsive contraction (supposing that such action can exist in a chronic state at all), it is simply an over-action imposed upon the muscles by extrinsic conditions already discussed. Again, lumbar curves arise from muscular actions evoked to compensate for some distant abnor-

mity (as pelvic obliquity), or set up by some extraneous malady (as ovarian irritation); in either case no disease of the bones, or cartilages composing the spine, is productive of the curvature. On the contrary, when these circumstances have caused the vertebræ to rotate, and the spine to curve, certain changes in the column are produced; and it will be desirable to examine what those are, and the signs which should lead us to consider them remediable or the reverse.

Firstly, to elucidate what these changes are, I must, even at the risk of repetition, refer to the explanation which I have given of the curves induced by the erect posture in the straight infantile spine, and to the fact that these normal antero-posterior curves are permitted by compression of the intervertebral substances, by tension and relaxation of opposed ligaments. This being the case, it must likewise be the fact that the normal lateral bending and rotation, such as I have measured and described, produce analogous compressions and tension of different parts. And again, when the lateral flexion and torsion

begin to become morbid and fixed, can it be for a moment supposed that other conditions in the column itself, beyond those above mentioned, exist? At first, then, a spine affected with lateral curvature is by an extraneous force so placed that the intervertebral substances are compressed, the ligaments relaxed on the concave aspect, while on the convex face of the curve a contrary disposition prevails. This is positively all;* the column itself is normal, but is held in a certain posture by a force outside itself. We have never, or hardly ever, a chance in England of making a thorough examination after death of a spine in the first stages of lateral curvature. By the word thorough I mean such an examination as can permit us to compare bony with ligamentous and muscular change. To make this investigation, the column, together with some portions of the ribs, must necessarily be removed, and the parts rigidly measured. There are, it is true, in the various pathological museums of

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* A few cases of rickety spine are here excluded.

London sundry specimens of curved spine, but nearly all these are rickety cases, and the others that I have seen are old bones, certainly not under forty years of age, and in which, therefore, the distortion must have lasted thirty years at least. Nevertheless, had these cases undergone the sort of scrutiny above indicated, some further information than that afforded by the dry skeleton would have been obtained. Some information, namely, such as that afforded by M. Cruveilhier, who examined a case of old and considerable distortion by careful measurement.

The curve extended from the 3rd to the 11th dorsal vertebra, and was so severe that the radius measured 189 millimètres, the aggregate thickness of these nine bones was on the convex side 222, on the concave 125 millimètres. The fibrocartilages measured on the convex side 65, on the other 45 millimètres. That is to say, that even in so old a case the bones had altered to only $\frac{1}{30}$ of their length, the cartilaginous discs to $\frac{1}{7}$. Moreover, the 9th, 10th, and 11th bones of the back were equally thick on their two sides,

while on the convex sides the intervertebral cartilages were 28, on the other only 16 millimètres in depth (‘*Bulletin de la Société Anatomique*, 1846’). This, with another case also quoted by Malgaigne, but from a journal to which I have no access (‘*Journal de Maisonabe*’), is conclusive concerning the cartilaginous compression in this disease. It must be recollected that these measurements are taken from an old curve in a dead recumbent subject, in which the flaccid spine supports no weight, and on which the vital resiliency of ligamentous parts has disappeared. They represent, therefore, with regard to hard structures, the same difference; but with regard to soft ones, a less difference than during life.

Having thus proved that the bend and torsion of a lateral curve is permitted by compression and tension of ligamentous parts, it becomes our duty to discover what amount, and what duration of curve will have been sufficient to deform these parts beyond their power of recovery. I know of no direct means whereby this question may be answered.

A belief expressed at the Royal Medical and Chirurgical Society,* that all lateral curvatures accompanied by rotation are incurable, shows only that they are not to be cured by the means which the speakers adopted. Nevertheless an indirect method of answering this question by estimating the normal resiliency of the intervertebral substance lies within our reach.

Herr Hirschfeld, of Prague, the first to doubt that the thickness of the vertebral bodies varies with the direction of the normal curves, goes further in his experiments. He cleared from a spine all the muscles, leaving the ligaments intact; then, by cutting through all the pedicles, separated the bodies. All the normal curves disappeared, the intervertebral substances increasing their thickness behind in the lumbar and cervical regions; in front in the dorsal, and decreasing on the opposite aspects.

I have not been able to discover the age of the subject in the above description,

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* 'The Lancet,' Nov. 20th, 1865.

and therefore twice repeated for myself this troublesome experiment: once on a subject aged thirty-four; and again on one aged forty-three. Precisely the same result followed, nor could I find any difference between the two in the rapidity with which the spine became straight. Thus although in these cases the intervertebral cushions had been subject to compression on one side, and elongation on the other, during thirty-two and forty-one years respectively (I deduct two years for infancy previous to walking), yet these substances retained all their elasticity. Therefore a lateral curve also must have lasted a long time before those cushions lose their power of recovery.

We may now go on to the next point, for it is well to know what changes affect the spine when we see them in the dead subject; but the useful and the practical point is to recognise the presence or absence of morbid alterations in the living. I shall, when describing certain curative means, have occasion to speak of the influence of the recumbent posture in annulling or diminishing lateral

curvature; for some amelioration, except in very severe cases, is always produced by the prone position. Abnormal curves of moderate amount entirely disappear, while those of greater amount and older date are only ameliorated, and the oldest, sharpest curves may not perhaps be straightened at all. The amount of benefit in this posture will, at all events, represent the amount of resiliency left in the ligamentous portions of the spine. In the first class this is altogether unimpaired, and if we can remove the extrinsic restraining force the column will straighten itself. In the next class the diminished elasticity of ligamentous matter is such, that we must, besides reinstating the impaired muscular balance, apply certain force to supplement for a time the lost resiliency. In the third and more restricted class all that we can do is to prevent the case getting worse, to relieve pain from pressure in abnormal directions, and in some few to obtain a certain, though probably a small, amount of improvement in form.

I may also describe another method which

I have of late found of considerable prognostic value in lumbar curvatures. The patient is supposed to stand in drill posture; the surgeon seated behind her grasps in either hand the side of the pelvis, the ilia—giving sufficient notice to prevent alarm, and forbidding any movement of the feet,—he moves the pelvis from side to side, beginning with slow and short gyrations, gradually increasing them both in rapidity and amount till his point is gained, keeping of course within a reasonable and easily-supported limit. Now a normal spine will curve from side to side freely and equably with every movement; a spine which is stiffened into incurable curves will move but little,—only very slight gyrations can be borne—will never straighten itself, much less bend in the contrary direction. Between these extremes there are many stages; but a curable spine will at least straighten itself, and in people still young should at the proper angle of the pelvis reverse its abnormal curve.

We must, having studied the prognosis of spinal curvature according to intrinsic condi-

tions, consider what are the prospects of those whose curvature depends upon permanent pelvic obliquity, for it is evident that a curve produced by this condition must be incurable as long as the inequality of limb continues. Since the second edition of this work was published I have been able to trace to the end a large number of such cases, and have found, with few exceptions, that when growth ceases the limbs become even, the pelvis therefore straight; or, in other words, the limb which grew quickest ceases to grow first. The rapid development of one limb has been of the nature of a precocity. These cases are therefore very hopeful, if care be taken, that during the period when the limbs are uneven the spine be so treated, as to prevent any contraction of ligaments, or shortening of muscles on the concave side. As long as that condition lasts we must prevent as far as possible any twist of the spine towards the low side of the pelvis, and during a certain time every day cause a contrary curve to be assumed. Neglect of these precautions must inevitably lead to a permanent curvature.

CHAPTER VI.

PRINCIPLES OF TREATMENT.

ANY person pointing out a better method of treating some disease is bound to show wherein the old one is defective; and it therefore devolves upon me to demonstrate the theoretical and practical errors of the prevalent mode of treating lateral curvature. But if I state that by exclusive and special dealing with this disease its treatment has got into a vicious groove—if I direct attention, however strongly, to some of the points in orthopædic practice which appear to me faulty and injurious—it must be permitted me once for all to say, that no personal ill-will whatever guides my pen. However badly I may think of this practice, and of the mode in which it is carried out, I entertain no other feeling than of all due professional respect towards

those gentlemen who practise a system from which I am conscientiously bound to differ.

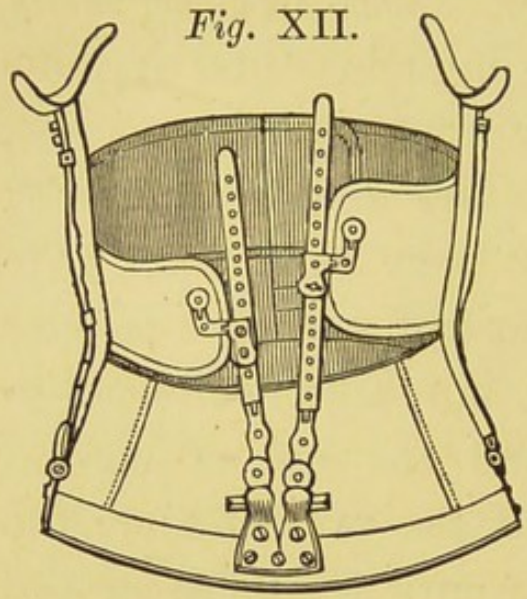
The multitudinous theoretical errors, which have attributed the origin of lateral curvature to sundry causes already discussed, have naturally led to corresponding misdirection of treatment. This misdirection has in all its forms much the same tendency, since, whatever be the theory of causes, the proximate defect has always been attributed to the spinal bones, ligaments, or muscles, and the treatment, therefore, has been aimed at those organs. So exhaustive have been the devices employed, that if these were really the peccant parts, they must inevitably have yielded to some one or more of the vast powers brought to bear upon their evil influence. Sometimes, with the idea that these organs are too weak to support the body's weight, patients have been kept on their backs for years, the head and trunk have been upheld in slings and cages, they have been exercised by gymnastic performances. Sometimes supposed too strong, the muscles have been cut, or stretched by machines formed and used like gallows; also

on couches—some of which act longitudinally, others by endeavouring to bend the back contrary to the curve. These devices, many of which are equally ingenious and impracticable, possess every requisite for success, save any influence on the deforming cause; we therefore find that they have fallen into complete desuetude, except certain exercises occasionally employed, but still misdirected to the spinal muscles, and the use of certain machinery. Indeed, at the present time the treatment of this deformity is almost or entirely limited to the application, screwing and unscrewing of a mechanism termed a spinal support, which therefore requires some description before we proceed to consider its value or the reverse.

The instrument referred to is represented in the annexed figure, borrowed from an orthopædic work published a year or two ago. Its foundation consists of a steel band passing round the hips and abdomen, which carries two steel rods provided with crutch-handles, and also two movable levers bearing plates of the same metal, that are to be placed on

each side over the ribs. The object aimed at is this: The patient is to be placed in the machine; the steel belt is fastened around the abdomen; the shoulders are strapped to the crutch-handles; then, by screw or ratchet, these are lengthened so as to lift the shoulders, with the intention of extending the spine; furthermore, the movable levers are screwed so as to force the plates with a certain pressure against the protuberant parts of the ribs and loins.

Fig. XII.



A "SpinalSupport."

The rounded parts about hip and buttocks alone afford, however, no sufficient means of fixing a band immovably, and unless the steel circle from which all these levers act be immovable or nearly so, the force of the screws &c. will twist and displace the belt, but cannot affect the spine. With the vain hope of gaining the necessary immobilisation, therefore, sundry

swathings and bandages must be added. One of these surmounts the metallic pelvic band, and, inclosing the loins, is tightly laced over the abdomen; while others, passing forward from the crutch-handled staves, are similarly fastened in front of the chest. This scaffolding aims at placing the individual in entire immobility as far as the trunk is concerned; the crutch-handles, if they act at all, must keep the hip and the shoulders equi-distantly apart, and as the belt round the pelvis is intended to be immobile, any sideways movement, any bending forwards or backwards, any turning round, are to be rendered impossible; the figure must move all in one piece, like a Dutch doll. This, I say, is the object aimed at, and which, if the instrument is to have any influence on the spine, must be attained; fortunately, however, for the well-being of the patients it is pretty nearly impossible to arrive at this end, as any one who has endeavoured to hold the trunk even of a baby still is aware.* Thus the immense power and

* The impossibility of fixing this pelvic band was illustrated in a ludicrous manner by a patient who came

flexibility of the figure soon causes this or that steel rod to yield in one or the other direction, giving the body sufficient liberty to make life endurable, and to negative the supposed influence of the levers on the spine. The instrument then simply resembles heavy stays of an exceptionally unwholesome construction.

There is another portion of this machinery which does not yield: the tight swathings above described, although they slip round the figure so as to allow the scaffolding rods to give, encircle the abdomen and effectually check its respiratory movements. But we have already seen (p. 37) that anything which by preventing the breathing movements of the belly, forces that function to be unduly pectoral, is in itself an efficient cause of dorsal curvature.

The instrument, therefore, absolutely increases the root of the evil, not only by the

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to me directly from the hands of one greatly using this sort of machinery. He had in order to keep the right side of the pelvic band down, fastened it by an additional steel rod to the knee.

abdominal constriction, but by the belt over the chest, which presses back the ribs chiefly, of course, on the side of the largest lung—the right. Such confinement and such compression of important organs have their natural effect, and few girls emerge from such treatment without considerable loss of health; and in cases where even slight predisposition exists, consumption is induced, as many physicians in London are aware. A patient in whom the effect of such treatment was clearly shown was brought to me in June 1869 by Dr. L. Sedgwick. The muscles of the back were so weakened as to be nearly useless, and to allow the spine to bend and droop in all directions; but as the girl could not possibly in such condition carry about a heavy instrument, she had been condemned to perpetual recumbency; hence her lower limbs, mere skin and bone, were all but paralysed. By leaving off the instrument, and using carefully regulated exercise we had enabled her to sit up for a time, and even to walk a little with the support of an arm, when an intercurrent disease broke off—only temporarily, we will hope—the treatment.

Nevertheless, I must in justice say that in a certain very small percentage of cases these mechanisms have effected some good. Such cases belong to the class of weight-bearing curves, and they have been benefited by relieving the spine of the weight of that shoulder which lies on its convex side. But such object can be effected by a far simpler method, which does not imprison the trunk at all, nor produce such dangers.

Lest it be imagined that I am unjust towards this mechanism in asserting that it benefits only a very small percentage of cases, and lest my testimony concerning an instrument which I never use be considered valueless, I will here sum up shortly the experience of those who do use them, and who would certainly be disposed to give the most favourable view of their value. Dr. Little says,* "They are not adapted to the removal of the primary causes of lateral curvature; they cannot, therefore, be employed as curative means." And, in a very recent work,† "Notwith-

* 'On Deformities of the Human Spine,' p. 379.

† 'On Spinal Weakness and Spinal Curvature,' p. 65.

standing all that has been said or written in relation to lateral curvature and spinal supports, no spinal apparatus or support hitherto designed is able to overcome rotation of the spine." Mr. Tamplin and Mr. Brodhurst both eulogise these scaffoldings; but it is difficult to find what results they gain, or expect to gain, from their use. Mr. Adams, whose treatise on the subject is more exhaustive, says,* "I have no hesitation in expressing my conviction that if these cases be submitted to treatment before any very obvious external deformity has occurred, they are generally curable within one or two years. In some instances, especially if an hereditary tendency to spinal curvature exist, and the girl is of feeble constitutional power, a longer period may be required." Which appears to mean that if a strong young girl of healthy parentage be fastened up in one of these machines for two years, she may be cured in that period of a deformity which can hardly be said to exist. A further insight is

* 'Lectures on Curvature of the Spine,' p. 326.

afforded by the expressions of two of the above-named gentlemen at the Royal Medical and Chirurgical Society meeting of January 9th, 1866 :* "The result of my experience has been to convince me that where lateral curvature existed in any marked degree, and before it amounted to an external deformity, it is essentially an incurable affection" (Mr. Adams). "When rotation has taken place" (the *primum mobile* of the deviation), "appliances are useless." The causes of so sad an experience require some comment. A malady may be non-amenable to treatment, from positive incurability, or from impropriety of measures taken. Now, firstly, it would be very unwise to conclude that a malady is incurable if a certain application had done no good, but probably some harm. Secondly, it seems *primâ facie* absurd to affirm that a slight deviation of form in a young person is incurable. Thirdly, the result of my experience leads to a very different conclusion.

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* Vide 'The Lancet' of Jan. 23rd, 1866.

Nevertheless the belief thus expressed is a valuable experience of the inefficacy of the treatment by "spinal supports."

Another device, spinal myotomy—already justly condemned and dead,—will here require no further notice or mention at my hands.

The plan of treatment which I have pursued for some years, and which I am about to describe, differs from the prevalent method of orthopædy in several very essential principles. It is intended to strengthen the weakened muscles, and to prevent undue pectoral breathing, or, at least, to obviate its injurious effects. Thus, for both forms of curvature described in foregoing chapters, the treatment resolves itself into three portions—viz. support, position, and exercise. The two last divisions might strictly be classified together, since every remedial position, necessitating activity of certain muscles, is in truth an exercise; nevertheless, it will be more convenient for our purpose to retain the classification as above, premising only that by position I mean the ordinance of a certain immoving posture; by exercise certain movements are denoted.

Regarding supports, which must be of different forms in varying cases, it will be desirable to say a few words which apply to them all. In the first place, they must never be rigid: to fix immovably for an indefinite time a portion of the body, which is intended by nature to be mobile, at first weakens and subsequently destroys muscular power—that power, namely, on which we must rely, at the end of treatment, for the maintenance of an erect posture. In the next place, the direction in which the force is to act must be considered; and, to do this fairly, I must again revert to the change produced in a lateral curve by recumbency. In my earlier studies of lateral curvature I was much struck by the fact, that in commencing cases the curve vanishes when the patient lies down. In a later stage the curvature, though greatly diminishing, does not entirely disappear. I tried, therefore, in these latter cases, to increase the effect of posture by longitudinal traction. Instantly the curves were aggravated: no matter how gradual or how sudden was the force employed, it always increased

the curves according to its amount. I then tried the same expedient in cases in which the morbid posture was entirely annulled by position; and in these, when traction was made, the curve reappeared. This was equally the case whether the upward or counter-extension was made from the head and neck, or from the shoulders and upper part of the chest. I then perceived this fact—that recumbency, while it obviates the lateral bend, does not affect rotation; or, to make this phrase easier, by expansion, I would say: On a rotated spine the erectores spinæ act in a lateral direction (since they turn with the bones), and bend the column sideways. In the erect posture those muscles are in full action, and the deviation, therefore, well marked. In the prone position the organs are at rest, and the lateral curve ceases: rotation, however, being dependent on other causes, still continues. All muscles, however, are excited by stretching; so, when in recumbency traction is employed, the erectors contract and reproduce the curve. Hence to use force in the longitudinal direction, with the hope of straightening

the spine, is a physiological and mechanical blunder.

Let us return to the curves which only partially disappear during recumbency. Force upwards and downwards—*i.e.* in the direction of the crutch-handles in orthopædic instruments, aggravates the curve; but the effect of force at right angles to the spine is quite different: no muscular effort is excited thereby,—hence very little power, save in old cases, will straighten the column. Indeed, when a patient with curvature stands before the surgeon, he instinctively places a hand on each side at the greatest point of deviation, and, by pressing in opposite directions, finds that, according to the severity of the case, he can entirely or partially restore the straight line of the spine. The bandages, which I use, are contrived simply to render permanent, by an elastic force, the office which the surgeon's hands can only temporarily fulfil.

The postures, which I have devised and advocate, are not simply positions which place a passive spine into a new and different curve; but are such as act by causing the muscles

themselves to change the posture of the spine—or, in other words, cause those parts, by whose fault the column has got wrong, to repair the error.

With regard to the other item of treatment, I would only remark that, to devise exercise for any deformity, the originator will act upon his views of the causes of disease, and of the actions which he thinks most calculated to obviate them. In following out this sort of work, he finds certain methods fail to call forth the power he intended, or they may not only act as he calculated; but evoke also other and unexpected forces, which subvert the object in view, so that modification or abandonment of some cherished design becomes necessary. The actions and powers of a machine are easily reckoned—a certain force, a known size of wheels, a given number of cogs, and the result is fixed; but nothing is more subtle or varied than the acts of the human body. I have found that muscles employed in the maintenance of a given posture will, as they become fatigued, suddenly shift their burden, and thus, with scarce any appreciable change of position,

different groups throughout the system will be employed. So with various individuals; we shall not always find that the same, or apparently same, condition is produced by exactly the same cause, nor that it can be met by precisely the same means. Thus slight modifications will be required here and there in the broad rules about to be laid down. In writing, as in hospital teaching, it is impossible to do more than indicate the broad markings of practice; the finer distinctions and the close adaptation of treatment must depend on the perceptives and acumen of each surgeon. But in all my method of treating deformities it has been my object to make the treatment "direct." The most important postures which I shall describe, the respiratory and lumbar exercises, the bandage and arm support, are calculated on that principle. They are aimed straight at the mark they are intended to hit, and in my experience the shafts fly true. Yet, before describing the detail of my method, it will be well to mention an example of what I mean by the term "directness of treatment," only premising

that no established curve can be so easily cured; the case simply illustrates the advantages of an attack upon the cause of curvature.

Case IV.—Miss A. W., aged nineteen, had long been the subject of strumous inflammation of the left knee, which occasionally had brought her under the threat of amputation. When I saw her in January 1861 the swollen joint was discharging by three sinuses, from which small particles of bone had frequently come. In eighteen months she was able to walk with the aid of a stick. After an interval of two years, on seeing her again, I observed that the lumbar spine was crooked, though she wore a thicker boot on the left foot. This curve continued while she sat on a level seat, and only partially disappeared when she lay down. Seeing that she walked and stood a great deal, and that the obliquity of the pelvis caused the spinal curve, I wished to counteract this effect by placing her while sitting in such a position as should reverse this obliquity. I carefully measured the difference in length between the two limbs, and caused a cushion to be made of such wedge-shaped form as should, when she sat upon it, lift the right side of the pelvis to the same extent as it was depressed in standing. This, of course, reversed the pelvic obliquity, and in time caused the spine to curve while she was seated in the contrary direction. This means and a bandage, to be hereafter described, sufficed to annul the lateral curvature.

CHAPTER VII.

TREATMENT OF LUMBAR CURVE.

In stating, at the end of the last chapter, that a spinal curvature cannot be cured simply by making a patient sit for some time on a sloping seat, it was, in fact, merely asserted that this, like other diseases, must be treated with reference to its severity and cause. For this reason, much pains has been taken to define the essential causality of each class of curvature; and it must be permitted me here to recall these facts; that while each class of primary dorsal curvature is always followed by a lumbar curve, so a curve primarily lumbar calls forth a dorsal arc in the contrary direction,—the bend thus produced by the primary one being in each case called secondary or compensating. In all these maladies it is desirable to obtain the earliest symptoms indicative of the disease; and I would remind the

reader that in lumbar curvature a peculiar backward projection of one side of the pelvis is earlier than its lateral projection; but contemporary with, or only slightly preceding, an amount of rotation which the practised hand can detect. Obliquity of the pelvis is also frequently present quite early in the case (p. 50 *et seq.*).

This prominence or obliquity, or both, marks the causality of the disease which we have traced to some changed posture o pelvis and thighs. The direct and natural plan of treatment will therefore most evidently be to correct these faulty conditions; and no doubt, if we could always encounter the malady in its earliest stages, such treatment would in itself prove efficacious, as in the case related in the previous chapter. The deformity, however, comes on so slowly that it is rarely detected by a mother, or other daily companion; but is usually first observed by a dressmaker or dancing-master, who points out that one or the other hip protrudes. Hence the distortion rarely falls under skilled observation in the earlier part of its course;

and thus we have to encounter, besides mere habit and the influence of super-incumbent weight, passive shortening of certain muscles, debility of others, and, in tolerably advanced cases, contraction of ligaments. Sufficient and commensurate treatment for an established curve will naturally include the divisions of treatment already discussed, which are destined to counteract those different defects.

Firstly, it is necessary to examine the patient while standing absolutely erect, *i.e.* the heels together, both knees straight, the weight equally distributed on either limb; the arms hanging down by the side (drill posture). Then (supposing the surgeon has satisfied himself that a curve exists) he must next examine into the existence or non-existence of pelvic obliquity. To do this, it being of course understood that habitual obliquity (p. 59) has been eliminated by the posture above described, the surgeon will so place his patient that, stooping behind her, he can get the ilia on a level with and parallel to some horizontal straight line in his room—the top of a dado, the line of a book-shelf, or the edge of

a table. Then he will put his two forefingers on the corresponding parts of the crista ilii at the outline of the figure, and compare their relative level by means of this line. If now the finger of one side, or what is the same thing if the ilium of one side be found higher than the other, permanent obliquity must be present. As this may depend upon some defect of the lower limb, the research must be carried further; the line of the one thigh and tibia must be compared with the other, by passing the hand outside the remaining garments down the limbs; and if nothing be found here the foot and ankle should be questioned. It frequently happens that a valgous knee, or foot, or some bend of the long bones, produces permanent obliquity. But if nothing of this sort be found, examination into the difference of level must be more fully carried out, and its existence absolutely ascertained; if we find that no deformation of limb accounts for a slope of the pelvis, certainly present, there seems no alternative but to ascribe it to different lengths of the legs; and, in suitable cases, this may be measured.

Other patients exhibit in the drill posture no pelvic obliquity : it is then of importance to place the patient at ease, and while conversing or asking questions concerning health, age, &c., to watch the posture assumed, to observe the position of the feet, or the mode of sitting, whether cross-legged, on one side, &c., to learn the habits and occupations, and to conclude, as far as possible, what circumstances in the daily life may have given rise to any posture of the lower parts of the body which, by causing habitual obliquity of pelvis, shall have called forth the deformity. Although these may sometimes escape investigation, yet careful study will very frequently lead to the detection of the injurious habit, and this, of course, must be at once attacked.

The considerations on pelvic obliquity, and its effect in producing a primary lumbar curve, have been discussed with considerable minuteness, partly because the very cause of these deformities suggests, of itself, a means of cure. I would ask the reader to refer to the plates at p. 56. In one of them the patient is standing on the level floor, therefore the

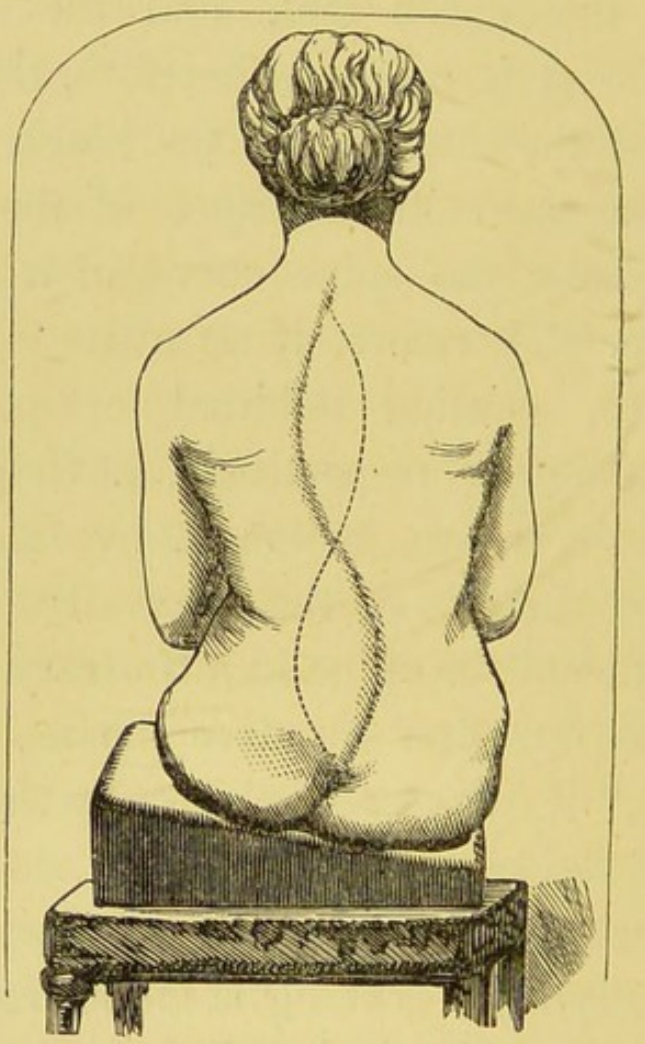
inequality in length of the legs, throwing up one side of the pelvis, causes a marked curve of the spine. In the other, the deficiency of the short limb is neutralised by a block placed under the foot, and the spine is straight. It is evident, therefore, that if we increased the thickness of the block, so as to over compensate the shortness of the leg, we should make the spine curve in a contrary direction. Therefore, if an attitude, or limb deformity, causing habitual or permanent pelvic obliquity respectively, have produced lumbar curvature, we may, by raising the pelvis on the side of the convexity, cause an effort to bend the spine in a contrary curve.

Hence our first curative means, namely, position,* is represented chiefly by the sloping seat—a device for lifting that side of the pelvis which is abnormally depressed. The accompanying engraving is taken from one of my patients, who had all but recovered from a rather severe lumbar curve, represented by

* It may be as well to repeat that all remedial position implies to a considerable extent exercise of those muscles, which in the malposture are unused.

the dotted line. The figure is placed upon a seat, which slopes downwards from left to right, *i.e.* from the convex to the concave

Fig. XIII.



The Sloping Seat.

side; and it is from this figure evident that, if we artificially lift the part of the pelvis which lies to the convex side, the spine, forced by the law of balance, will tend to assume a

curve in the opposite direction, as represented by the shaded line. The reader will aid his comprehension of this condition if he will look back to p. 47, at the diagram which represents the undulations of the column in a figure rocking from side to side. The block in the above engraving, upon which the torso is seated, hardly represents, however, the mechanism by which I work in these cases. I have a stool with a top, which, lying horizontal, can be raised at one end, by means of a winch and cogged wheels, so gradually that the changes in the position of the spine and the action of the muscles can, during the elevation, be accurately observed, since the patient need not rise from her seat or make any effort, further than that necessary to maintain balance. Now, when the patient sits on this stool, with the feet stretched out in front so that they do not influence the trunk, and when the end on the convex side is slowly lifted, one observes the following changes: firstly, and previous to any perceptible alteration of the lateral bend, the lumbar vertebræ begin to relinquish their torsion, to untwist

themselves; the parts on the convex side become less hard, those on the concave more so, and the transverse processes sink deeper—are not so evident; the lateral inflexion then also becomes affected, and in all but severe cases it will disappear at the same time that the torsion ceases. I have, however, in a previous sentence, used the phrase "the spine *tends* to assume a contrary curve," because I would guard against any appearance of exaggeration; therefore I must not be supposed to say that an established lumbar curve can be at once inverted by such means, or even that it will be immediately effaced. An evident and manifest improvement is, however, while the figure is sitting, instantly produced, and as the back becomes stronger, the patient can use the device for longer periods, so as to keep the spine in a more normal, and at last, with the assistance of other means, in a perfectly normal position during the greater part of the day.

Simple as the device appears, its efficacy is very considerable; indeed, although when I first began to employ this mechanism on

deformed patients, there were many reasons to expect very considerable advantage from its use, I was not prepared for the amount of change induced. Its regulation therefore requires considerable care; indeed, there are few things in practice more difficult than to fix the degree of slope, and the time of employment which will be beneficial.

By means of the contrivance for regulating the angle of inclination without obliging the patient to rise or use any muscular effort, one can, however, arrive at a very accurate judgment of the amount of force exerted on the spine, if the action of the lumbar muscles during the elevation of one side be carefully watched. I would also point out that it is partly the diminishing torsion in the lumbar, the primary curve, and partly the behaviour of the dorsal (secondary) curvature, which must serve as an index. The secondary curve is thus available; because, since it is consecutive, it is also less indelible, and because the longer sweep of the arc, formed by the ribs, renders such change more appreciable. While we bear in mind that a slight degree of

slope will produce little or no benefit, a violent inclination, or too long a period of use, may be productive of very considerable evil.

Case V.—Emma T., aged seventeen years and a half, came to me on Feb. 16th, 1863. She is employed at a sewing-machine, which she always drives with the right foot; is strongly built, but now pale, and evidently out of health, suffering from profuse leucorrhœa. On examining the back I found a considerable primary lumbar curve to the right, with a secondary dorsal curvature, both of which only partially disappeared on lying down. Seeing the depressed state of health, I only ordered tonics, with similar regimen, and certain recommendations about the mode of working.

March 2nd.—Better. Finds great difficulty in working with the left foot, and it is often impossible to do so. I ordered a sloping seat, being very careful to fix both the angle and the time of use small, on account of state of health; also ordered a bandage as hereafter described.

April 2nd.—Up to the middle of the month considerable improvement had taken place, and I had simply advised continuation of the same course. At the above date, however, she was looking very ill, and complained of severe pains in the back and loins. I found that her cousin, seeing the improvement produced by gentle means, had counselled her to have the slope made higher (nearly doubled) and to use it

the chief part of the day. On examination, I found the back less well; the muscles on the right of the spine were swollen and tender to the touch; the loins so weak that she could with difficulty sit or stand upright. She was ordered to leave off the sloping seat; the bandage was tightened; and the cousin was shown how to rub the muscles upwards with a liniment of ammonia, chloroform, and opium.

May 7th.—As the patient had now quite recovered from the pain and weakness, the use of the sloping seat was cautiously resumed; and from this time the case went on uninterruptedly till I discharged her from my care, quite straight, on Dec. 16th, 1863.

Such device can, from its very nature, only be used while sitting; hence, when the back becomes more straight, and the lumbar muscles on the concave side sufficiently strong, we may carry on the same principle in the standing posture by ordering an additional sole of cork to one boot, *i.e.* that on the convex side of the curve. For the first day or two the patient finds this awkward, but very soon becomes accustomed to it.

The immediate adoption of these remedial measures is especially important if the patient be quite young, between the ages of eight and fifteen, when the vertebræ are undergoing

pretty rapid development, and must not be allowed to assume a one-sided formation. Such patients are, by the nature of their growth, very sensitive to any deforming causes, and if this seedtime of their symmetry be neglected, it may take years of future work to effect less than can be done at this period in a few months. For the patient sensitive to deforming is not dull to curative influence: we have but to direct it aright.

Case VI.—Lord —— —— was sent to me by Mr. Marsack of Tunbridge Wells in April 1873. He is $10\frac{1}{2}$ years old—active but delicate. He is one of a large family, and there is spinal deviation in some of his sisters, but strongly marked in one only; there are phthisical tendencies in the whole family.

The spine of this patient was very markedly curved, the deformity being plainly visible through his clothes; the right crista ilii lies very nearly two inches above the level of the left, and as he was only 4 feet $3\frac{1}{4}$ inches high this must be considered very large. As he was rather depressed in health, being pale and having some pulmonary disturbance, treatment of the spine had to be very careful.

I ordered him to sit on the sloping seat for ten minutes thrice in the day, and to use the lumbar bandage, hereafter described. He was allowed to

walk a little, and chiefly to take air and exercise on a pony going at walking pace.

At the end of May the spinal curve was rather less. I ordered him to have all his boots made with an inner sole of cork ½ inch high on the right one. He was ordered to Bournemouth, and was under the care there of Dr. Thompson.

In July he was certainly better, both in health and in form, and from that time has gone on improving.

In June 1875 the difference in the relative height of the two crista ilii was 1½ inches; the spine had contracted no fixed curve, as when he lies down or when sitting with the left side raised the column becomes either straight or the curve is reversed.

In May 1876, the last time I saw him, the two sides of the pelvis were uneven to the extent of nearly ¾ of an inch, he still therefore wears a ½ inch additional sole, but with that the spine is perfectly straight, and as he is growing fast it is probable that the limbs will soon be of equal length, and the spine will then be perfectly normal without external assistance.

Whenever some defect in the lower limbs causes the pelvis to be in the erect posture markedly oblique, a high boot is absolutely necessary. Judgment must be used in its regulation, because we have to do with a

condition which in itself may, or may not, be curable, and our object differs in either case. If the cause be a congenital deficiency in length of one leg, we must be content with obviating its consequence—the oblique pelvis and curved spine. If, as is not infrequent, the obliquity be due to a varous foot—or to an habitual position—as in Cases VIII. and X. —we must take several points into consideration. The varous foot and, still more easily, the bad habit may be cured. If we have to do with a young patient (under twenty-one), and if the spinal curvature be not severe, we may, while devoting our attention to the original evil, trust to inverting the curve during sitting only. By this means we prevent the establishment of a confirmed curve. The spine—since while sitting we make it curve in a direction contrary to that assumed in standing—becomes very flexible; and when the limbs have been put right, the back is in the best possible state for a rapid cure.

These considerations lead naturally to the answer of a very frequent question: "May the patient ride?" Males not severely de-

formed may certainly take this exercise; and in some cases, I believe, advantage has accrued from using the one stirrup leather a little shorter than the other. With girls the matter is different; if the lumbar curve be to the left the patient must ride, if at all, in the reversed posture, namely, on the off side of the horse and with the left leg in the pommel; while, if the lumbar curve be to the right, she may ride in the usual posture. Whether the curve be right or left, no violent riding should be allowed to either sex, unless the case be very slight. In any further advanced curvature, nothing beyond walking the horse should be permitted, until considerable advance have been made; then more potent exercise is advantageous rather than otherwise, as long as the proper position be enforced.

Exercise is in a great measure included in the position produced by the sloping seat and the high shoe; but we may advantageously add to these certain calisthenics destined more especially to increase the power of the muscles at the lower part, and on the concave side of

the spine. Space forbids my entering very fully into details; I will simply mention those which I have found most advantageous. Let the lumbar curve be to the left: the patient, with both knees perfectly straight, stands on a block or book from one to three inches high, as the case may demand, and with the right foot so close to the edge of the block that, by just separating the limbs, the sole passes over the border. Still keeping the knees quite straight, the right foot is by action at the hips (both knees being kept straight) made to sink till its sole rests fairly on the ground for a short period; then it is replaced on the book, and this manœuvre is repeated for a prescribed time, and at a certain rate.—A chair is placed against the wall, the patient standing sideways to the wall, balances herself with the left hand upon it, and planting the left foot on the chair, slowly lifts herself until she stands upright.—Standing with her back to the wall, the patient slowly lifts the left knee forward till the thigh is at right angles to the body, and gradually lets the limbs fall again, repeating this movement

slowly and rhythmically. After a time the foot is to be weighted according to the strength of the patient.

An exercise very valuable in long-standing and severe cases, for stretching ligaments on the concave side of the spine, is the following. The patient stands with the back to the wall, and, if possible, with the right side against the corner wall, or some upright piece of furniture, as a piano or bookcase, so that she may be sure of not deviating from the perpendicular to that side. A block, of carefully-proportioned thickness, is placed under the left foot. Fixing the left arm a-kimbo, she quickly and forcibly (according to her strength) bends the upper part of the body sideways to the left, and repeats this several times. The back must be kept against the wall, the knees kept rigidly straight, and if the limbs be rather weak, or the patient awkward, a napkin or round towel passed round the hips, and secured to the wall on her right, must uphold the due position of the pelvis.

I am also in the habit of using an exercise

which, however, requires personal superintendence, either surgical or of a skilled attendant. In employing it the patient must be without stays, or other tight-fitting garment; but if the case be suitable for the loin bandage (immediately to be described) it should be left on the figure. Let the patient stand in drill posture: the attendant sitting behind her grasps the hips between the outstretched hands; then, cautioning her not to move the feet, he pushes the pelvis over to the right (supposing the curve be to the left), brings it back again, and repeats this action, with a certain rapidity, ten or more times, according to the strength of the patient, the amount of curve, and of the effect produced. It is very undesirable to give this exercise into the hands of parents or friends, since it requires careful regulation from time to time; but, properly used, it is very valuable and potent.

These are the more important among the exercises which I employ. They are to be used with great caution, and from time to time the surgeon must watch them, lest any

awkward trick in their performance render them useless or injurious.

It is necessary to warn the reader against ordering any of these exercises—indeed, any part of the treatment—lightly or incautiously. Simple as they may seem—indeed are,—they are also *direct*, and as a force applied directly is the more potent in proportion to this quality, so, if improperly employed, its power for evil will be great.

The form of support which I use in this description of curve is founded on the principle of employing force as nearly as possible in the direction of the radii of the curves. Figure XIV. shows a lumbar curve to the left, together with the simplest form of bandage. A round well-covered strap, about the circumference of a finger, passing round the upper part of the thigh, supports on the hip a triangular pad; from the two upper angles a well-fitting piece of some strong material passes round the loins. This portion becomes broader, so that its greatest breadth is over the most prominent part of the curve; from that point it passes round in front, but remains

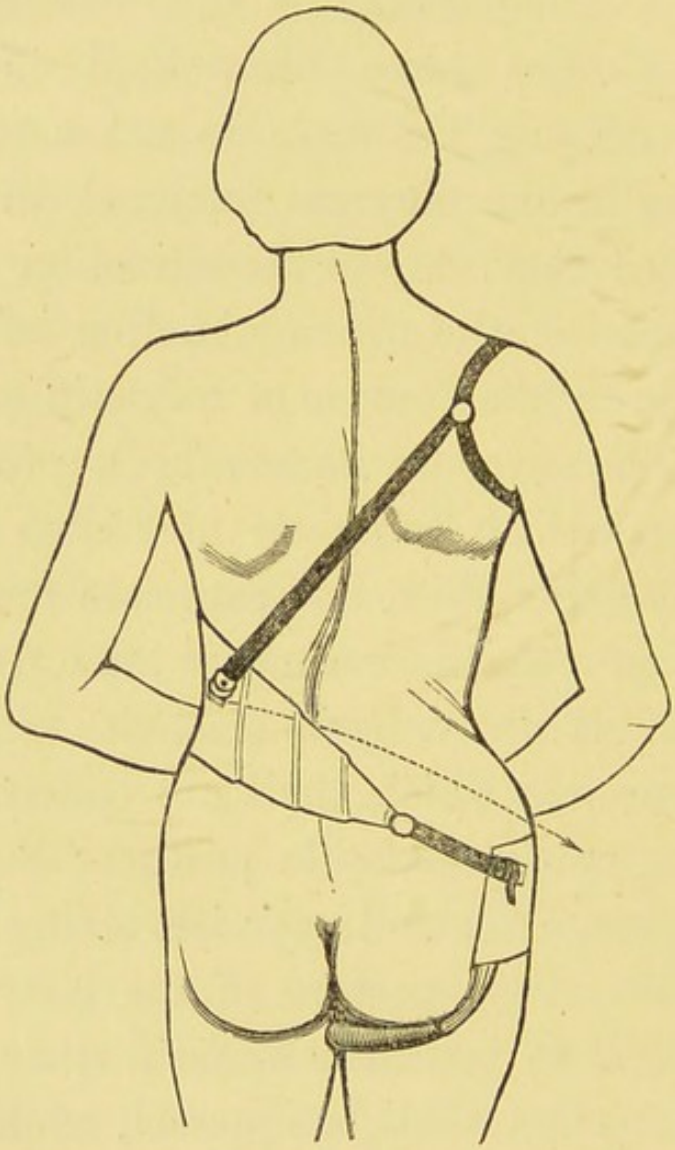
broad over the abdomen until near the right hip. The application of a firm inelastic force would of necessity be worn either so loosely as to be useless, or would if tight be unbearable and injurious; the proper action of the band, its power of yielding to movements while still exerting power on the curve, is secured by an elastic force introduced at the part where both in front and behind the bandage becomes narrow. This force is represented by a ring formed of strong india-rubber cord, to which is connected an arrangement whereby the surgeon can himself vary and fix the proper amount of tension, without leaving it to the hap-hazard will of the patient. In order to keep in place this part of the bandage (the whole arrangement I have termed "loin bandage") an additional portion is generally to be affixed. This consists of a loop, inclosing the shoulder, and made elastic by similar intercalation of india-rubber rings, whence two braces pass obliquely across the figure to the loin piece. The length of these portions fixes the place at which the lumbar band shall exert its force.

A little care in the arrangement will cause the front brace to pass between the mammæ so as to do no injury.

In the construction of this bandage the following aims have been kept in view. Firstly, causing the force to act across the curve, as in the diagram annexed, in which the dotted line shows the direction of the morbid curve, the arrow the line of force. Secondly, by the absence of any stiff material (which can never sit immovably), producing a support which lying on and close to the figure does not shift, but exercises force constantly on the place and in the direction required. Thirdly, by its elasticity rendering the power one which shall not constrain the figure in one immovable posture; but shall permit movement and exercise, acting indeed thus: that every posture of the body which would tend to bend the spine further in the faulty direction shall be opposed, while every posture tending to decrease the morbid curve shall be assisted. Fourthly, by this same elasticity obviating any interference with the respiratory movements. It may be added

that the round form of the band at the top of the thigh prevents any cutting or chafing,

Fig. XIV.



The Loin Bandage.

and the fact that the tension upon it is almost at right angles causes the pressure to be very slight. Patients very soon get accustomed to

the little irksomeness which this or any new article of dress may at first produce, and express themselves greatly more comfortable for its use. They say they are very much relieved from sense of fatigue or pain while wearing the bandage.

It frequently occurs that the lower portion of the curve yields quickly, while the upper lumbar vertebræ still continue out of the straight line; it then becomes necessary to modify the bandage, so as to press higher up. To secure this the lower edge has to be made proportionably shorter than the upper. This inequality is present in the band above described; but the higher it rises in the figure the more does the disproportion increase, till the belt becomes almost sickle-shaped. In a few cases I have had to pursue the curve, as it were, into the dorsal region, until at last the oblique bandage (p. 177) has completed the cure.

These broad principles must suffice as the guides of treatment. One exercise will be found most applicable in one case, while another may be found suitable to a different

patient, and what is advisable in one stage is not useful in another. I do not know that I can give any certain guide to choice; and, although a considerable experience enables me now to judge what will be most available, I always let the movement be first performed in my presence, under careful supervision. It is, however, well always to prescribe the less powerful exercises for weak persons, and in the weakest to leave all absolute exercise out of the question, and to work by position and support alone. The advantage of this plan will be seen in some of the cases detailed.

Case VII.—Miss E. C., aged 22, came to me May 5th, 1866, with a well-marked spinal curve, which was only suspected, however, a few weeks ago. She now suffers considerable pain in the lower part of the left chest and lumbar region; for this she underwent treatment directed to the digestive organs, and thinks that she was much weakened thereby. During the last year her health has failed; she has dysmenorrhœa, faulty appetite, and sleeps badly; is pale and exsanguineous.

I found that there was considerable spinal deviation, with retrocession and lateral projection of the back part of the pelvis; a compensating curve had

formed in the dorsal region. A plumb-line, dropped from 7th cervical vertebra, crossed the S-shaped curve between the 9th and 10th dorsal vertebræ; the 2nd lumbar spinous process lay 1 inch 4 lines to the left of this line, the 5th dorsal $\frac{3}{4}$ inch to the right. The left transverse processes of the loins formed easily felt prominences, while a hollow lay on the right side of the loins. The patient being so far out of health, it seemed to me desirable to proceed very gently; I therefore simply ordered her to sit on a seat sloping $1\frac{1}{2}$ inch in the foot, for a quarter of an hour twice a day, and after this to repose on the couch for an equal space. Tonics of steel and some aloes were prescribed.

May 14th.—There is a certain small improvement; a support, such as described in the text, was adopted, at but a small degree of tension.

June 1st.—At a previous visit the tension of the bandage was increased, and the use of the seat ordered for thrice in the day. Her health is now better; she has all but lost the pains complained of, and the complexion is less bloodless; appetite is also improved.

June 28th.—The health has manifestly improved. The curvature now has the following measurements: 2nd lumbar 1 inch, 5th dorsal $\frac{1}{2}$ inch from mesial line.—To continue with a rather tighter bandage.

July 14th.—The back continues to improve, and the patient has gained strength considerably.—

Ordered to have a boot $\frac{1}{3}$ inch higher on the left than on the right side.

Sept. 10th.—The patient, seen occasionally during the interval, has continued with those ordonnances; has greatly improved, so much so that the straight line of silk between 7th cervical vertebra and middle of sacrum lies over all the spinous processes—but in the loins they only skirt the right side, in the back the left side of those projections. Rotation is still marked enough to enable one just to feel the left lumbar transverse process. The lady considers herself well, and it is only my insistance which causes her to continue under treatment.

Dec. 17th.—I now also consider this patient well, since I can detect no lateral deviation, no sign of rotation, and the parts are equally hard on both sides of the spine. She also can turn her body equally to both sides, as shown by the rotation measurer.

June 10th, 1867.—This patient wished to see me again previous to a projected marriage; I examined the back, and still found no deviation whatever.

Case VIII.—Alice B., a short but strongly-built and muscular girl, aged 17, was brought to me with a sharp and well-defined lumbar curve to the right, Nov. 1865.

The backward projection of the right sacro-iliac joint was particularly well marked—the rotation at the loins strong, while the curve itself was sharper

and more defined than usual. On watching the positions which the patient assumed, I found that she, in walking and standing, turned the right knee and foot a good deal in ; and on a subsequent visit, as I gave her some portion of bandage to stitch, I observed that as she sat to work she threw the left leg well across the right, and leaned her left elbow on the thigh of that side. She was a shoe-binder, and worked in this attitude a good number of hours daily.

I explained the absolute necessity of changing this posture : ordered a sloping seat, highest on the right side, to be used only a short time, thrice in the day, namely, at meals. By degrees the time of its use was increased, until she was able to work upon it while sitting, and very shortly after a strong lumbar bandage was employed.

This case improved rapidly in the first two months of treatment, during the greater part of which she had discontinued that employment. After that interval, and during a period of three months, the progress became slower, and she lost health to a certain degree. I took her into hospital, April 1866, and had her exercises and the posture of sitting properly superintended. I also had her right boot heightened by a piece of cork half an inch thick.

July 30th, 1866.—The case had now very much improved, and as another employment—domestic service—has been found for the girl, I have dis-

missed her from the hospital; in the mean time she has been cured of her awkward tricks of sitting and walking, and the back, while the bandage is *in situ*, is not far from straight.

Oct. 5th.—This patient has been seen about every fortnight, and the back has been improving. Occasionally a certain amount of the cork has been cut from the sole, and for the last three weeks the boots have been of equal thickness.

The back is now quite straight, the girl stands well upright on the two feet, and the parts on each side of the spinous processes are equally hard and protuberant.

Case IX.—Miss L., aged 24, has for some time been suffering from a curvature of the spine, and has worn for more than four years the usual form of orthopædic support. She came to me on the 5th May, 1866, and gave the following history.

About five years ago, she, being previously well and hearty, began to lose health, and suffered pain in the back; these symptoms increased, menstruation became irregular, and all but ceased; appetite failed, breathing became short and difficult. She was taken to a practitioner near her residence, and he, in examining her, found signs of curvature, and sent her to London in 1861. The orthopædist, whom she consulted, told her that she must remain some considerable time in town, and wear an iron support. She did remain the greater part of a year in London;

during which time the instrument was screwed up, at first thrice, then twice a week, and afterwards once a week. At the end of rather more than ten months she found herself unable to stay longer, or to afford further treatment. The instrument was very much tightened, so as to last longer without alteration, and she left London. At that time she was suffering more pain in the back; her health was much broken, and she was, when the instrument was removed, more crooked, although she says that when the scaffolding was tightly screwed she was a little taller. She had, however, lost health more rapidly; had become very thin; was very easily wearied; scarcely able to walk; her appetite was very small, and somewhat capricious; she suffered also considerable pain, chiefly on the right side. She continued to wear the instrument for some time, in the country; but after a little more than two months her strength so failed that she was obliged to take almost entirely to bed and the sofa, leaving off the scaffolding. Her health now began to improve again, and as she shortly was enabled to get about, she became again desirous of improving the shape of the spine, and resumed the support, but found again that her health failed, and was obliged to discontinue it. After six weeks more she consulted me.

At the date above given, I found her pale and weak: she could not sit up for more than a few

minutes at a time; appetite bad and capricious; pulse small; menstruation irregular and scanty.

The following measurements give the curvature of the spine. A silk thread between the 7th cervical vertebra and the middle of the sacrum crossed exactly over the 9th dorsal spinous process. The 2nd lumbar spine was $1\frac{1}{8}$ inch to the right, the 5th dorsal was $\frac{6}{8}$ inch to the left. When she lay down the curve decreased.

In this case it was, I felt, necessary to be very cautious in the application of any treatment. I ordered therefore at first a seat, sloping only $1\frac{1}{2}$ inch in 15, for ten minutes twice in the day, to rest on the back immediately afterwards, and to take steel wine twice a day—a steel and aloes pill night and morning.

May 18th.—She is better in health; the back has, of course, hardly altered, but the hardness and protuberance of parts on the right of the spine are rather less marked. A bandage has been constructed, and this was now applied with but little tension; to continue the sloping seat.

June 12th.—The health has decidedly improved, and the patient has gained flesh with rather remarkable rapidity: the back also is better, the improvement being chiefly manifest by the decreasing rotation, as seen in the greater equality of hardness on each side of the spine.

July 20th.—In the three or four visits since the

former date there has only been to observe the gradual improvement in health and in the form of the back: a higher slope to the seat was instituted a fortnight ago; the tension of the bandage has been two or three times rearranged. The deviation was to-day carefully measured: 2nd lumbar spine $\frac{6}{8}$ inch to right, 5th dorsal $\frac{1}{4}$ to left. We have then gained $\frac{3}{8}$ on the lumbar (primary) curve, $\frac{1}{2}$ inch on the dorsal secondary curve. This, I may remark, is not uncommonly the case; the secondary curve yields first and most.

August 28th.—Again I leave an interval, in which there is nothing especial to remark; improvement during that time has been, however, more rapid. Health is now very good. Menstruation has occurred with perfect regularity in the last three periods. She has sufficient colour and plumpness; appetite good. Measurement gives the following result: The 2nd lumbar spine lies so that the straight line is $\frac{1}{4}$ inch from its left border, and touches the right edge of the 5th dorsal vertebra.

Oct. 2nd.—The patient may now be considered well. The line of silk touches all the vertebræ; no transverse processes can be felt, but the parts on each side are equal in hardness and resiliency.

A note or two of cases with habitual and with permanent obliquity may be desirable.

Case X.—Miss F. H., aged 16, came to me July

19, 1869, with lateral curvature. The girl is tall and largely built, sufficiently fat, but not strong; has lately had chorea, of which traces are still left.

The spine is considerably curved both in lumbar and dorsal regions; the spinous process of 2nd lumbar vertebra lying $\frac{7}{8}$ of an inch to the left of the perpendicular thread. While placed in drill posture, no inequality in the height of the ilia could be detected; but it is difficult to make her stand straight: she always wrings the lower part of the body so that the left side of the pelvis lies anterior to the right. Suspecting some habitual malposture of the lower limbs, I watched her closely, and on several occasions detected her standing only on the right foot, while the knee of the left was advanced in front of the other and bent. She was strongly warned against this habit. The use of the sloping seat and a piece of cork on the left boot were ordered. After a month a loin bandage was ordered, and tonics were given.

It is unnecessary to give long records: suffice it to say that the docility of the patient has enabled her to make rapid progress. On the 4th of April, 1870, a perpendicular line touched the right side of the 2nd lumbar spinous process, and the case is now nearly well.

Case XI.—Mr. ——, aged 16, came to me October 1869, with lateral curve, which had prevented his

entrance into the army. He is tall and slight, but of sound health. I found a long lumbar curve, which disappeared entirely on recumbency, and partially when he sat down. A further examination showed that, when in the drill posture, the right crista ilii was $\frac{7}{8}$ of an inch higher than the left. This measurement was taken on an upright staff, to which a rectangular movable arm was attached. He was then placed recumbent, and the lower limbs measured from the top of trochanter to junction between femur and tibia on the outer side (easily felt in so thin a lad), and from this point down to lowest point of outer malleolus; they ran thus:

	RIGHT.		LEFT.
Thigh	$17\frac{3}{4}$		$17\frac{1}{4}$
Leg	$17\frac{1}{4}$	A little less than	17

In this case the sloping seat and a bandage were ordered. In January 1870 the permanent curvature was so far annulled that in sitting on a flat chair it disappeared. Of course in standing (since in this posture the pelvis is necessarily oblique) curvature reappeared. An additional sole of cork was ordered; he wished to avoid the appearance of a high shoe, and would only tolerate about a quarter of an inch, but even this diminishes the curvature. Perhaps we must be content with such result. No surgical art can remedy the inequality in length of the two limbs; but the spine is now straight whenever the pelvis is not oblique—in other words,

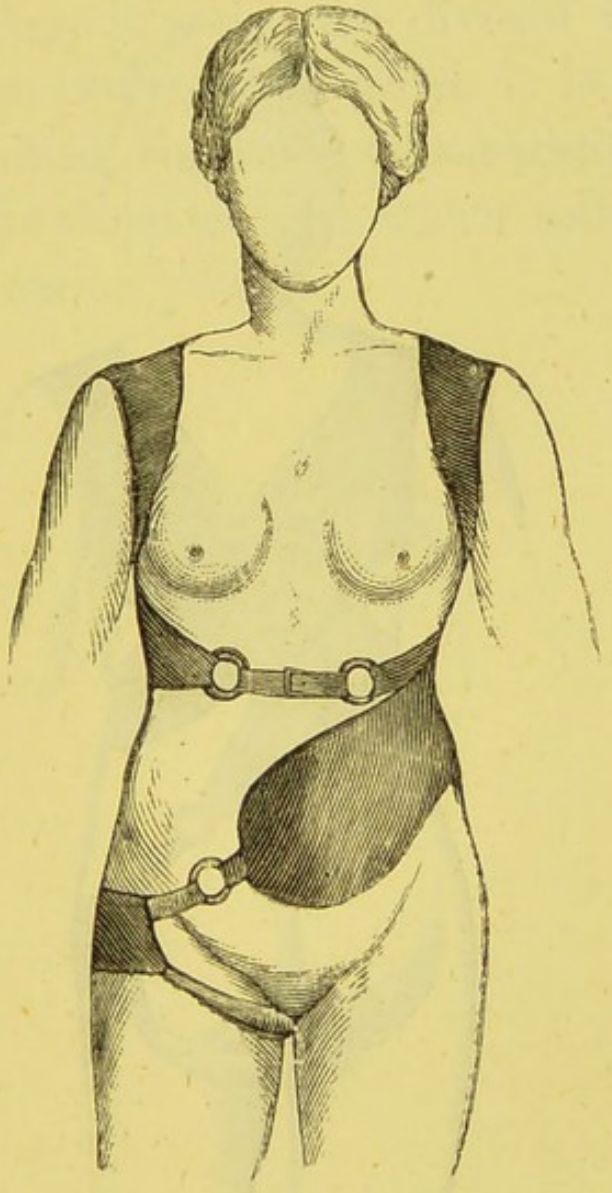
there is (April 1870) no morbid or permanent lateral curvature.

June 1872.—The limbs are, by the natural progress of growth referred to at p. 52, very nearly equal in length; the spine is straight; and he has passed the army medical examination.

An additional trouble is not unfrequently combined with lumbar curvature; namely, stooping or slouching shoulders. A youth of either sex having this habit or formation should not be permitted to write or read at a flat table, but always at a desk with a considerable slope, not less than forty-five degrees. This should be high enough to let the book or paper be on a level with the chin, when the patient sits upright, and should be eighteen or twenty inches broad, to allow a rest for the arms. If drawing or painting be studied, this should be done at an easel.

I do not, save in bad cases of stooping, apply any bandage, but sometimes the severity of the evil requires one. Under such circumstances, I have found great advantage from the use of a loin bandage and shoulder girt combined. The diagrams tell, I believe, so

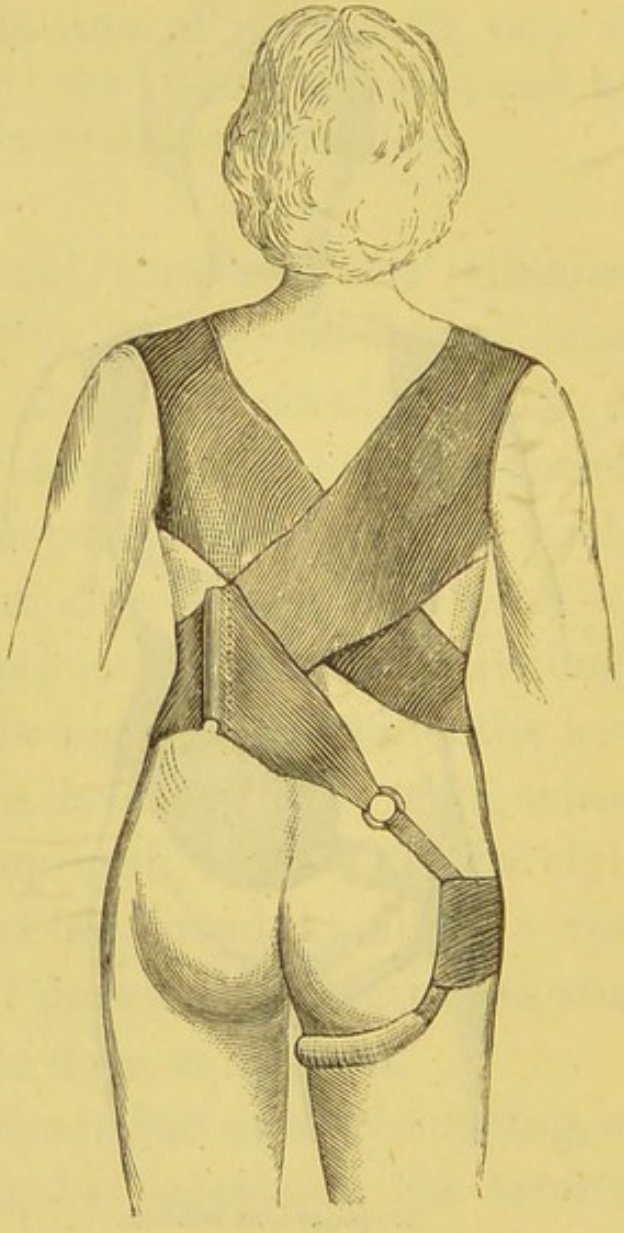
Fig. XV.



Compound Loin Bandage.

[*To face p.* 154.

Fig. XVI.



Compound Loin Bandage.

[*To face p.* 155.

completely their own story that no description appears necessary. I need only say that the loin bandage is as it were divided in two, or rather the two parts of which it is made are not conjoined, but are sewn separately to that part of the shoulder girt which embraces the right acromion.

CHAPTER VIII.

ON THE TREATMENT OF DORSAL CURVATURE.

ALTHOUGH curvatures primarily dorsal may not numerically preponderate over other forms, yet much interest is attached to them by their variety of species and cause. The first step in their etiology is simple: they are all produced by preponderance of one serratus over the other; but there the subject divides itself into a number of branches, for the want of balance may originate simply in overweighting of one arm, peculiarities in the mode of breathing, disease of respiratory organs, and more rarely in certain accidental conditions, such as position, &c.

Since, then, it is an essential part of the principles, advocated in this as in other of my works, to determine the causes in each case, and to treat the malady in accordance with such cause, it is evident that in both classes of the disease we must proceed by making

the muscle on the convex side act less, that on the concave more; but since in each division the sort of work is different, so must the means taken to regulate its amount vary.

Let us first take the class of dorsal deformity originating in weight-bearing. These cases are chiefly met with among the working classes, and hence some difficulty in enforcing those alterations of habits and that attention to directions necessary for recovery. Nevertheless, much can be effected; and I have succeeded in curing many cases, occurring in careful well-conducted families, of this order. In the first place, it is necessary either to relieve the patient of the sort of labour which produced the distortion, or to alter the mode of its performance. This work is generally carrying an infant or other burden: even long-continued sewing will produce slight curvature.* However we may wish to alter

* The mere movement of arm and forearm has, of course, nothing to do with the production of curvature. In all manipulations requiring evenness and uniformity of action, some part is kept fixed as a *point d'appui*. Those who have watched women at the needle will have observed that while the arm and forearm are

the mode of carrying burdens, it does not answer, save in the earliest stages, merely to tell a girl to use the other hand. I have, indeed, seen curves already well marked rendered worse by such ready and rather rough expedient. It is certainly best of all that the work cease for a time; next best, that the burden be supported on each hand alternately. It is not at the moment when all the body is braced to perform some act of strength that the mischief is done, but in the longer lapse of duller work, when the antagonist muscles, or those that fix the points of origin, neglect their duty, and allow the working muscles to lean upon bones and ligaments for their support. We have, then, to obviate the effects of constant or frequent pressure, rather than of exceptional action; and for this reason I have devised a bandage, or sling, intended, not to support any great burden, but simply to hang some of the weight of the right shoulder on the left one (supposing

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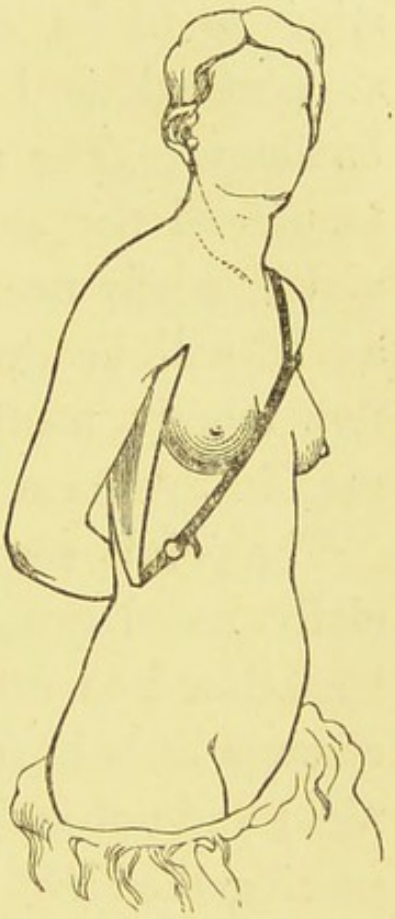
allowed free play, the shoulder and blade-bone are held peculiarly still: this fixity, being produced almost entirely by the serratus, has its effect on the spine.

curvature to the right). The difficulty here is the fact that both parts are on the same level. This was overcome by forming a strut or beam, consisting of a V-shaped piece of very thin highly-tempered steel, the upper ends of which are connected by a thick india-rubber cord, upon which (properly padded) the shoulder rests. From the lower part of the point of the V sufficiently broad pieces of webbing pass behind and in front of the body to the left shoulder, and these bands are interrupted at intervals by elastic cords disposed as rings, and by buckles, with means of procuring proper tension. The bandage, properly managed, does not cut. It fully answers its purpose of partially taking from the right

Fig. XVII.



The Shoulder-sling for weight-bearing curves in early stage. The triangular part under the arm consists of a support whose upper side is elastic and soft. The belt portion is rendered elastic by the insertion of strong india-rubber rings.

serratus the weight of the shoulder and arm; but since, in all but the earlier stages, it is necessary to produce also another effect, this sling is to be combined generally with a support which I have termed the "oblique bandage." The object of this latter band is to uphold the sides of the chest and spine, and is chiefly used in respiratory curves; but, as it will be described immediately, I will now merely mention it as a band also to be used in this form of dorsal malady.

The points regarding position to be especially noted are these: The patient should be induced to carry the right arm with the elbow a little in front of the body. A convenient and not inelegant posture is insured by placing the right hand on the left side at the waist. The left elbow and shoulder should be habitually thrown rather back. In sleeping the patient should be encouraged, whatever posture the body may assume, to keep the right hand on the left shoulder or left side of the neck. The left arm, if the posture be not uneasy, should lie behind the body. Fig. XIII. shows the action on the spine of

the sloping seat; and it is to be observed that although this agent was especially designed for lumbar curves, yet its influence does not stop at the loins, but affects also the back, and is of great value in all forms of dorsal curve; on this subject more must be said in the future.

The exercises to be used in the weight-bearing curve require very careful application, because there are certain points to be considered which I have till now purposely postponed. It is evident that if a weight have produced upon its support a certain effect, that consequence may arise from the excess of weight (either in mass or in time), or from the weakness of the support itself. In practice both these forms of case present themselves to our notice; and, besides, there is a third variety: the support, originally strong, has been injured, and the strength has for the time disappeared. In each one of these classes we must arrange differently our mode of using exercises, and their intensity; in the stronger and the rarer form, we may employ them immediately after having by

the above-described devices produced some effect upon the curves, and straightened them to some extent. In the cases originally weak, work must rather be discontinued than applied; in those which have acquired debility, exercise —even the sloping seat—must be avoided until a considerable improvement in health has been obtained.

The exercises are chiefly directed to the left scapula. Firstly, after, by the other means described, a certain improvement has been effected, and if the amount of debility do not forbid, we may weight the left arm slightly. This may be done in any way; a piece of plumbers' lead, properly protected, squeezed on above the elbow, is a convenient plan.—Let the patient stand in the position of a soldier at "attention," with the right side against the wall; then slowly lift the left hand and arm, at the same time throwing the head back;* or simply, in the same position,

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* The throwing back of the head, recommended in this and the following exercises, is prescribed in order to obviate action of the *trapezius* in lifting the shoulders,

with the neck well bent back, let her, keeping the arm by the side, lift or shrug the left shoulder several times.--A stronger exercise is to raise the left arm from the side until it forms a right angle with the body; then, with the head well thrown back, to lift it slowly six inches higher,* the head being well bent back.—Again, to swing the left arm strongly backwards and forwards nearly at right angles to the body, the hand pronated in front and supinated behind; when the patient is strong enough, a weight may be placed in the hand, both in this and in the preceding exercise. The influence on the ribs and spine of the two last exercises will be much increased by the following device. A hook or staple on the patient's left holds an accumulator attached to a handle grasped by the patient on the

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and to throw the whole burden of that movement on the *serratus magnus*.

* The reader is reminded that the arm may be lifted sideways to a right angle without moving the shoulder, but any higher angle is produced only by lifting the acromial end of the scapula; with the head well thrown back, this action is confined entirely to the serratus.

right, with her arm passing in front of her body, so that the force draws the hand well over to the left side.

If the weight-bearing curve be in the opposite direction, all these manœuvres must be reversed; they are not to be used lightly, nor indiscriminately, and must be from time to time rigidly watched.

The other form of dorsal deformity is far more common, especially in the upper classes of society; and when the surgeon has made so accurate a diagnosis that he is sure of having to do with a respiratory curve, not having its origin in internal disease, he will be aware that his treatment must be directed to combating exaggerated pectoral breathing, and the backward tendency of the right ribs. However early, however advanced the case, this must be one of his aims; indeed, if in the earliest stages of the malady he could insure such result, he would have done enough; but the deformity usually comes under care in a further advanced condition, and it is necessary, therefore, that he add means to obviate lateral deviation and to restore normal position.

In the first place, it is very important that the arrangement of dress should be conformable to health and functional activity. It is the duty of the surgeon to examine carefully into this point; nor should he rest satisfied with a mere assurance that nothing tight is worn. Let him rather not think it derogatory to see the sort of corset which the patient affects, particularly the hardness and resistance of that part which overlies the abdomen; let him, too, observe the amount of constriction produced by petticoat-strings, also the weight of the clothing. This is frequently considerable, especially in the colder months, when breathing, being more rapid, should be less constrained, but when the mere pressure by gravity on the abdomen renders respiration too pectoral. In cases where the curve is rapidly increasing, part of this weight may be suspended from the left shoulder, by means of an arrangement something after the fashion of braces. This can be managed without any difficulty, and I have in some cases seen considerable improvement follow such change.

The dress of very young girls (children) is

usually so contrived that most of the lower garments hang on a pair of loose stays, which in their turn are supported with the rest of the upper clothing by shoulder-straps. There is no objection to this mode of dress, except when the shoulders are sloping, or where some formation of a similar sort causes the multiplicity of tapes and strings to be constantly slipping, and the child to be as constantly shrugging her shoulders to keep her clothes on; even then, though a child condemned to this Sisyphus labour may be pitied, she will not be injured unless there be a slight curve or a tendency to curve. In that condition such irregular exercise is to be avoided, especially as it falls with more severity on the side which ought to be kept quiet; therefore either another mode of dressing or a simple contrivance to keep the unruly strings in order must be adopted.

The positions to be enforced in this form of curvature are aimed at two objects—the retrocession of ribs and the lateral deviation. I have, in speaking of weight-bearing curvature, described certain postures. They are

intended to bring forward the base of the right scapula, and thus to prevent overaction of that serratus on the ribs ; therefore to increase the vantage ground for such influence of the left muscle. All attitudes which bring the right elbow in front of the body, the left behind, are desirable—the patient should be encouraged to acquire as a habit, in walking and standing, to keep the right hand on the left side of the waist. In sitting she may advantageously let the arm cross still further, so that the hand rests over the left thigh. In sleeping she should, if possible, lie on the right side, a small cushion should be placed under the axilla, the right arm, brought well forward, should be so placed that the hand may be over the left shoulder or left side of the neck, while the left arm should if possible fall behind the body. Let none, till he has tried them, consider these matters trivial ; the force at any given moment of a single drop of water may be small, but let one fall at every instant, and the aggregate effect will soon be quite sufficiently marked. Of the postures calculated to obviate the lateral deviation the

first and most important is again the sloping seat. I would beg the reader to refer back to p. 126, on which is the figure representing the action of this device. It will there be seen that, though it was designed originally for cases of lumbar curve, yet its action does not stop at the loins, but is continued upward to the dorsal spine. When a patient is placed upon the mechanical stool, with the seat horizontal, and a plumb-line is dropped along the back from the seventh cervical vertebra, it will cross the spine once at or near the ninth dorsal vertebra, the fourth or fifth will be at a certain distance from the line, and this distance may be measured by callipers. If, then, the one end of the seat be slowly and gradually raised to a certain height, and this distance be again measured, it will be found to have decreased in proportion to the amount of slope. The effect of this posture on dorsal rotation will also be very evident if it be studied by looking down upon the back and shoulders after the manner described at p. 76. The diagrams on that page show the greater protrusion backward of the

ribs on the right than on the left side; this protrusion marks the degree and is the cause of spinal rotation. If, then, a careful eye note this inequality and its amount while the seat is horizontal, and again when it is made to slope, it will very distinctly perceive how much more equable the two sides become when a proper obliquity of the pelvis has been attained. The gradual subsidence of the right costal protrusion, and the proportional rounding backwards of the left ribs, is to me always a very gratifying proof of the principles and theories on which my practice is founded, and shows in each case according to its amount the value we may expect to derive from its application.

In all but severe cases we can by a considerable angle of slope perfectly straighten the dorsal spine; yet this is not desirable, the exertion necessary to the posture being too severe, and likely, as in a case related (p. 130), to produce evil results. We must content ourselves with a less amount of immediate effect, and in each case form our judgment of the desirable angle from the aggregate experience

of its action in other cases; and from an estimate of the patient's strength, a long back with weak muscles bears less of this exercise than a shorter and sturdier figure. The changes in the lumbar spine must be called in counsel, and the diminution of its rotation will prove useful as an index. In practice it will be found that a slope of from 1 inch to 2½ inches in 15 inches will be about the limits within which choice must be made. Before concluding all that I shall have to say upon the value of this device, it may be well to point out that its efficacy appears to me to lie in the fact that it does not, like external force, compel a passive spine into a certain posture, but obliges the muscles themselves to straighten out the abnormal curve, and accustoms them to keep the spine straight.

Another available but far less valuable posture is that known as the lateral swing; it is simply an arrangement of a broad bandage into a loop, comparable to a round towel suspended an inch or two above a couch; in this loop the patient lies in such a manner that the most pronounced part of the curve is sup-

ported by the bandage, the rest of the figure reposing on the couch on a lower level than the suspended portion. If this device be properly managed, it is advantageous to a certain extent; but it has many defects. It acts on a passive spine, and therefore has no influence on the muscular root of the deformity. The bandage, too, is apt to slip, it therefore requires careful watching, and thus the patient cannot sleep in it, which would otherwise be its most advantageous use.

The exercises, which are useful in this form of curvature, are only those that influence the respiratory movements of the chest and abdomen. All the experiments which I have made show that such gymnastics (and many are described by authors) as affect the spinal muscles proper are futile. A point omitted for clearness' sake from the etiological history of the malady must, however, here be noticed. If the surgeon watch the respiratory movements, either by touch or sight, as may be most facile, he will, in all cases of increasing curvature, find that the abdomen is perfectly motionless—even during forced breathing—in

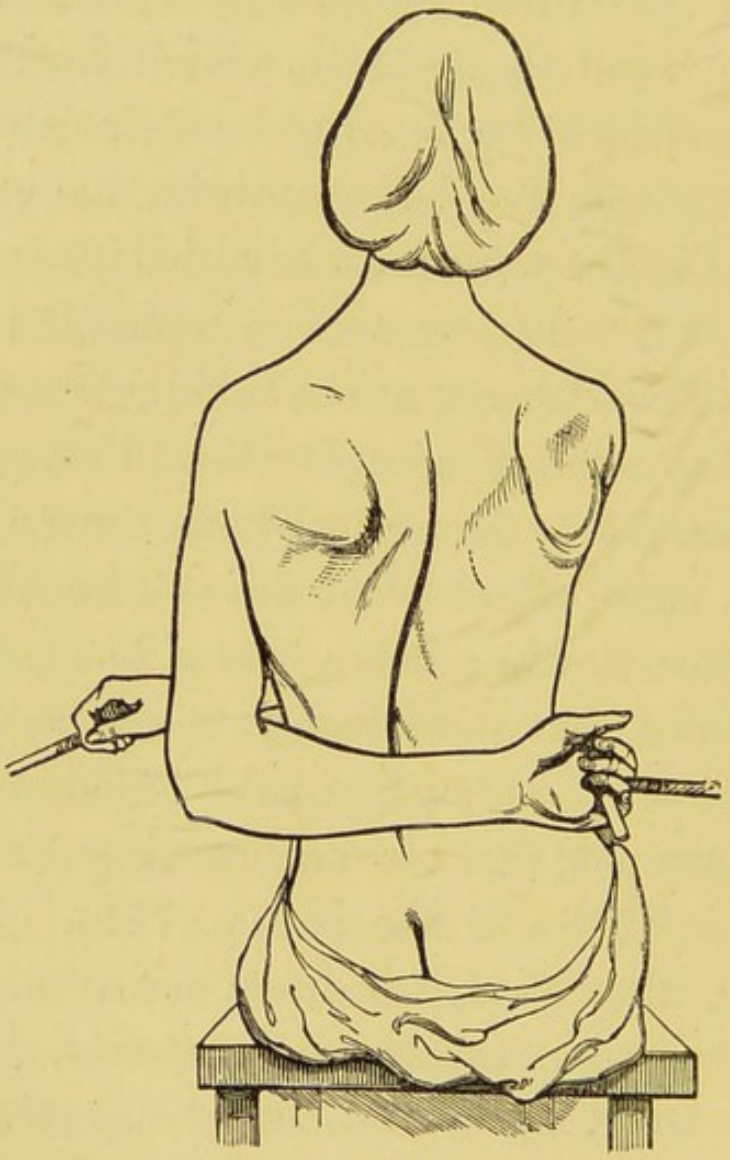
the deep breaths which he may require the patient to take, this part of the body is singularly immobile. Let him go further, and direct the patient to move the abdominal walls in and out, and he will in a large proportion of cases find that there is great difficulty in obeying his instructions. The physicians and other medical men to whom, as opportunity offered, I have, in Hospital and in my consulting-room, pointed out this peculiarity have been much struck with the phenomenon; its correction is one of the important objects in the physiological treatment of this malady. In all cases marked by much of such immobility, any attempt to teach at once the normal, alternating actions of abdominal breathing is useless; the patient must first be directed simply to draw in and throw outward the abdominal walls at any regular or irregular interval, and after a time these movements may be combined with those of the chest and diaphragm until a more normal form of breathing is acquired.

Other exercises are thus planned: we desire to place the trunk with appendages in such posture that in respiration the right

serratus shall be in a disadvantageous position, the left in the best possible position for acting with power on the ribs. And here it may be permitted me to call attention to a peculiarity of the methods which I advocate, for therein will be found to be their value. In order to keep the body upright, the erector-muscles of the spine must be called into action; but if they act upon a spine which is rotated so that they lie, not at the middle, but at one side, they must of necessity bend that spine to the other side. Hence to attack these muscles as the cause of crookedness is like blaming water for flowing down the side of a hill; hence also that desuetude into which nearly all devices of orthopædy have fallen, and the sort of despair expressed concerning the action of those that still survive (p. 111). But if, on the other hand, we direct our attention to the torsion, and overcome that defect, then the erectors will not in contracting make the spine crooked. For this purpose, we, among other exercises, enforce certain actions of the serratus (the dorsal rotating muscle), in such wise that the respiration shall affect the left

ribs as much, the right as little, as possible. If the patient be sufficiently strong, we shall gain

Fig. XVIII.



Left Respiratory Exercise.

two objects at once, by letting her perform the exercise while seated on the sloping seat; but if the bodily powers be feeble, one or the

other exercise will be enough at a time. To the wall on each side of her stool let hooks be fixed, and let these bear strong elastic cords terminating in handles, which she is to use in the following manner: the right arm is to cross in front of the body and hold the handle attached to the wall on the left, while the left hand passes behind the trunk and grasps the handle from the right. The amount of tension must be carefully regulated, so that it shall not be irksome, and yet shall draw the right scapula far forwards, and the left well back. The accompanying figure, from a photograph of a patient, shows the kind of posture produced. Keeping then in this posture, the patient is to be directed to make several very deep inspirations: let them be long and slow —if possible, only six to the minute; the inspiration occupying more time than the expiration. By the different postures of the shoulder-blades the left serratus has more power than the right, and at each breath the left ribs will be chiefly used, giving a twist to the vertebræ contrary to the abnormal torsion.

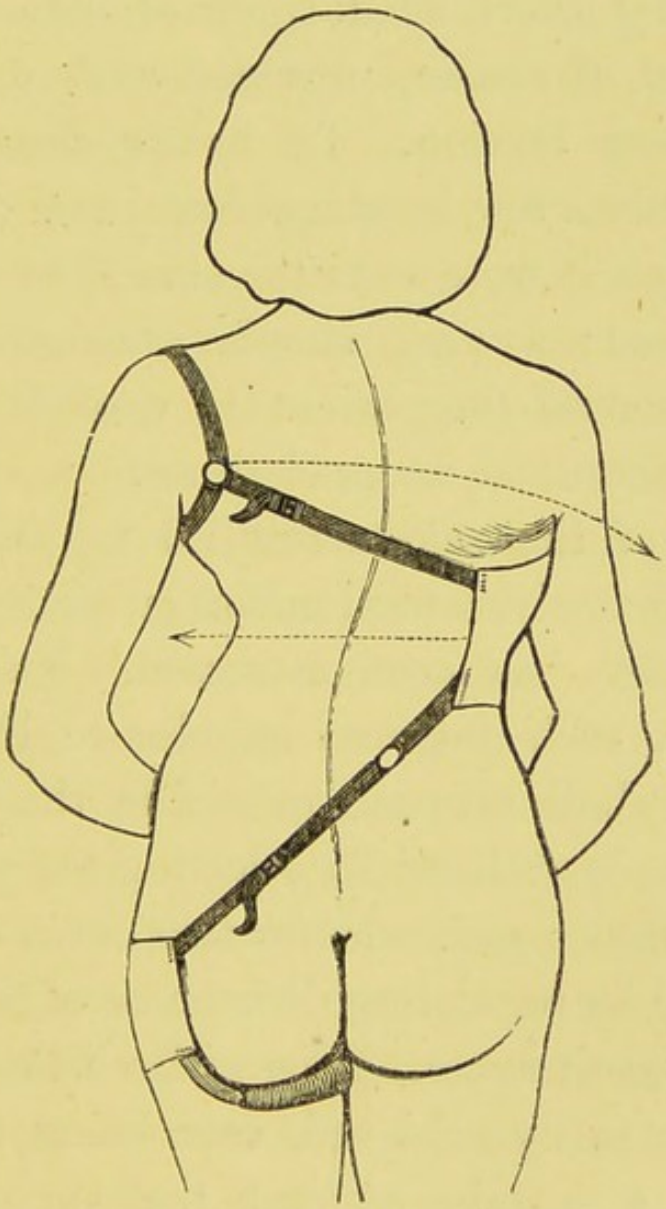
Let the patient, while sitting on the sloping seat, keep the right arm crossed well over the chest; then, taking a deep inspiration, throw back the left arm so that the hand describes part of a horizontal circle; let this be repeated three times before taking a fresh breath and re-commencing the manœuvre. After a time some weight may advantageously be placed in the left hand.

These exercises, combined with the positions at repose, and the gradually increased use of the sloping seat, will suffice for the purposes indicated; but, besides these, it is, in all but incipient cases, desirable to uphold the spine, and to prevent retrocession of the right ribs by certain bandages. The first of these and slightest is the oblique bandage. The principles upon which these are founded have been already explained; it will be only necessary to repeat here that the forces are applied as nearly as possible in directions transverse to the chords of curvature.

The fixed point is gained at the side of the pelvis by means of a trapezoid piece of coutil, which is held in place by a circular strap

passing around the upper part of the thigh, as in the loin bandage. From this pad runs,

Fig. XIX.



The Oblique Bandage.

both in front and at the back, a webbing strap to another pad placed on the right over the

most retrograde ribs; and from this again, over both chest and back, other traces pass to the left shoulder. The straps are rendered elastic by intercalated rings of india-rubber, and are, of course, provided with means of regulating tension. To insure clearness of illustration, the bandage has been depicted as though it were next the skin; but it is not thus used; a very simple arrangement of dress enables the patient to wear it outside the chemise and under-clothing.

One of the objects fulfilled by this apparatus—namely, lateral action on the curves of the spine—has been discussed. The other, namely, such forward impulse to the right ribs as shall prevent, or aid in the cure of, rotation, is attained by selecting the place for the shoulder pad, whence that force can best act, and by regulating differences of tension in the different traces. This, with a little practice, is very easily achieved, care being taken to fix at a certain amount the variations of pressure. There are, however, some cases, chiefly those of old standing and much deformity, which require a somewhat modi-

fied bandage. Such changes are easily imagined, but I shall, when speaking of aggravated curvature, describe a form of band, a combination of this and of the loin bandage, also another, devised on a rather different model.*

A certain custom or experience in the use of these different expedients will lead to a method that shall in each case develop their greatest value, and perhaps a few hints on the varying constitutions of patients affected with curvature will not be misplaced. Among persons thus suffering we find all different forms of growth and constitution. The overgrown, pale, and slim young girl, whose form is popularly considered as the type and *beau ideal* for such distortion, is hardly a more frequent victim than the strong, ruddy, and firmly built. But as the physical condition in these individuals is different, so will it be wise to make such variations in the method and

* The shoulder-sling is, in cases of weight-bearing curve, to be combined with this bandage simply by letting the point of the V-shaped strut be supported by the pad on the right side.

time of our appliances as shall suit the particular case. The former sort will require at first only a small allowance of the exercises prescribed; the performance must be somewhat carefully watched. The use of the sloping seat also must be guarded. The same angle will affect a long spine more than a short one; but more especially it will be well to remember that weak muscles must not be over-exerted. On the other hand, the use of the bandage must at first, in the weaker spines, be more decided; and the lower pair of straps, more especially, must be made to do their work. Also in some of these cases, especially if the patient be not so much weak in health as over-grown, so that the muscles have not yet acquired their due mastery over the preponderating bones, it will be well to use the very powerful bandage described in the next chapter, under the name of "dorso-lumbar," as more particularly applicable to severe curves.

In such variety of constitutions, we shall, of course, find that medicinal treatment must vary. Some practitioners, under the idea

that all lateral distortion is a result of debility, give quinine or iron in every case; others, clinging to the notion that some disease of bone produces the disease, administer lime, iodine, &c., whenever a lateral curve makes its appearance. In practice, however, we find that among a number of people laterally distorted there shall be all varieties of general condition—robustness, anæmia, and, in fact, the only point of physical resemblance shall be the curve itself; hence, in many cases, medicine is quite unnecessary, and had better therefore be omitted; in other cases the general disturbance speaks for itself, and must be treated. The curve and its immediate cause are not to be benefited by medicines; but when the severity of the distortion has produced loss of health—a not uncommon circumstance—we shall find certain tonics—quinine, iron, perhaps cod-liver oil, and frequently iodine, available;—that is to say, they will be of some use; but these may be administered to profusion, yet the pain and the lassitude will continue until the local treatment has improved the condition of the back,

and then such symptoms will decrease. Concerning the choice of the above medicines, little need be said. The function of menstruation is not unfrequently greatly troubled in lateral curvature; and very little experience of these cases leads one to observe, that this occurs more especially in the lumbar form of the malady. Such state will give a clue to the sort of medicinal treatment needed. Excessive languor, inedia, a shortness of breath, or a hacking cough, furnish sufficient data for treatment in other cases; while the absence of any such symptoms will warn us to withhold medicines where they are not wanted.

Perhaps it will be remembered, that a promise has been made to show how the rotation-measurer, whereof I have once or twice spoken, may be used as a means of determining whether a case be improving, or the reverse. If a patient with a dorsal curvature to the right present herself for treatment, it will be found, when she is subjected to test by this instrument, that the body will turn less to the right than to the left, and the difference will be commensurate with the

severity of the curves; * hence it follows that if the patient get better the variation will decrease, and *vice versâ*. Of course I do not subject all patients presenting themselves for treatment to this test—many circumstances, besides the value of my time, would preclude such practice; nevertheless I have, in a goodly number of cases, kept a regular record of these measurements, and subjoin one or two such diaries:—

CASE XII.—Miss C. B., aged nineteen, 1866.

	RIGHT.	LEFT.
19th February	30 deg.	40 deg.
25th April	26 „	36 „
10th June	30 „	35 „
15th August	36 „	35 „

CASE XIII.—Miss L. L., aged sixteen, 1866–1867.

	RIGHT.	LEFT.
27th July	40 deg.	70 deg.
24th August	35 „	61 „
21st September ..	40 „	60 „
19th October	50 „	59 „
16th November ..	54 „	58 „
14th January	58 „	58 „
11th February	60 „	58 „

* Very severe curves are, however, rather irregular in their indications, and backs which have been kept in steel supports have been thereby artificially stiffened: their performance cannot therefore be relied on.

CASE XIV.—Miss S. C., aged seventeen, 1867.

	RIGHT.	LEFT.
6th April	25 deg.	40 deg.
14th May	29 „	39 „
28th June	32 „	38 „
17th July	34 „	36 „
4th August	38 „	37 „

A different way of measuring,—that by a silk thread stretched between the middle of the sacrum and the vertebra prominens,—may be adopted. There is, however, some difficulty in rendering such measurement very accurate, since the breadth of the spinous process is sufficient to give large margin for error; by carefully marking on the skin with ink, the inner and outer boundary of the bony prominence, and taking the centre as the point for measure, we can, however, obtain considerable exactitude in estimating lateral deviation in tolerably severe cases; but when the curvature is either slight in its commencement, or has advanced considerably towards cure, this is of very little avail. For instance :—

CASE XV.—E. F., aged 22, came to me 15th of November, 1865, with marked respiratory curvature

to the right. She was a tall, rather slim girl; had of late lost health rapidly, and got thinner; appetite bad; complains of a good deal of dull pain at and about the right shoulder-blade and arm-pit, and also about the upper part of left ilium. There is evidently something vague and unsettled about this pain, as she finds difficulty in fixing its exact locality: it decreases when she has been for some time recumbent. Measurement of the curve gave—

	5th Dorsal	$1\frac{7}{10}$	to right.	2nd Lumbar	$1\frac{2}{10}$	to left.
14th Dec. 1866.	„	$1\frac{1}{10}$	„	„	$\frac{8}{10}$	„
11th Feb.	„	$\frac{9}{10}$	„	„	$\frac{7}{10}$	„
1st March	„	$\frac{5}{10}$	„	„	$\frac{4}{10}$	„
25th April	„	$\frac{2}{10}$	„	„	$\frac{2}{10}$	„

August 15th.—There is still a perceptible, but scarcely (on the living body) a measurable distance; the line touches all the spinous processes, but does not lie over the centre of some of them.

September 27th, 1866.—The back is now perfectly straight; neither by eye nor manipulation, by measurement or the rotation test, can I find any difference.

Case XVI.—Miss R——, aged $17\frac{1}{2}$ years, was sent me by my friend Dr. Cotton, October 12th, 1867, on account of the following conditions. During the last three or four months she having lost health, flesh, colour, and appetite, was taken to see Dr. Cotton, who found no signs of tubercle in the lung,

but simply failure of vital power, he also saw upon her one of the usual steel supports that had been ordered her by one of that persuasion, and made by a practised maker. On questioning her the physician found that five months ago some apprehension had been excited by tendency to stoop, and she was taken to Mr. ——, who, ordering the usual mechanism, had seen her frequently, to screw up the levers in the interval.

In my presence the scaffolding was removed, and I found a dorsal curvature to the right pretty strongly marked; with those particular additions, which I have always observed on backs that have for a length of time been supported by a stiff instrument—namely, that on first removal the spine remains in the same attitude, with a certain rigidity; and rotation is more marked than the lateral bend. After a time, and generally of a sudden, the back gives way and sinks into very considerable curves, and then the spine becomes again more flexible. There is considerable tenderness of the spinal muscles.

The patient is suffering under a morbid irritability; she flushes very easily, and has fainted once or twice on very slight occasions. I therefore ordered no exertion by position or exercise, but simply that she should remain erect but very little at a time, until a less exacting mode of support could be made.

25th.—The bandage was applied on the 18th, and she has since sat up more, and walked about a little,

she is better generally; irritability is much less; the pain and tenderness of the spinal muscles have disappeared, or nearly so.

20th November.—The back has improved each time that I have seen it (about every ten or twelve days), and now the condition is very much better; her morbid irritability is gone, and although closely watching, I have seen none of the old transient flush. The tenderness of the spinal muscles has also quite disappeared. The sloping seat, rising 1½ inch to the foot, is ordered for her, which she is to use ten minutes twice in the day.

December 18th.—Still improving.

January 23rd, 1868.—During the last few weeks this young lady's improvement has been very rapid. There is now but very little lateral deviation; the rotation, however, is to a skilled examination very evident.

March 2nd.—This case is to be considered well. The patient's back is perfectly straight; she has gained health and flesh, her spirits are good, and she can take a fair amount of exercise.

April 17th.—I saw this patient again; the back remains perfectly straight.

Case XVII.—Miss F., aged 24, came to me, 12th April, 1869, with a well-marked dorsal curve to the right. She is tall and slender in build, and is thin; the limbs are not weak, but she has worn an iron instrument, with crutch handles, for two years and

six months, and the muscles of the back are shrunken. A fortnight ago some of the steel broke, and, during its repair, both she and her friends were alarmed to see how little she could sit up; how her power of walking even a little way had diminished. The instrument was therefore not reapplied, but the young lady was brought to me.

I found the back excessively feeble, so that it could with difficulty support the trunk. The muscles on each side are shrunken, so that the spinous processes project. The back, besides being weak, is very stiff, and does not yield to the lateral movement of the pelvis (p. 101) as it should do. I consider this rather the effect of the treatment than of the disease. If she be told to sit quite upright for a time, and the back be watched, it will be seen to remain in as good a position as can be induced for a time, then it suddenly gives way, and the spine sinks into more severe curves.

For this patient was ordered an oblique bandage, with a larger pectoral pad than usual. Until the bandage was made she was to remain a good deal recumbent, and under all circumstances to lie down as soon as the back became fatigued. After a week the bandage was applied.

12th May.—The difficulty of this case is not with the disease itself; the excessively weakened back barely permits further management than the mild non-restraining support, and avoidance of fatigue. This debility has a little decreased.

June.—There is now more evident return of strength, and the health has improved.

July.—Considerable improvement in strength, and the back is straighter. She is now permitted to use the sloping seat a few minutes at a time.

October.—The case has greatly advanced towards recovery. The back is now fairly strong; she walks a mile at a time without difficulty, and has walked two, but that fatigued her. The same ordinances, with the addition of allowing her to ride on the wrong side of a steady old horse, and at a walk.

The rest of the case is not worth following minutely. The patient at the end of March 1870 was considered well, but still asked to wear the support. I saw her again in May of the same year, and the bandage was discarded. She is quite well in health, the back being perfectly straight. She has become sufficiently *embonpoint*, and is a very pretty figure.

CHAPTER IX.

ON DORSAL CURVES FROM INTERNAL CAUSES — ON EXAGGERATED AND ON SLIGHT CURVATURE.

By the first term at the head of this chapter I intend to designate curvatures of the dorsal spine which arise from some disease of lung, pleura, or both. In earlier pages the form of distortion has been mentioned, it now remains for us to examine it more fully.

In every case of painful pleurisy, for instance, of the adhesive type, the spine curves to the sound side.* If the case get worse, and large effusion take place, so as to over-fill that side of the chest, the curve still continues in the same direction. The disease may still progress, and the fluid, be it pus or be it

* Some years ago it was my fate to be consulted on the case of an Eton schoolboy; when the iron scaffolding with which he had been provided was removed, I found him suffering from acute pleuritis.

serum, may be evacuated by operation, the lung may have collapsed, become bound to the back of the chest by bands of adhesion; that side of the thorax will be much too empty. Nevertheless, the curve still continues towards the same side. Thus, whether the diseased side be in a state of over-fulness, or over-emptiness, the spine always curves to the sound side.

In cases of pneumonia the same thing happens. The lung may be acutely inflamed, *i.e.* enlarged, hepatized, or shrunken; the curvature is nevertheless always towards the sound side.

In phthisis of one lung, sufficiently advanced to affect a large portion of a single organ, there is curvature to the sound side.

It is evident, then, since all these various, even contrary conditions produce on the spine the same effect, they must have in common some character which is the active agent in the production of the curve. The only point which belongs to all these maladies is disuse, more or less, of the diseased part of the lung. In order that any part of the lung may be left

out of action, it is necessary that the rib or ribs over that portion cease to move; that is to say, that the particular portion of the serratus attached to the bones overlying the diseased spot remain inactive. But on the sound side respiration continues normal—or is exaggerated to compensate for the lost respiratory space—that is to say, the serratus on that side is in full work. It is not counterbalanced by the muscle in whole or in part of the diseased side, hence the ribs are constantly being drawn back on one side only, and must of necessity rotate those particular vertebræ which are connected with the passive ribs on the diseased side of the thorax.

Thus are produced various curvatures, all of them away from the locality of disease; but of different characters, and in different parts of the dorsal spine, according to the malady, and to the portion of the lung affected by it. Also a marked influence is due to the age of the patient at the time of illness, a fact of great importance in the treatment of young subjects.

The most severe dorsal curve I ever saw was in a young girl aged 22, who, at the age of

seven years, suffered from pleuro-pneumonia. An old scar on the left side shows where pus had been evacuated. The left lung was solid and shrunken. The lips and conjunctivæ were dusky from insufficient respiration. The left side of the chest was so small that there hardly appeared room for the heart; the upper ribs so short that they appeared absent, and the finger pressed under the clavicle impinged on the venter of the scapula. Now, in this case there was not merely lung-disease, but also absolute want of development on one side of the chest, impressing certain peculiarities on the curve. But here, as in others of like causation, we find a particular form of spine, which differs from the ordinary type in the greater length of its curve. The bend occupies the whole of the dorsal region, or nearly so, ten, eleven, or twelve vertebræ, hence the lumbar compensating curve occupies a less number of vertebræ, and is proportionally less severe. This form of curve will be found in all cases where the whole of a lung is affected.

When a less extensive pneumonia attacks

the lower part only of one lung, we find a curve which commences quite low. Under such circumstances compensating deviations, necessary for balance, generally appear both above and below the primary curvation, producing that sort of disease known as multiple curvature. There are namely two, more rarely three, curves in the dorsal region alone; but the lowest of these is the primary affection, if the disease above specified have produced the deformity.

Consumption, when but one lung is tuberculized, has also its own curve. This is a high one, beginning immediately below the root of the neck, occupying but three or four vertebræ, and accompanied in its severer forms by a short compensating curve also in the dorsal region, from about the fifth to the ninth vertebra. Therefore, this lung-malady is also occasionally a cause of multiple curve. The particular deformity produced by tubercular lung is very unmistakable. I have frequently asked physicians to examine the lungs of patients thus affected, and, as far as I can remember, have never been wrong in

my anticipation that tubercular solidification would be found.

Of treatment in such cases little can be said; as long as one lung is bound down by adhesion so as to be quite useless, or as long as the tuberculated state of a lung exists, all we can do is to diminish as far as possible the effects on the spine, and surgical treatment must be cautiously subordinated to such management of the health or of the lung-malady as the physician may prescribe.

Any acute lung-disease occurring in childhood, and leaving the organ imperfect, should cause us to watch carefully the shape of the spine, and at this early age much may be done to prevent the patient growing up deformed. The treatment must be, however, very gentle, and all care be taken not to tax the strength, or to hamper freedom of movement, nor can I see any possible proceeding likely to be more injurious than fixing a child of four years old with a damaged lung in a heavy stiff iron cage, checking all enjoyable play, such as I found on the trunk of a little patient brought to

me some years ago, and which was left in my museum by her friends.

Exaggerated curvature is a term, which seems applicable to a condition of spine, in which the radius of curve is less than its length. Such condition may be primarily lumbar or primarily dorsal, but the distinction in such extreme distortion is of little value, nor can it always be made. In these cases rotation has proceeded so far that the angles of the ribs form a hump between the spine and the scapula. This latter bone is thrust outwards, the dorsum looks upwards and outwards, and the angle projects backwards. These changes are produced by alteration in the position of the ribs, upon which the shoulder-blade rests. Some notion of this position may be gained by studying the last diagram on p. 76. In these cases the extreme backward projection of the ribs causes their angles to form a prominent hump, visible even through a loose cloak.

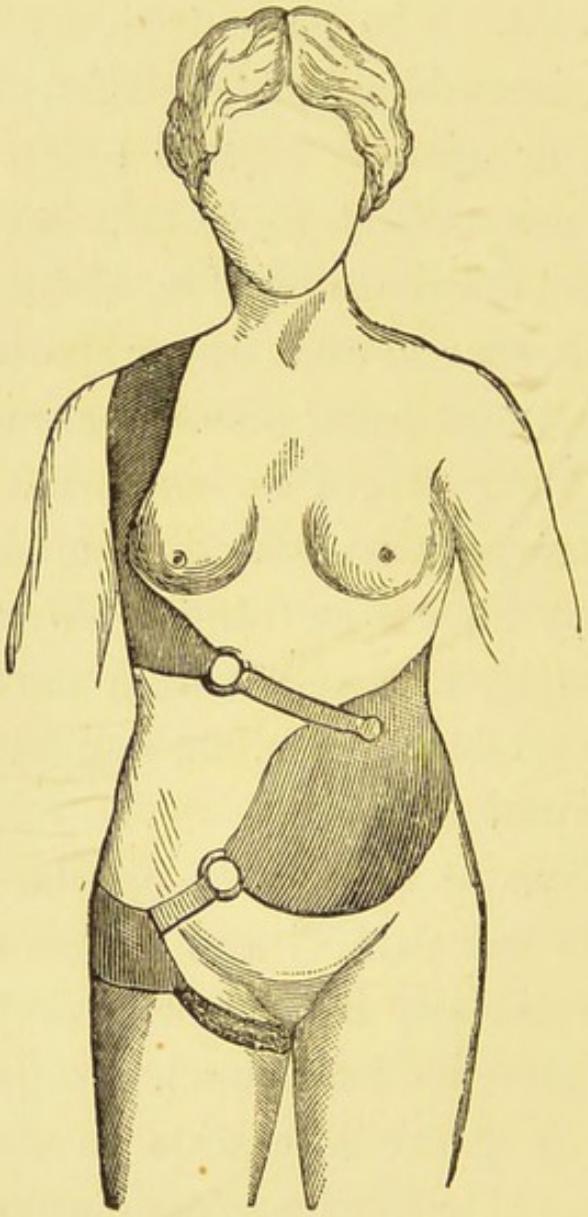
Such very severe cases are exceptional: nevertheless, we not unfrequently meet with exaggerated distortion dependent either on the

usual causes or on internal disease, and although either class cannot be considered curable, a good deal may be done to alleviate the suffering produced. The patients thus affected are generally incapable of any exertion, of standing or of sitting upright beyond a few minutes, and they are subject to certain severe pains on the left (the concave) side, about the lower intercostal spaces and upper parts of the abdomen: these pains also sometimes extend lower. Their origin is somewhat obscure: the peculiar position affecting muscular conditions may have something to do with them, or again they may result from narrowing of the intervertebral foramina, and pressure on the intercostal nerves.

Our object in such cases can be simply to render life less painful and burdensome; we cannot—especially if the curve result from internal origin—hold out much prospect of producing any great alteration in form. The patient should as much as possible avoid sitting with the back unsupported, and her chair should be prominent at the region of the loins, so that the whole of the figure, not merely the

shoulders, are upheld ; and I certainly have always found benefit from making this seat

Fig. XX.

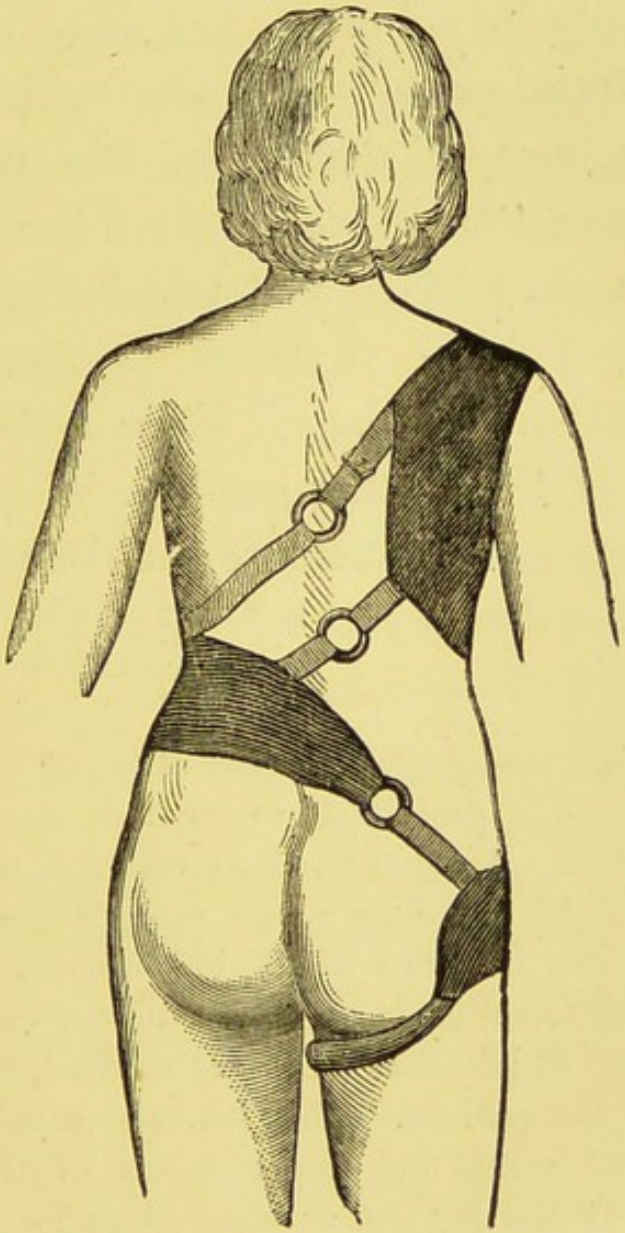


Dorso-lumbar Bandage.

slope from left to right—benefit, that is to say, in diminishing pain. Some sort of support is

also necessary, but not such a one as renders, or endeavours to render the figure immov-

Fig. XXI.



Dorso-lumbar Bandage.

able; these are, after a certain time, very frequently discarded. In many cases, and those

not among the most severe, the oblique or the loin bandage gives all necessary support, and patients have expressed themselves greatly relieved by its adoption, but other cases of a severer form, or suffering more pain from an equal amount of distortion, find advantage rather from a band, which gives more support over a larger surface, and which from its construction I have ventured to name "The Dorso-lumbar Bandage," since it is a combination of the lumbar bandage with a means of making strong pressure on the prominent part of the dorsal curve.*

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* This is a modification, a perfection, of a somewhat similar bandage described under this name in my second edition. Another bandage, called in that edition "The Spiral," I now very rarely use, not because of its possessing any inherent defect, but because I find the new form of dorso-lumbar bandage answer nearly every purpose for which that one was devised, with more comfort to the patient. This bandage consists of the leg-pad with strap and the loin-belt of the lumbar bandage. It has besides a broad piece for the right, the prominent ribs and shoulder. This bandage is depicted, back and front, in the diagrams annexed, Figs. XX. and XXI., and will be more readily understood than described. It need hardly be said that much of

The support and comfort which this bandage affords in the most advanced forms of curvature are very great; also, when patients have at my instance been released from iron scaffoldings, I have, if the back have been much weakened by such instruments, used this form of bandage to uphold the debilitated spine until a certain amount of strength has been regained.

Case XVIII.—Miss B. was brought to me by Mr. Marsack. She is 51 years old, and has for years suffered from dorso-lumbar curvature. She does not look for cure, but has lately suffered very severe pain in the shoulder at a spot above the upper costa of the scapula, and also between the base of that bone and the spine. She has also certain other affections not necessary to be specified here. I adapted a bandage of this description with some difficulty, and she was not inclined to bear restraint and was afraid of pressure over the abdomen. By making the abdominal portion of the lumbar belt partly of elastic

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its efficacy depends on accurate fit. I always cut the patterns myself on the body of each patient, and those that are difficult of adaptation I try on before finishing, making what alterations may be necessary to secure pressure where needed, and to avoid pressure where, not being wanted, it would be hurtful.

material, and by certain other modifications, I managed to get made a bandage that she would wear. In six weeks she had quite lost the pains at the shoulder; she stood better and with a straighter spine.

April 1877.—About a year after I first saw this patient I lost sight of her till March of present year, when I was asked by Mr. Rayner of Cambridge Place to see her with him. She had been suffering from a painful intestinal disease, and was still in feeble health. Till this last attack had sent her to bed she had continuously worn the bandage, and was comfortable; but she has now got thin and so changed in size that it no longer fulfils its purpose. When she had been out of bed a few days without this aid she found the old pain in the shoulder returning, and required another bandage, which has again relieved her of all discomfort.

The few words which I would say on the subject of very slight curvatures rather relate to diagnosis than to treatment. The natural anxiety of a mother that her daughter should grow up straight leads many parents to take a girl to some one reputed skilled in this class of case, in order either that any desirable treatment might be adopted, or that her parental fears may be set at rest. Under

such circumstances it is necessary that a correct judgment should be formed, still more that it be given. In such cases the probability is that some unevenness of the shoulders will have caused the lady's doubts, and it is upon the sort of difference in height of those parts that I would speak; for the right or the left shoulder may assume an habitual attitude a little higher than the other, and yet there may be no spinal deviation.

The scapula is very movable; it may be temporarily lifted by the action of the trapezius and serratus to a considerable height, or it may, through some awkward trick of habit in the same muscles, be kept permanently above the level of the opposite side; but in all these postures the dorsum of the bone will not alter its aspect; like its fellow of the opposite side, it looks backwards and a little outwards, and but very little or not at all *upwards*. If the acromion be brought forward, the dorsum of the one bone will look more outward than that of the other. But something more than this happens when the shoulder is displaced by deeper causes. At p. 73 is given an

account of the manner in which the scapula is pushed back from beneath by the retrocession of the ribs. The bone overlies the upper ribs from the second to the seventh; its lower angle just touching the one last enumerated, when the arms hang by the side. Now we know that the fifth dorsal vertebra is that which has most deviated, and the fifth rib, the one that in its lever-like action recedes most. Hence it is the lower part of the scapula which is most pushed back when the ribs recede, the upper costa being but very little, if at all, affected. The bone then becomes too horizontal, the dorsum will look too much *upwards*, and the lower angle will protrude too far back—stick out too much. This is the position which should inspire anxiety; the mere elevation of the shoulder, while the bone retains its perpendicular position on the back, has nothing to do with spinal curve. Even this too horizontal position alone is not to satisfy the surgeon that curvature exists. He must also, by examining the relative position of ribs on both sides of the back, ascertain if rotation have taken

place (p. 73); that is to say, if the peculiar position of the scapula be due to its being pressed backward by the ribs themselves. The mode of examination by looking along the patient's spine, as described at p. 75, will be the most effective for determining whether or no the ribs have receded more on one side than the other, and I would request the reader to refer to the diagrams on that page. I have been induced to insist with a certain minuteness on these points; because, in several instances, medical men bringing me patients have been somewhat inclined to doubt my assurance, that no lateral curve existed, referring again after such negation to the heightened shoulder; but all those friends have acknowledged to me, that subsequent events have proved the correctness of my diagnosis.

Again, it has appeared well to lay such stress upon this subject, because it is closely connected with what may be called "hysterical spine." There is, in my experience, no mock disease more common than an hysterical simulation of dorsal malady. But in nearly every such case diagnosis is not difficult. The

pain or flinching upon slight contact, the ease with which steady pressure is borne, either absence of any rotation and curve, or presence of one simple curve, which increases while the patient knows herself watched, and disappears nearly or entirely when her attention is directed elsewhere, these and other signs, are all very strongly marked, affording sufficient grounds for undoubting diagnosis. Sometimes, however, we meet with mixed cases—cases in which there is weakness of the spine, with slight rotation, a tendency to, rather than actual distortion, and mingled therewith a highly hysterical condition—such a case was quite lately sent me by Dr. Theodore Davis, of Clevedon; others also presenting extreme difficulty of diagnosis and of treatment have come to my notice. The points, however, regarding the position of the shoulder and the occurrence of hysterical complication must be well known to the surgeon examining these cases, lest he fall into error.

There is hardly a malady in surgery so liable as spinal curvature to be imputed to perfectly healthy girls; nor for which so

many, innocent of all disease, have been subjected to long treatment; while very many more young women, so slightly affected as to require only a few months' easily-borne management, have been irreparably injured both in health and happiness by being laid upon couches, forbidden healthy exercise, and fastened into steel machines.

CHAPTER X.

ON ANGULAR CURVATURE OF THE SPINE,

AND ITS TREATMENT BY PLASTER OF PARIS.

ANGULAR curvature of the spine differs entirely from lateral curvature, not merely by the shape and direction of the bend, but in its method and cause of production, since the posture of parts always results from destruction of the vertebral bodies. Although it is not my intention to discuss the morbid anatomy of this malady, yet, in order to elucidate the advantages of the treatment advocated in the next few pages, a few words conerning its pathology must be said.

The caries, which causes the curvature in question, attacks the very open cancellous network of the vertebral bodies.* This

* It would be out of place to enter here into the question as to whether the disease ever commences in

malady eats away a certain part of one or more of the bodies, so that if the column could, under such circumstances, continue in its erect position, there would be a gap or hole in the front of the spine. But the weight of the superincumbent parts forbids the retention of an erect attitude; when the caries has taken away the supporting power the column must in such conditions bend or sway over towards the point which has been undermined. Hence results a sharp bend forward of the spine, and an equally sharp projection backwards. This projection, formed by the spinous processes, is so constituted that the most prominent point marks either the vertebræ furthest advanced in the destructive process or the central bone of a long series of diseased vertebræ. For the malady is not by any means always confined to two

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the intervertebral substance, or how often, how early, or how far this material may participate; the only object of the present chapter is to show the mechanism of the angular bend, and of the treatment which may be employed chiefly in their anterior aspect, although often a little more deeply on one side than on the other.

or three bones only, but may extend over six or seven: in the former case the destruc-

Fig. XXII.

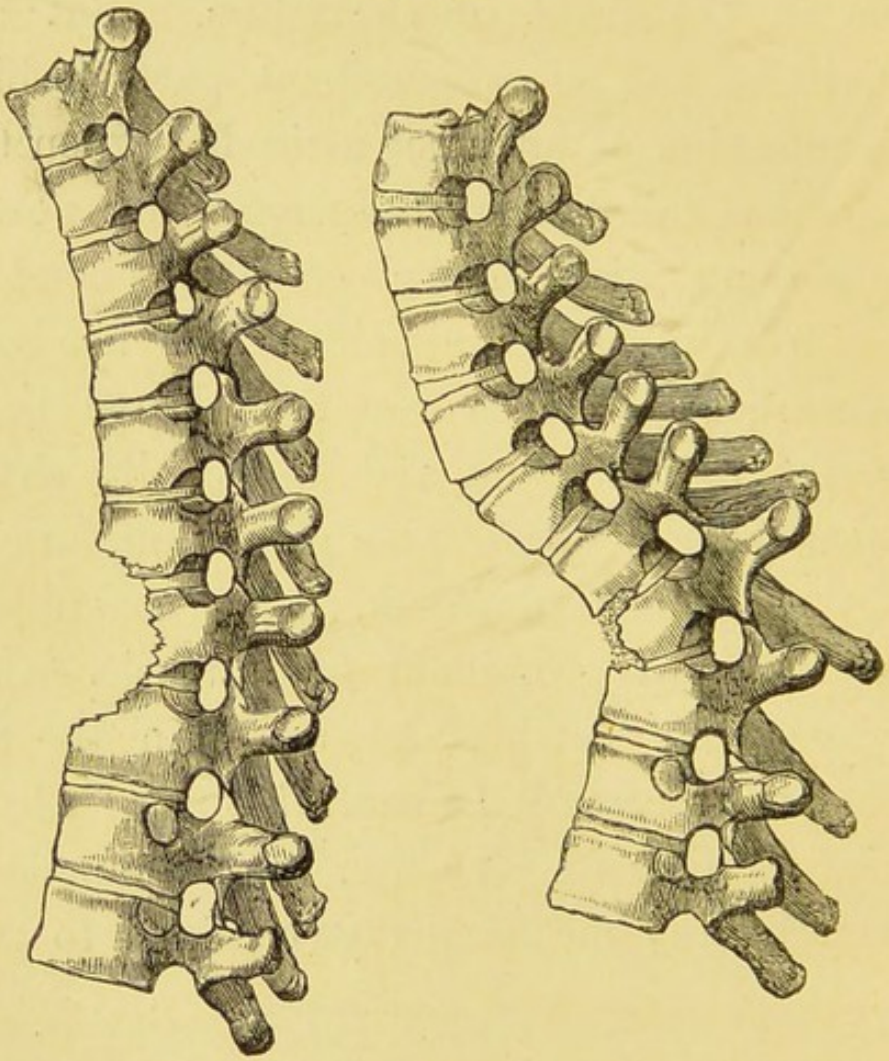

Diagram of Spinal Caries.

tion spreads towards the depth, in the latter towards the length of the column.

The annexed diagram (and it is to be

accepted merely as a diagram) shows how the spine, when vertebræ have been more or less eaten away, falls together in front and projects behind, and how the column above and below the point of disease assumes certain backward incurvations to compensate for the primary morbid bend

Whether this disease may commence in tubercle (supposing there be such a thing as tubercle of bone, which I very much doubt) or whether simply in a slow form of inflammation is unimportant; since the tubercle itself is harmless until it has called forth inflammatory conditions. Caries, a resultant of inflammation, is only produced by its aid, and therefore we must simply accept the fact that the malady, wherever and however primarily lit up, is of inflammatory origin. One fact, however, for us now the important point, is the persistence, the inveterate quality of the disease, which goes on always till a certain, often till a very great deformity, combined frequently with paralysis, is produced. Not unfrequently indeed, either from the exhaustion of continual discharge or from secondary

affection of the spinal cord, the patient succumbs and dies.

The obstinacy of this disease may be in part due to the strumous constitution of those subject to it, but chiefly, I believe, to the mechanical conditions of the spine itself. The bodies of the vertebræ support the whole weight of the head, trunk, and arms—each one the burden of all above its own level; and no circumstance is so well adapted as pressure to keep up and extend destructive processes. Besides mere weight, however, certain muscular conditions add to the compression of vertebræ —conditions which, harmless under normal circumstances, act especially on the front part of an inflamed or ulcerating vertebra, with great power. We saw at p. 43 of this work how the abdominal muscles draw down the ribs, diminish the cavity of the chest, and act as muscles of expiration. We saw too how the normal bend of the dorsal spine is due to this action of the abdominal respiratory muscles. It is easy to perceive that if any vertebral bodies be weakened by inflammation, traumatic or otherwise, these two sources of compression—

weight and muscular action—will have a great and injurious influence, more especially on the front part of the bodies—that part most liable to the more inveterate forms of spinal caries. Moreover I have in almost every case of spinal caries found the muscles of the abdomen hard and contracted, and believe that irritation, produced by the disease acting through the nerves, sets up an abnormal amount of contraction in these parts. In another work* I have shown that caries of a joint surface or inflammation of the articular bone end causes muscular contraction, resulting in abnormal pressure, which adds to and keeps up the disease. At the spine the same sequence of events takes place : the irritation set up by the caries produces irritation of nerve fibres—chiefly, it would seem, of the intercostal last dorsal, and others distributed to the anterior aspect of the trunk. I say it would seem, because the matter is one which cannot be revealed by anatomical examination. We cannot trace these minute disturbances of function in

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* 'A Treatise on Diseases of the Joints.'

autopsy. In the living body, on the contrary, we may and do find their effects in the rigid state of abdominal muscles, in the quiescent and fixed condition of ribs during respiration, &c. Now the effect of such contractions is to bend the spine forward, and thus to increase the pressure at the front of the vertebræ.

Another cause for the obstinacy of spinal caries is the movement of one bone on the other, which, though not very great between each two vertebræ, is nevertheless essential to the life and being of the column as long as no external restraining power prevents such action. Stooping, walking, sitting down, rising up from bed or from a chair, and a thousand other actions (see p. 16 and Fig. IV.) may be conceivable without or with but slight spinal movement if some outer power restrain and keep the bones fixed, but as long as such power is absent that movement must take place. If then, from some traumatic or constitutional cause, one or two of the vertebræ become diseased, motion of the sort described fosters and aggravates the malady, and

together with pressure, is probably the main cause of its persistence.

The natural, and indeed the only, cure of vertebral caries is by anchylosis, which means that new osseous matter thrown out by the adjacent healthy or somewhat irritated parts binds together and consolidates the whole number of diseased vertebræ into one compact mass of bone. This new matter is not of course formed from parts actually ulcerating; but by the neighbouring periosteum either over less inflamed parts of the carious bones or over neighbouring bones sufficiently near to be irritated by the disease, or from both such portions of membrane. Also it must be observed that the districts which, when inflamed, are destined not to ulcerate, but to produce fresh bone, must be in such position as to be subject only to little pressure; otherwise they might easily overstep the quantity of action necessary for a formative, and pass to that which leads to destructive processes, like the original malady. Such places are, during the continuance of the disease, generally at the sides of the vertebræ;

hence there results first in that part a series of arches and buttresses which unite the healthy bone below to the next sound one above, while any still healthy parts of an intermediate carious bone throw out struts and spandrils to join the newly-formed bridge.

As, however, to the production of this new osseous structure absence of strong pressure is necessary, so for its solidification and union with the older bones considerable immobility is essential ; for the material, which afterwards becomes bone, is, when first formed, not a hard substance, but a soft easily-compressible tissue, which moulds itself to the morbid shape of the column, twists or bends with each movement of vertebræ, and changes with the increasing angle of the spine, until it is hard enough to preclude motion and strong enough to prevent further collapse. This leads us naturally to perceive how the production of anchylosis should prove curative to the caries, viz. by the entire prevention of movement and of pressure. It also furnishes us with the necessary guide for treatment, if only

it could be successfully followed, viz. to imitate nature in preventing both these conditions.

We thus come to consider two principles of treatment which have at different times found favour. The one was directed to making the ulcer as small as possible, by allowing collapse of the vertebræ above and below; the other aimed at keeping those bones asunder. The former of these, enjoining rest, chiefly by means of recumbency, obviates that part of the pressure which is caused by superincumbent weight; but the other part, that by muscular action, is ignored. One sees such patients worn with long lying, bending up more and more, till at last those who get through the treatment rise from their beds with the deformity as fully developed as the circumstances would permit. What a weary matter it is too, this condemnation to a bed or couch for months and years; one not at all likely to promote that state of health which is needed for the cure of strumous ulcerations, as well as for the establishment of such sthenic actions as might promote anchylosis.

The other method, that which aims at minimizing the deformity by keeping the

bones apart, effects at the same time diminution of pressure, especially at the front edges of the vertebræ. For a great many, indeed for several hundred years mechanisms for stretching the spine have been alternately vaunted and discarded. Mr. Chessher, about sixty years ago, used to stretch his patients by means of a sort of rack, and fixed on the trunk, while thus elongated, a machine not unlike the spinal support of the present day. He failed to do much good; not, I believe, because the idea was faulty, but because all these mechanisms are nearly as futile for angular as they have been shown to be* for lateral curves. They do indeed succeed for a time in taking some of the weight from the spine, by upholding the shoulders; but the mechanism soon gives, and gets out of gear,—it cannot fit close enough on the pelvis, &c., to support any great amount of weight. Nevertheless, as some means to keep the spine from collapsing (the characteristic of this treatment) must be used, a great many modifications and changes have been introduced, which fail to do

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* See pp. 36, 112.

more than show the unsatisfactory nature of the whole expedient.* Thus, whether these affairs are applied on a spine during stretching, or only while it is in its morbid bend, they turn out equally unsatisfactory. We want something more potent and less irksome—something that will keep the spine all but motionless, in as straight a condition as possible, and that can be worn night and day, equally well whether the patient be moving about or lying asleep.

Having long entertained these views, and having frequently attempted, with only partial success, to construct something that would fulfil the object desired, I was much struck with the plan proposed and carried out by Dr. L. Sayre of New York. It appeared to me to have every element requisite for rational treatment, and to combine the necessary powers of giving rest, preventing pressure, allowing a sufficiency

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* One of these may be found depicted and recommended in Mr. Holmes's 'Principles and Practice of Surgery,' p. 455: it is a singular construction, since its only support to the spine, unless the usual crutch-handles be thus considered, is applied *below* the curve.

of exercise, and preventing distortion as far as possible. At the same time I felt some little doubt as to the difficulties in the way, some of which appeared to me hardly such as could, under ordinary circumstances, be overcome. In practice I have found that there are, in the first endeavours to follow out the method, very considerable difficulties, but that, by patience at first, by experience afterwards, they are quite to be conquered.

The idea itself is simple enough: merely to suspend the patient for a few minutes by the armpits and head, so that the weight of the lower limbs and buttocks shall straighten out to some considerable degree the bend in the spine; and to apply, while the column is thus stretched, a plaster of Paris bandage from below the ilia upwards beyond the upper limb of the curve—indeed generally to the axillæ. Thus, when the plaster is sufficiently dry, and the patient is let down on his feet again, the body cannot yield forwards, but the spine is upheld, not merely by a point here and there, but by the whole circumference of the trunk.

The difficulties are these :—1stly. To render suspension painless and innocuous. 2nd. Avoidance of injurious pressure on bony projections by the plaster. 3rd. To make due allowance for respiratory movements, and yet to apply the bandage sufficiently firmly to give all support.

The first of these caused me great embarrassment. Indeed, one patient, a full-grown youth, who came to me before I had had time to perfect my arrangements, suffered enough pressure on the axillary nerves to produce considerable numbness. Now, however, I find no difficulty, although I have been obliged to vary Dr. Sayre's method, which is to suspend from a single curved bar by braces, which run from the head and from the axillæ perpendicularly upwards. I use a cross of steel, each arm being eight inches long, with a hook at the end; from the hooks which lie at the right of the patient my suspenders pass to his left armpit and *vice versa*. Thus the pressure falls on the side of the chest about the first intercostal space, and hardly at all on the arm and axillary plexus. My head-

stalls, made of soft leather, consist of a semilunar piece, the broad part of which lies under the chin, while to each horn of the crescent a webbing strap is sewn. Also of a second smaller demilune to each of whose angles a brass ring about the circumference of a shilling is attached. In application the webbing straps of the one piece are passed through the rings of the other, previous to being buckled near the centre of the cross. It is necessary to have several of both these leather appliances, which can be tried in various commutations previous to suspension, so that such as fit best and are most comfortable, especially such as leave the ears uncovered, may be chosen and employed.

It is necessary, in order to keep the patient hanging as short a time as possible, to have at least two assistants—one to mix and manage the plaster; another to hold the patient's arms, and prevent his twisting; even a third may be found useful for any little requirement that may arise. I do not, like Dr. Sayre, apply the plaster band over a woven shirt, but first bandage the patient with flannel,

then roll a properly prepared plaster band round and round until sufficient thickness has been obtained. In cases of large heavy persons, strength with little additional weight may be secured by strips of tin placed perpendicularly on each side of the spine, and at intervals about the body, between layers of the plaster band.

A few precautionary measures are valuable : the bandage must not cease at or nearly at a level with the crista ilii, but must extend well below that place ; otherwise the skin will be cut and chafed between that prominence and the edge of the plaster. A pad should be placed over each anterior spine of the ilium, and is to be withdrawn when the plaster has not quite set, thus preventing pressure on those parts. I also place a napkin, folded into a rather narrow shape, four or six times according to its thickness, over the middle line of the abdomen, and withdraw it simultaneously with the other pads, leaving room for respiratory movement ; nor do I find that this interferes with the efficacy of the appliance. I do not think this method well applicable to patients with lung

affections; the form of bronchitis, which so frequently accompanies rickets, for instance, offers an obstacle, and if the bandage be in such case used at all, a rather thicker pad should be placed over the abdomen.

Very young children eat, in proportion to their size, a larger bulk than adults, and the bodies of such patients, more especially if they be strumous, increase considerably after food; hence the same precaution must be taken.

Two or three times I have employed this treatment for young women whose mammæ were well—in one case largely—developed. The difficulty thus produced must be met by placing a sufficiently large pad between the glands, and another much smaller on their outer side; afterwards a window must be cut in the position of each nipple.

If two or three vertebræ project so as to make a sharp prominence, lying as they often do near the skin, they must be carefully protected. I prefer to do this by placing over and for some distance around the angle a sufficiently thick smooth layer of wadding. Then, when the plaster is nearly dry, cutting

a fenestrum down to the wadding, dividing this in a number of radii from its centre, and turning the whole thickness over the plaster; thus pressure is obviated, and the edge of the opening protected.

If an abscess exist in any part to be covered by the bandage, it must be emptied—this is best done antiseptically, and the opening must be large enough to enable the flocculi to escape,* and to ensure perfect outflow of all the contents. Over the opening a large piece of antiseptic protective is to be applied, over this a pad of antiseptic gauze and dressing.

Before putting on the flannel bandage a large surveyor's pin is placed over the pad in the situation of the wound; and while bandaging both with the flannel and with the plaster care must be taken not only that the pin retains its place, but also that the point perforates each fold. When all is complete this pin will form a guide to the spot where

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* The aspirator is not adapted for the evacuation of these abscesses, since the flocculi block even the largest needles.

an opening is to be made. After cutting this opening, the surgeon, having removed the gauze, &c. (which should be done under the carbolic sway), comes upon the protective, and divides it from the centre to the circumference of the hole in a radiating manner, and turns each point of the star over the plaster, and fixes it with some varnish; this ensures the bandage against fouling with discharge; but it is well to varnish also a circumference around the opening.

Having now obtained a sufficiently detailed insight of what is to be done, and of the little precautions to be taken, we may advantageously go through the process succinctly. The patient comes with a plainly marked angular curve of some considerable duration; the lungs being sufficiently sound, it is determined to use the plaster of Paris bandage; the height of the figure is carefully measured; head-stalls are chosen; arm-slings, &c., found to fit; and the assistants are summoned. But it is desirable to know if anchylosis have not already taken place sufficiently to ensure the peccant vertebra against pressure, &c.

Let a piece of lead wire about $\frac{1}{4}$ inch diameter be laid upon the spine and moulded to its form, then pull the patient up, reapply the shaped wire to the spine; if there be no change of the bend, cure is already pretty far advanced; if there be change, the surgeon may go on with his work. He will bandage the trunk in the manner and with the precautions above described. Also, I may say, I have found it advantageous, when the plaster is about half fixed, to run my finger on the smooth handle of a paper-knife between the skin and the lower edge of the bandage, making it pout a little and mitigating its sharpness. When the whole is nearly dry, its further progress to complete hardness takes some little time; the patient, therefore, is let down horizontally into the arms of an assistant, if he be a child, or if of older growth, into a small blanket held by two persons, who manipulate it so that the lower part of the figure is lifted, while the upper portions recline, and that no perpendicular posture be allowed. Then the patient is laid by on a couch or bed till the plaster has completely set, when the

height may be again measured and the increase noted. In the meantime the surgeon traces the outline from the wire on a piece of paper, which he dates, and puts by till the time may come for removing the plaster just applied, and applying another bandage; he then takes another outline for comparison.

When this time may come depends in part on the skill and care with which the bandage has been applied, in part on the irritability or docility of the patient, in part on the quality of the plaster. It is, of course, desirable that such a mould, which must take some little time and trouble to apply, should not require very frequent renewal. I find that an average of time lies between six and fourteen weeks; although not unfrequently the first application must be changed somewhat sooner; because some latent cause of irritability or of weakness becomes manifest. It must also be pointed out that, if some of the irritation and smarting arise which indicate abrasion, it is useless to wait; unless the spot be at the edge, quite within reach of some protective pad, it is

better to take the whole thing off at once, and reapply it with the proper precautions.

The time within which a cure may be established varies very much with the extent of disease, and its duration previous to the application ; nor am I in a position to give of my own experience any very accurate data, because only five months have elapsed since the method became known to me. Dr. Sayre's experience appears to show that cure with a much straighter and less deformed spine than under other circumstances is usual between six months and a year. One of my cases got well in three and a half months, and was an inch and a half taller after I had done with him than before. Another, a girl aged thirteen, had since infancy been the subject of a long angular curve. In February 1877 very severe pain in the back and considerable loss of health threatened renewal of disease. On suspending her a certain straightening of the angle was verified. The plaster was applied, and she was very much more comfortable. At the end of March it was removed, and a new one adapted. Pain entirely ceased, and

she was able to run about very well. In the middle of May she was in excellent health, and very comfortable. I expect shortly to remove the bandage altogether. Another patient, with extensive caries and large psoas abscess, is progressing admirably, although on account of an intercurrent febrile disease I had for a time to suspend the treatment. It is worthy of remark that when the bandage was discontinued discharge from the abscess increased, and diminished rapidly on re-application.

I must refrain from giving any succinct history of cases, since the treatment has only been carried on under my direct observation for about five months. I will only say that the experience of that period confirms the very favourable report on it by the American Medical Association and the expressions of Dr. Sayre himself.

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