Curvatures of the spine / by E. Noble Smith.

E.N. Smith

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1883

Edwin Clarke.

With the Author's Compts.

CURVATURES OF THE SPINE

BY

E. NOBLE SMITH, F.R.C.S. Ed., L.R.C.P. Lond.

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AUTHOR (JOINTLY WITH DR. KLEIN) OF 'THE ATLAS OF HISTOLOGY';
AUTHOR OF 'THE DESCRIPTIVE ATLAS OF ANATOMY'
AND OF 'THE SURGERY OF DEFORMITIES'

WITH ILLUSTRATIONS

LONDON
HENRY RENSHAW, 356 STRAND
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PREFACE.

In the following pages I have endeavoured to describe in a practical manner the nature, symptoms, and treatment of Curvatures of the Spine. The great prevalence of these deformities; the suffering which they entail upon the affected individuals; the small degree of attention which is paid to them in works upon general surgery; and the fact that a great deal of good can be done for them by treatment, have induced me to publish this pamphlet.

The success which has attended the publication of my work, 'The Surgery of Deformities,' leads me to hope for an equally favourable reception of the essay which I now offer to the profession.

E. Noble Smith.

24 Queen Anne Street,
Cavendish Square,
London, W.

CONTENTS.

PAGE

THE SPINE 3
Movements 5
The Undeveloped Spine 6

EXCURVATION (POSTERIOR CURVATURE OF THE SPINE) 6
Effects of Excurvation upon Respiration 7

INCURVATION OF THE SPINE 9

LATERAL CURVATURE OF THE SPINE 11
Morbid Changes in the Cartilages and Bones 15
Theories upon the Origin of Lateral Curvature 21
Causes of Lateral Curvature 23
Some Bad Habits of Position 29
Some of the more frequent Functional Derangements caused by Lateral Curvature 32

TREATMENT 32
Local Stimulants 33
Rest 33
Mechanical Extension and Pressure 34
Muscular Exercises 37
Mechanical Support and Pressure 40

TREATMENT WITHOUT INSTRUMENTS 44

CASES 44

CURVATURES OF THE SPINE.

THE evils which result from lateral curvature of the spine may be summed up under two heads—*firstly*, the deformed appearance which is produced, and *secondly*, the influence of the affection upon the general health of the patient. The first of these evils I do not propose to discuss, except to suggest that for the sake of appearance alone, the prevention, cure, or arrest of the deformity, as the case may be, is of sufficient importance to demand the attention of the surgeon.

To *prevent*, the surgeon but seldom has the opportunity ; to *cure* is not always in his power ; but the arrest of increase of the deformity he ought always to be able to accomplish.

The number of persons who are afflicted with curvatures of the spine is very great—a fact which may be observed in any large assembly of people—and it may be safely affirmed that every one of these sufferers might have been saved from deformity if judicious treatment had been adopted at a sufficiently early period of the development of their distortion.

The influence of lateral curvature of the spine upon the general health of the individual is very considerable, but not greater than ought to be expected as a consequence of pressure upon the thoracic and abdominal viscera and of pressure upon the nerves and vessels which pass to and from these parts.

In the early stages of the deformity, especially in the very young, little or no effects upon the general health may be noticeable, and pain may be entirely absent. It is in the early stages that this affection is often considered trivial and insignificant, and not worth the attention of the medical attendant. A slight prominence of one shoulder is frequently thought to be of no consequence and the case is left to take its chance.

What is the result ?

Very rarely such cases recover without treatment, or probably as the result of the accidental abandonment of some bad habit of position ;

sometimes the curvature ceases to increase without any special treatment, and the child grows up with a slight deformity ; but *too often* the affection continues to increase until an incurable degree of deformity is produced and the general health is materially affected.

Local pain and functional disorders occur sooner or later in the progress of this deformity if it is allowed to increase, and frequently they commence in the early stages.

The alteration in the shape of the thorax and the pressure upon its contents may cause palpitation of the heart and difficulty of respiration ; and derangements of the liver, stomach, and bowels. I have also known severe neuralgia, numbness and coldness of the legs, and other symptoms result from the deformity.

I have always been reluctant to attribute such symptoms to the spinal curvature, considering that possibly the general state of ill-health might be the cause both of the deflection of the spine and of the symptoms of functional disorder ; but in so many cases have I found the latter evils succumb to well-regulated mechanical treatment that I now have no hesitation in asserting that progressive lateral curvature of the spine always, sooner or later, gives rise to the disorders that I have mentioned, and causes considerable deterioration of the general health of the patient.

I have just referred to mechanical treatment, but I will take this opportunity of urging the importance of treating lateral curvature, when possible, *without mechanical appliances.* In the early stages of the affection the avoidance of bad habits of position, carefully regulated muscular exercise, and attention to the general health will generally effect a cure, and hence every case should be dealt with as soon as possible.

When an instrument is absolutely necessary, then the surgeon ought to direct his attention to supplying one that is as light as can be made consistently with a due degree of strength, and one which *does not interfere with muscular exertion.* Moreover the plan of construction and the adaptation of so important an apparatus ought not to be left entirely to the instrument-maker. A knowledge of anatomy, of physiology, in fact the whole special knowledge of a medical man, is requisite to fully understand the nature of the deformity, and to properly determine the places where and manner in which any pressure or support is necessary or justifiable. Mechanical and medical knowledge are both required for the purpose, and so, while the mere mechanic is not qualified to deal with these cases, the surgeon who purposes to treat lateral curvature of the spine should possess or acquire a good knowledge of mechanical principles.

In the above few introductory remarks I have referred to lateral

curvature only, but in the following pages I discuss the nature and treatment of some analogous kinds of spinal deformity—namely, excurvation or posterior curvature, and incurvation, or anterior curvature of the spine, but concerning these affections I have not thought it necessary to make any special preliminary observations. Another form of curvature of the spine—namely, that produced by disease of the vertebræ (caries)—is not discussed in this paper, for I have elsewhere [1] described the nature of this affection and recorded the results of my experience regarding the treatment.

The Spine.

The spinal column is admirably adapted for fulfilling the combined purposes of protecting the spinal cord and of affording a basis of support for the whole trunk. It is a strong yet flexible column, which can be moved in any direction by the muscles which are attached to it, or fixed by these muscles in such a manner that support is given to the rest of the body in a great variety of positions.

Viewed from the side, the spine is so shaped that it forms an anterior curve in the neck and loins, and a posterior curve in the back.

These curves vary slightly in degree in different individuals. They are due partly to the shape of the bodies of the vertebræ, and partly to the shape of the intervertebral substances.

The curves of the spine weaken it as a supporting structure (although Rollin and Majendie have asserted the contrary), but enable it to sustain a greater amount of violence without injury than if it were perfectly straight.

This advantage, derived from the curves, is exemplified when an individual leaps from a great height. The shock upon alighting is disseminated through the column by an increase of the curves as well as by the elasticity of the intervertebral discs.

A slight dorsal lateral curve to the right has been described as a normal condition of the spine. Quain and Sharpey, Bichat, Béclard, Otto Bühring, and others offer various explanations of this condition, the majority considering it the effect of muscular action; but Little, Adams, and other modern observers, after careful inquiry, have satisfied themselves that there are no obvious *natural* lateral curves in healthy persons.

The intervertebral discs together form about a fourth part [2] of the length of the spinal column; but they are thicker in the cervical and lumbar region than in the dorsal, such arrangement being in con-

[1] *The Surgery of Deformities.* Smith, Elder, and Co., 1882. *British Medical Journal*, June 1880; May 13, 1882; October 28, 1882.

[2] W. and E. Weber state one-fifth.

formity with the greater freedom of motion which exists in the neck and loins than in the back.

In the neck and loins the discs are thicker in front than behind, and are thus the chief factors in the curves which belong to these regions; but in the dorsal part of the spine the surfaces of the discs are nearly parallel, and the dorsal curve is formed chiefly by the shape of the bodies of the vertebræ.

FIG. 1.

Natural Curves of the Spine.

The intervertebral fibro-cartilages are very elastic, but do not possess the power to resume their full thickness after compression, while the body remains erect. They collectively lose by compression about three-quarters of an inch in the course of one day, and a recumbent position of from six to eight hours is necessary to allow them to regain their complete extension.

This peculiarity of the intervertebral discs is, as Bauer remarks, 'no doubt operative in the establishment of distortion of the spine.'

It is not considered necessary in this work to describe the ligaments which unite the vertebræ to one another; but it may be well to remind the reader of the elastic nature of the ligamenta subflava, which unite together the laminæ, and which, after flexion of the spine, tend to restore the column to its former position, a much smaller expenditure of muscular force being required for this purpose than would be necessary without their assistance. These ligaments act, therefore, like the ligamentum nuchæ of the herbivorous and carnivorous animals.

The spinal column can be moved anteriorly, posteriorly, or laterally; or these movements may be combined in circumduction. The whole spine can also be rotated upon its own axis.

In *rotation* the front of the cervical vertebræ may turn to one or other side. This effect is produced by each vertebra twisting very slightly upon the one below it. The movement must always involve many, if not all, the vertebræ.

The muscles of the spine are brought into action for a great variety of purposes. Besides the varied movements of the column itself, many movements, ordinarily supposed to belong entirely to the extremities, take a direct basis of action from the spine; and in order to use muscles which have no direct

communication with the spine, others which are attached to this column must often be in the first place 'fixed.'

The muscles of the back are very extensive and varied in their arrangement, so that all the movements which have been described above can be carried out by them. In fact, the muscles, if sufficiently exercised, are capable of performing a greater degree of movement than the ligaments of the spine will ordinarily permit.

Acrobats, whose ligaments have been freely stretched, are able to control by muscular action any position to which their vertebral column will extend. These performances denote great strength with much laxity of ligaments, and go far to prove that the strength of the back, and the power to maintain it in an upright position, depends more upon a healthy condition of the muscles than upon the strength of the ligamentous structures ; and we may consider that the characteristic erect position of the human body is maintained by the muscles which surround the spine.

Movements.

The free movements of acrobats just referred to, although partly dependent upon flexibility of the spine itself, are in a great measure effected by the movements at the hip-joints and of the head upon the neck. Horizontal rotation movement and lateral flexion of the column are limited by the oblique articular processes as described by Mr. Bishop.[1]

Mr. Adams, in urging that the spine is much less flexible than is commonly supposed, remarks that 'the graceful lateral postures of 'female dancers and gymnastic exhibitors, which have been attributed to the flexibility of the spinal column, are mainly due to the ball-and-socket articulations of the hip-joints and of the head.' While assenting to the correctness of this statement in general, I may say that in the case of those acrobats who can bend their bodies until the head is placed between the feet, the movements of the spine are very materially increased.

A few months ago some English lads were rescued from an Arab who had bought them when children from their parents and had kept them in bondage for many years, training them to perform a variety of acrobatic feats. Freedom of movement in the back seems to have been the most important part of this training, and each of these lads bore evidence of the great pain in the back which they suffered in consequence of the forced positions in which they were fixed by means of straps frequently and for long periods. The straps were tightened day by day, and one of the lads of the 'troupe' seems to have died from this treatment. It was thought that his back was

[1] *On Deformities of the Human Body.* 1852.

broken. I carefully examined these lads while they performed the feat already referred to, and I satisfied myself that, although the hip-joints contributed materially towards the movement, yet that the spine itself was bent to an extraordinary extent, and this bending took place almost entirely in the lumbar region.

Mr. Adams has stated his opinion that the erect position of the spine is not maintained by *active tension* of the muscles, but that it would be more correct to describe them (the muscles) 'as in a state of *vigilant repose*, ready on the instant to check and limit the flexion of the spine when its balance is disturbed.' Notwithstanding Mr. Adams's usual accuracy of research, I venture to offer the following reasons for differing from this view :—

The lax condition of the spinal and other joints of the body in a dead person, or in one temporarily insensible, renders it impossible to keep the spine of such a person in an upright position, even when the individual is seated in a chair. This condition of the body is the result of inaction of the muscles, and therefore, when an individual holds his spine erect, some muscular exertion is always exercised.

The Undeveloped Spine.

The foregoing description refers chiefly to the fully-developed spine—the spine of the adult. As we meet with disease and distortion chiefly at an early period of life, before the spine is fully developed, it is desirable to consider the condition of the column during its period of growth. At birth each vertebra consists of three bones, united by cartilage. The osseous laminæ unite behind during the first year, and the body is joined to the arch about the third year. The centres of ossification for the transverse and spinous processes do not appear until the sixteenth year ; and those which form the thin plates at the upper and under surfaces of each body not until the twenty-first. All these parts are not thoroughly joined together, and the bone completely formed, until about the thirtieth year.

During this period of growth the spine is more susceptible to injury and deformity than after it is fully formed, the various portions of bone being even liable to complete separation one from another as a consequence of injury. The spine is more flexible, and the normal curves are only partially developed ; in fact, in the infant there are no physiological curves.

Excurvation[1] (Posterior Curvature of the Spine).

This deformity may occur at any age ; it is common in infancy, and generally occurs to some extent in old age ; and in the latter

[1] Bampfield, in making use of the word 'excurvation,' remarked that it is not a genuine English word, but he trusted that its use would be excused as being very expressive in contradistinction to 'incurvation.'

instances it is often considered a natural result of senility. In infants the whole body may seem to be affected by debility, and the child, when placed 'sitting up,' is unable to maintain the position. If the case is not quite so severe, and the child can remain 'sitting up,' there is a general backward *bow* of the spine, and the spinous processes of a few or many vertebræ will project, causing the skin to be stretched over them. This curve can, in the early stages, be removed by an alteration in position; but, in the course of time, the anterior portions of the vertebræ and intervertebral fibro-cartilages are retarded in their development, or become absorbed, because they are subjected to a greater amount of pressure than the other part of the vertebræ, and so the curve becomes more or less perpetuated. The bones and cartilages are thus converted into wedge-like forms, and, as the curve increases, so does its tendency to get worse increase.

The dorsal muscles become elongated; the positions of the abdominal and intercostal muscles and the diaphragm are altered, so that the functions of the thoracic and the abdominal organs, but especially of the former, become deranged;[1] the power of inspiration is lessened, and the action of the heart is impeded.

Effects of Excurvation upon Respiration.

In consequence of the bending forwards of the body the abdominal muscles are relaxed by approximation of their origins and insertions, and their power of action is consequently lessened or entirely lost. This fact was pointed out by Bampfield, who remarked that under such circumstances the 'abdominal muscles do not act as effectual antagonists to the diaphragm in respiration, and they do not perform those offices assigned to them of pressing upon the abdominal viscera and assisting in the various functions of those parts. . . . In inspiration the cavity of the chest cannot be dilated to its normal capacity in its lateral or perpendicular diameters, because the shortened intercostals cannot elevate the costæ to their usual extent, and the fibres of the diaphragm, shortened laterally, cannot depress the abdominal viscera as low as usual, and from the forward inclination of the body, the abdominal muscles, in expiration, cannot so completely contract the thorax and press the viscera so forcibly against the diaphragm as they could do if they continued of their ordinary length. Hence it is that respiration is so often short, irregular, or even laborious, and the second order of muscles subordinate to this function are called into action.'

These effects occur chiefly in caries of the vertebræ, when the bending forwards of the trunk is more permanent than in excurvation,

[1] See Bampfield, *Essay*, Lond., 1824, and Brodie *On the Joints*, p. 285.

but still they are very prominent in many cases of the deformity now under consideration.

At the commencement of this deformity there is usually some pain in the back, and a general sense of weakness in the dorsal muscles, especially after exercise, if exercise can be taken.

In children the period of walking is deferred; or, if the child has commenced to walk, it loses its activity, stumbles and falls about, and is soon tired.

The general health becomes impaired.

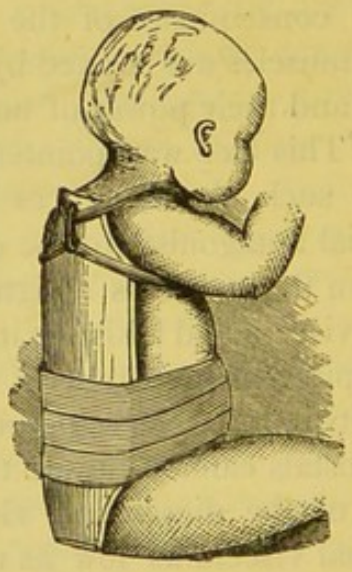
Causes: in infants.—This deformity is caused by general debility affecting the dorsal muscles.

In *youths* and *adults*, also, it may be the result of weakness, or of long continuance in the stooping position, independently of weakness; or it is said to be sometimes a natural conformation of the body.

The *treatment* in infants should consist in the application of a splint moulded to the back, made of leather or gutta-percha, lined with some soft material, and attached to the body by a broad abdominal belt and armlets, as shown in the figures.

FIG. 2.

FIG. 3.



The general health will also require attention. The splint is to be used until the child has become stronger.

In youth, treatment by drilling and various gymnastic exercises, and cold bathing, and active games usually suffices to cure the deformity. The use of the skipping-rope is very good, the right and left foot being alternately put forward, but in some cases (especially in girls) it is necessary to adopt a mechanical apparatus. The simplest apparatus consists of shoulder-straps attached to a stiff

central pad, which projects over the scapulæ, and extends down to a belt, or a well-padded backboard with arm-straps and belt, or a slight steel upright attached to a pelvic band, and having an abdominal belt with arm-straps ; but *spinal instruments, with crutches, should never be used.*

For recumbency the prone position is better than the supine (see p. 34).

Stafford, from having observed that in a military band the drummer was the most upright man, advised the use of a weight suspended from the shoulders to the abdomen. The muscles of the back are thereby exercised, and induced to keep the body upright, in order to counterbalance the anterior weight ; but in the majority of cases of excurvation, such treatment would be likely to cause the spine to give way laterally, in consequence of weakness of the muscles.

Andrey [1] proposed the carrying of weights by the patient upon the head. To balance the weight and prevent its falling off the muscles of the trunk have to be employed, and the spine must be held erect; but as in these cases the patient is often unable to use the dorsal muscles for long periods, this plan is inapplicable.

Well-regulated gymnastic exercises are very beneficial, but should never be prolonged sufficiently to cause fatigue.

Local stimulant embrocations, cold-water bathing, and a generally tonic plan of treatment, should also be adopted.

For further remarks upon the mode of exercising the spine, see under ' Treatment of Lateral Curvature.'

Incurvation of the Spine.

Synonyms.—Latin, *Lordosis* ; French, *Lordose* ; German, *Lordosis.*

The spine is curved forwards in this affection. It most commonly affects the lumbar region by an increase of the natural curve ; but it may occur in the dorsal, and even in the cervical region.[2]

It may occur—1. In *rickets*, from depression of the pelvis, the increase of the lumbar curve being produced in order to maintain the equilibrium of the body.

2. As an effect of congenital dislocation of the hips.

3. As a compensatory curve in caries of the vertebræ.

4. From paralysis of the abdominal muscles, or of some of the spinal muscles (Duchenne).

5. From ankylosis of the hip, the thigh being flexed.

6. From contraction of the psoas muscles.

[1] Paris, 1741. [2] See specimens in St. Thomas's Hosp. Museum, E. 20 and E. 22.

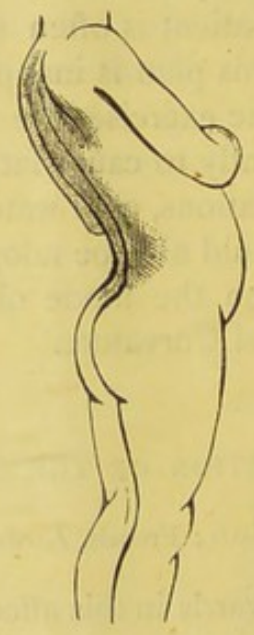
Contraction of the psoas muscles may arise from—

1. Spasmodic action.
2. Long-continued repose in the contracted position.
3. Inflammatory changes in and around the muscles.

The causes of muscular contraction have been discussed in Chapter I. of my work on 'The Surgery of Deformities,' and I have not considered it desirable to trouble the reader with their consideration in this small work.

As an example of the first variety may be mentioned the contraction which takes place in hip-joint disease. An example of the second is seen in cases of long illness from some painful affection of the abdominal organs, in which the patient has remained for a long time in the recumbent position, with the thighs flexed upon the abdomen ; and the third is sometimes seen as a result of psoas abscess.

FIG. 4.



Incurvation from Paralysis of the Abdominal Muscles.

Cases are sometimes met with in which the remote cause is not apparent, and in which contraction of the muscle or muscles is the only obvious condition.

Incurvation occurring in the dorsal region is referred to by Mr. Adams as a symptom sometimes of rotation of the vertebræ. As a compensating curve in caries, incurvation may occur in any region of the spine.

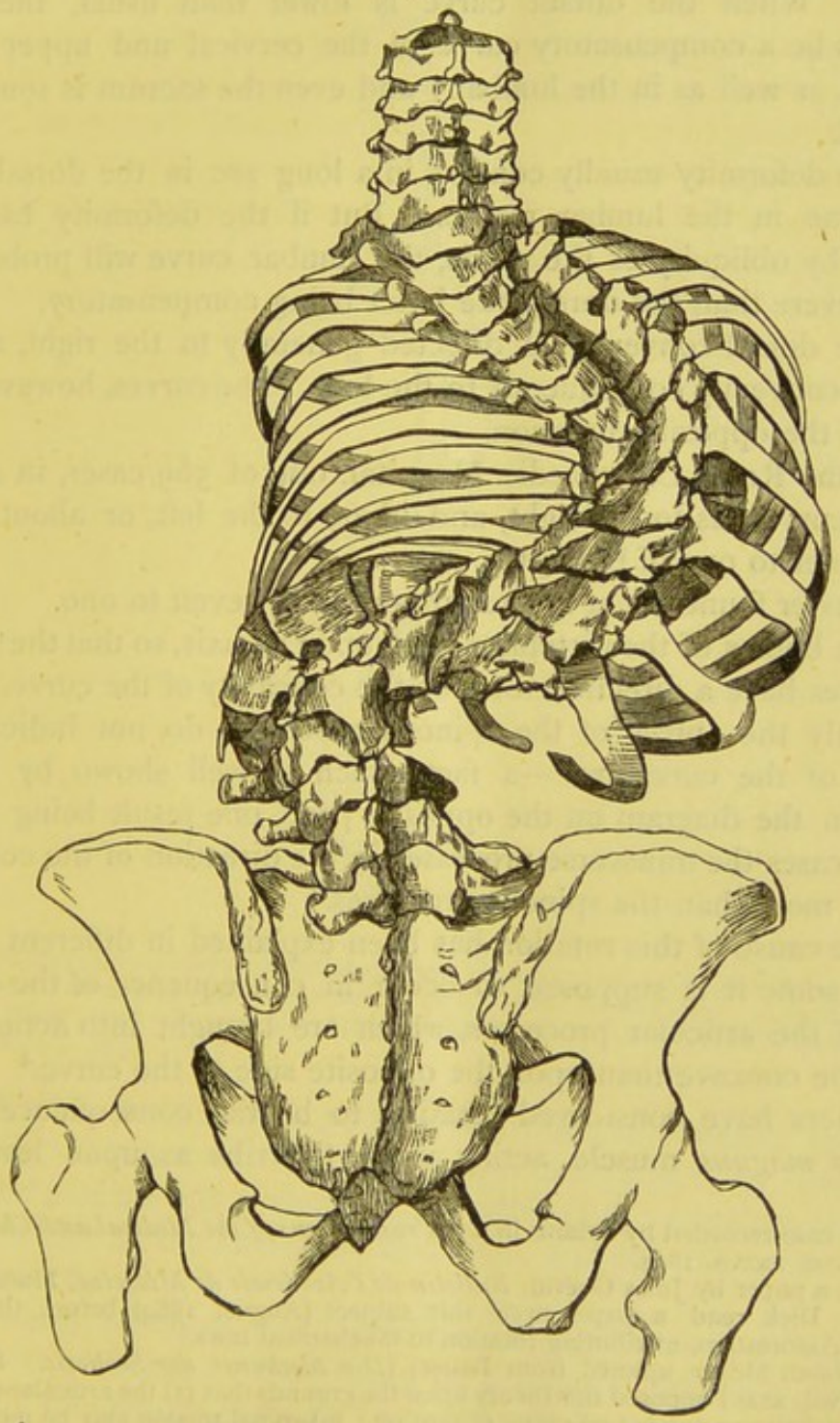
Treatment.—The treatment will depend upon the cause ; but an apparatus will generally be required consisting of the splint (fig. 17) for lateral curvature, with prolongations reaching to the thighs, and rack joints to produce extension.

Lateral Curvature of the Spine.

Synonyms.—Lat. *Scoliosis*; French, *Scoliose*; German, *Skoliosis*, or *Rückgratsverbegung*; Italian, *Scoliosi*; Spanish, *Escoliosis*.

Description.—This deformity consists in a lateral deviation of a portion or the whole of the vertebral column and rotation of the deflected vertebræ upon their vertical axes, so that their bodies turn in

Fig. 5.



Skeleton of a severe case of Lateral Curvature. The rotation is well shown. (Copied from M. Bouvier's atlas, 'Déviations de la Colonne Vertébrale. Leçons Cliniques sur les Maladies Chroniques de l'Appareil Locomoteur.')

the direction of the convexity of the curve, and their spinous processes in the direction of the concavity.

The exact position and degree of the curvatures vary in different cases. There are usually two curves, and as one is compensatory to the other, it naturally forms in an opposite direction, producing a sigmoid appearance of the vertebral column, as shown in the figure.

There may be but one curve, or there may be more than two curves. When the dorsal curve is lower than usual, there will perhaps be a compensatory curve in the cervical and upper dorsal regions, as well as in the lumbar ; and even the sacrum is sometimes affected.

The deformity usually consists in a long arc in the dorsal and a short one in the lumbar region. But if the deformity has been caused by obliquity of the pelvis, the lumbar curve will probably be more severe than the dorsal, the latter being compensatory.

The dorsal convexity is directed generally to the right, and the lumbar convexity consequently to the left. The curves, however, may form in the opposite direction.

At the Royal Orthopædic Hospital, out of 569 cases, in 470 the dorsal curve was to the right, and in 99 to the left, or about five of the former to one of the latter.

Bouvier found them in the proportion of seven to one.

The bodies of the vertebræ rotate upon an axis, so that the spinous processes have a direction towards the concavity of the curve. Consequently the apices of the spinous processes do not indicate the extent of the curvature [1]—a fact which is well shown by Mr. A. Shaw in the diagram on the opposite page, one result being that in severe cases the transverse processes in the direction of the convexity project more than the spinous processes.[2]

The cause of this rotation has been explained in different ways.[3]

By some it is supposed to occur in consequence of the oblique form of the articular processes, which are brought into action more upon the concave than upon the opposite side of the curve.[4]

Others have considered rotation to be the consequence of the *serratus magnus* muscle acting upon the ribs as upon levers, the

[1] See case recorded by Adams in the *Transactions of the Medical and Chirurgical Society*, vol. xxxvii. 1854.

[2] See a paper by Jules Guérin, *Bulletin de l'Académie de Médecine*, March 1879.

[3] Dr. Dick read a paper upon this subject (August 1864) before the British Medical Association, attributing rotation to mechanical laws.

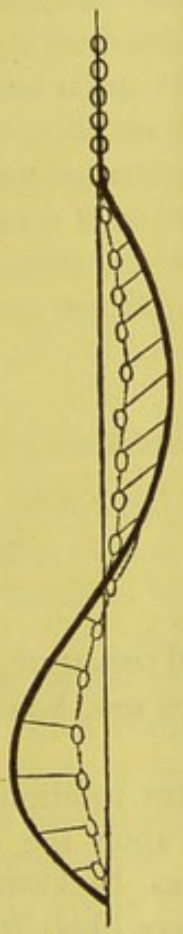
[4] Herman Meyer (quoted from Bauer) (*Die Mechanik der Scoliosis. Virchow's Archiv*, vol. xxxv) opposed this theory upon the grounds that (1) the articular processes have no definite or prescribed range of motion ; (2) spinal torsion may be met with in all parts of the vertebral column, although the oblique processes differ in shape and position ; (3) torsion prevails at an age when the oblique processes are not fully developed.

fulcrum of each rib being the transverse process of the corresponding vertebra.

The latter hypothesis might be disproved in many ways; but one objection will suffice—viz., rotation occurs as completely in the lumbar, where there are no ribs and no serratus magnus muscle, as it does in the dorsal region.

Another theory is one which was first advanced by Mr. Rogers-Harrison (1842), and lately revived and elaborated by Dr. Judson,

FIG. 6.



The bold outer curved line is intended to show the course of the bodies of the vertebræ; the faint dotted one that of the apices of the spinous processes (Copied from Mr. Shaw's paper upon 'Lateral Curvature of the Spine' in Mr. Holmes's 'System of Surgery,' vol. v. p. 859.)

of New York. It is based upon the fact that the posterior portion of the spine is a part of the parietes, and is thus more or less confined to the median line; whereas the bodies of the vertebræ project into the cavities of the chest and abdomen, and are free to move to the right or left.

Dr. Judson, to whom much credit is due for his clear exposition of this subject, illustrates the theory by placing a brass rod, having only lateral movement, through the canal of a spinal column, and attaching the spinous processes by elastic cords to a framework, as shown in fig. 7.

'To produce lateral curvature of the column, with rotation of the vertebræ, the knob at the summit of the rod is to be depressed. Double curvature, with rotation in each curve, may be produced by confining one of the dorsal vertebræ with the silk check loops, and depressing the knob.'

The supposed absence of rotation in lateral curvature, the result of pulmonary and pleural disease, Dr. Judson accounts for by the fact that the parietes on the concave side collapse, and the muscles and aponeuroses attached to the spinous processes upon that side consequently become relaxed.

FIG. 7.

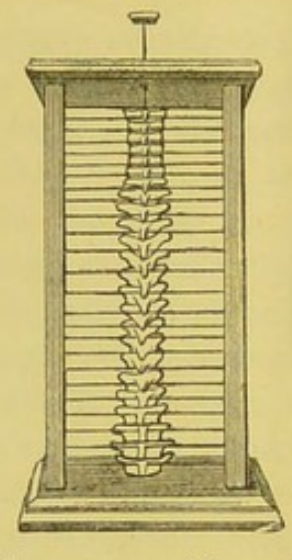
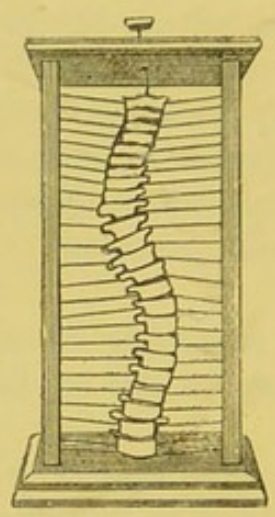


FIG. 8.



In the few cases of lateral curvature, the effect of thoracic disease, which I have examined, there was, however, distinct rotation of the vertebræ.

Mr. W. Hayward attributes rotation to the unopposed action of the erectores spinæ muscles, upon the convex side, pulling the ribs and the transverse processes backwards; but even if we could believe that such an effect were likely to be produced in the dorsal region, it could not occur in the lower lumbar region.

The theory of Mr. Rogers-Harrison and Dr. Judson appears to me the most reasonable one.

Rotation produces a curved rounded swelling upon the convex side, and the transverse processes may project to such an extent that they may be mistaken for the spinous processes, which are proportionately depressed.

In severe cases the rotation of the vertebræ in the dorsal region causes the ribs to protrude outwards and backwards to a very great extent; and a defined angle may be produced rather than a curve, an appearance which has been mistaken for an abscess or a morbid growth. In the lumbar region, the projection of the transverse processes has given rise to the same mistake. Mr. A. Shaw refers to

such mistakes having been made; Mr. Adams also records this error in diagnosis in the case of Dr. Gideon Mantell, given below; and I have met with a case in which an operation had been proposed for the removal of a supposed tumour, the tumour in this case consisting in the projection of the ribs.

One effect of rotation is the obliteration of the natural curves of the spine.

In lateral curvature the height is lessened, unless the growth of a child outruns the progress of the deformity.

The thickness of the lumbar muscles, and the forward arch of this portion of the column, render the lumbar curve less distinguishable than the dorsal; but a fulness upon the convex, and a depression, often a fold, upon the concave side may generally be recognised.

The lumbar vertebræ may be curved close to the brim of the pelvis, so that the 'waist,' if so it may be called, is raised on one side to a level with the ninth or eighth rib, while upon the other side it is represented by a deep hollow, causing an appearance of unnatural projection of the pelvis.

Morbid Changes in the Cartilages and Bones.

In consequence of the prolonged excessive pressure upon one side of the vertebræ, the bodies of the vertebræ, and also the intervertebral cartilages, become lessened by absorption and compression upon the side of the concavity. A wedge-shaped form is thus given both to the cartilages and the bodies of the vertebræ.[1]

The articular processes, which readily give way to pressure in a young subject, are also altered in form. The articular surfaces, which in the lumbar region are naturally vertical, become oblique from pressure. Mr. Alexander Shaw has described the process of this alteration in the following words :—

'If we attend to the natural structure of the spine it will be seen that whilst we lean the body to one side, the pressure is thrown almost exclusively upon the articulating processes of that side; these processes, delicate as they are, being the only bony structures which check the lateral movements of the trunk.

'Hence, when a habit is acquired of inclining to one side, or of resting upon one hip, as in sitting, the sharp edges of these small joints of bone receive the weight of the entire body. But as the articulating processes are remarkably soft and imperfectly formed at the age of puberty, it follows that they will become wasted by absorption when this position is long persisted in, and an inequality of the length of these two lateral props, on which the vertebræ rest

[1] The bone is usually more compact upon the lessened side of the vertebræ.

posteriorly, will be the consequence, those of the concave side being shorter than those of the convex. In lateral curvature of the spine, we have a distinct demonstration that the articulating processes give way more extensively than any of the other parts of the column. This is evinced by the rotation which the spine makes in its perpendicular axis, at the same time that it inclines laterally. The joints of the articulating processes being situated posteriorly, as well as laterally, the spinal column cannot yield in their direction, without wheeling partially round ; and it is owing to this rotation that the transverse processes and the ribs are directed obliquely backwards upon the convex side of the curvature, thus giving rise to a fulness or swelling on the one hand, and a depression or sinking inwards on the other.'[1]

The absorption of bone and cartilage and the alteration in form of the articular processes are probably the first morbid changes which occur in lateral curvature.

Displacement of the ribs occurs to a greater or less extent in every case of lateral curvature. The heads of the ribs are brought nearer together upon the concave side, and are separated farther apart upon the convex side, and, moreover, the direction of their axes is convergent at the concavity, and divergent at the convexity, so that the arcs of the ribs are abnormally near to one another upon the one side, and abnormally separated from one another upon the other. Notwithstanding this alteration, it is rare for severe compression of the nerves proceeding from the spinal foramina to take place, although irritation of the nerves is frequently produced.

The ribs are sometimes stunted in growth on the concave side.

The backward protrusion of the ribs upon the convex side of the dorsal curve, and the backward bulging of the transverse processes and muscles on the convex side of the lumbar curve, is the natural result of rotation of the vertebræ, and is well shown by the diagrams on page 18, copied from the article upon 'Lateral Curvature,' by Mr. Shaw, in Mr. Holmes's 'System of Surgery,' 2nd edition.

These figures show that the front of the body, although not quite so much deformed as the back, is yet considerably influenced by the rotation. The figures also show that the thoracic cavity is compressed chiefly upon the side to which the curve is directed.

The right scapula (if the dorsal curve projects to the right) is raised above its ordinary level, and projects backwards, and in consequence of the thorax upon this side being less flat than is natural, the posterior border may be raised from the ribs, and the trapezius muscle is sometimes very prominent.

On the left side, the upper part of the thorax being more or less

[1] A. Shaw, *Med.-Chir. Trans.* vol. xvii. (1832) p. 466.

flattened, the scapula, and with it the whole shoulder, falls downwards and away from the ribs.

In some severe cases the posterior parts of the ribs on the convex side are so bent, and the thorax consequently so collapsed, that the shoulder on this side also falls.

In the cases where this projection in the back has been mistaken for a morbid growth or for an abscess, the spinous processes have occupied nearly a perfectly straight line and the curvature has been produced almost entirely by the bodies of the vertebræ. The record of the case of Dr. Gideon Mantell, the geologist, by Dr. Hodgkin and Mr. Adams, is well worth quotation :—

'It appears that in 1842, being then 52 years of age, he suffered from excessive pain in the back, inducing him to apply an opiate liniment and leeches.' A fall from his carriage and exposure, upon a subsequent occasion, to intense cold, aggravated his symptoms and produced paralysis of the lower limbs. 'After many weeks the power of voluntary motion slowly returned ; sensation followed, with intense neuralgia. The tumour in the back rapidly increased, with supposed fluctuation. During the period of nine months, Liston, Brodie, Bright, Lawrence, Stanley, Coulson, &c., were consulted. The tumour became slowly harder, and almost disappeared. Sensation continuing to return, the tumour again became larger and harder, and the abdominal aorta was pushed forward.

'The cachectic appearance of the patient led to the suspicion of the formation of a malignant tumour in connection with the bodies of the vertebræ, an idea which was subsequently abandoned.

'By degrees the neuralgia became less frequent, but Gideon Mantell notes his health as broken up.

'To relieve intense suffering he sometimes resorted to anodynes, but it does not appear that he ever prescribed large doses for himself. On the last occasion, a dose of this kind, which is believed to have been taken on an empty stomach, produced the symptoms of narcotic poisoning which proved fatal.'[1]

Upon examination after death the only morbid condition present was extreme rotation of the lower two dorsal and upper third lumbar vertebra, producing a severe lateral distortion of the vertebræ internally, with a very slight deviation of the apices of the spinous processes from the central line of the back.

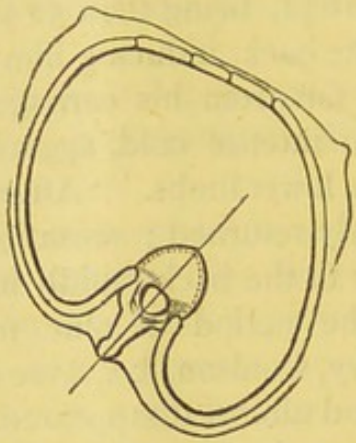
It is important to recognise this condition not only in reference to diagnosis, but also in regard to treatment, as will be shown presently.

All the above-mentioned external symptoms of lateral curvature are more marked when one of the curves is greater than the other

[1] *Med.-Chir. Trans.* vol. xxxvii.

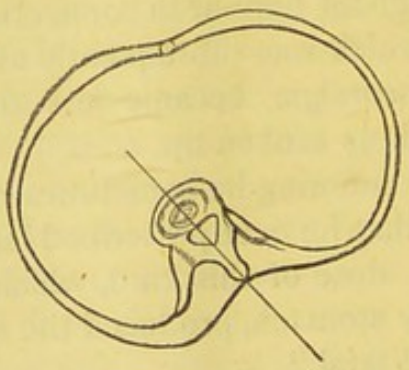
than when they are equal in extent; for in the latter case the shoulders may be nearly level. As the tendency of this affection is to increase continually, unless relieved the deformity may become so severe that very serious results may occur from pressure upon the thoracic or abdominal viscera; and a case is recorded in which partial excision of one of the clavicles had to be performed in order to avert suffocation from pressure upon the trachea. The cavities of the thorax and abdomen are so much altered in shape by the deformity that the viscera become displaced and changed in form to an extraordinary degree.

FIG. 9.



Supposed transverse section of the Thorax about its middle; to show the displacement of the ribs consequent on the contortion of the dorsal vertebræ. (After A. Shaw.)

FIG. 10.



Supposed transverse section of the Abdomen at the Lumbar Region. (After A. Shaw.)

The lungs, heart, liver, kidneys, uterus, and bladder may suffer more or less from compression in bad cases; the stomach and intestines more often accommodate themselves to their altered positions; but in many cases pressure upon these viscera or upon the nerves which supply them produces severe indigestion and other functional troubles. The curves of the spine soon become so fixed that extension and counter-extension produce no visible change in them; nor will they be altered by the patient leaning sideways.

Lateral curvature commences most frequently at about the period

of puberty, between the tenth and sixteenth years of age, but it frequently occurs at later or earlier periods of life. A. Shaw gives the age of fourteen as that of the majority of cases—an age when the bones are very incompletely ossified.

The affection occurs much more frequently in girls than in boys; and out of 173 cases recorded by Lonsdale and Adams, 151 were females and only 22 were males.

Sir Charles Bell [1] observed :—'Upon the whole, then, the effect of the lateral or sigmoid distortion is to produce an ungainly walk, to curtail the girl of her natural stature, to disfigure the bust or neck and shoulder, and to push out the left breast. But more; if permitted to increase (and it is of a nature to increase when once the bias is given), the capacity of the chest is diminished, and the lungs compressed, with consequent injury to the general health.'

Obliquity of the pelvis may give rise to lateral curvature, whether dependent upon inequality in the length of the legs or not; but an appearance of obliquity often occurs which depends entirely upon a depression above the hip on one side.

In the young, not only are the vertebræ semi-cartilaginous, but the joints are also very flexible; therefore, when curves are once formed, they increase the more rapidly the younger the patient. At the same time, the more flexible the column the more amenable is the case to treatment.

For these reasons early treatment is imperatively called for. While the affection remains untreated, absorption of the compressed parts of the skeleton continues to progress.

Diagnosis.—The possibility of lateral deformity of the spine being dependent upon caries must lead the surgeon to exercise great care in making a diagnosis in doubtful cases. No exact rules can be laid down, but all the symptoms must be taken into consideration.

In young children great weakness of the back may be present, which, in the positions of sitting or standing, allows the spine to bend in various directions, forming at one time an excurvation and at another one or more lateral curves. Although this condition would probably lead eventually to the formation of lateral curvature, yet in diagnosis a distinction is to be drawn, for when this condition of weakness exists, support to the back and rest are more important at first than exercise. In fact, in severe cases, the strength of the child is more rapidly and safely restored by absolute rest at first than by attempt to exercise the muscles. These curves are readily movable in any direction; the spine can be easily straightened or bent.

As lateral deflection of the bodies of the vertebræ usually exists to a greater extent than the deflection of the spinous processes, and the

[1] *Practical Essays*, p. 125. Edinburgh, 1842.

former displacement precedes the latter, it follows that the early stages of the distortion may be difficult to diagnose. Adams alludes to the flattening of the back which is sometimes present in cases of shoulder projection, unaccompanied by any lateral deviation of the spinous processes; but, upon the other hand, excurvation often precedes and accompanies the deformity under consideration.

As the position of the spinous processes does not indicate the position of the bodies of the vertebræ, the diagnosis of lateral curvature must not depend alone upon an examination of these processes. It is upon the posterior prominence of the angles of the ribs upon one side and their depression upon the other side that curvature in the dorsal region is to be detected; and upon the posterior prominence of the apices of the transverse processes on one side and their depression on the other side that curvature in the lumbar region is to be diagnosed.

The other symptoms already detailed will also, of course, guide the surgeon in forming an opinion as to the nature of the case.

In stooping, the distortion of the ribs is made much more apparent, the prominence being increased upon the one side and the depression being rendered more distinct upon the other.

Hysteria.—There is a class of cases in which there is an apparent inability to control the muscles of the back, associated with general or so-called hysterical symptoms. The curves are not fixed; the patient can be placed in a normal position, but when left to herself immediately relapses to one or other side, and the back becomes again curved laterally. These cases are easily recognised.

Nervous mimicry may assume other symptoms of lateral curvature, and Sir James Paget,[1] in discussing these cases, remarks :—'The curvatures of the spine that occur frequently in young persons are often painless, are seldom very painful, and have no characteristic pain; yet pain of any kind should always lead you to examine for curvature, and to suspect, if there be curvature already, that it is increasing.'

Hysterical curve may be formed very quickly and be apparently fixed, but if the patient stoops low enough to touch the ground with the hands, the back becomes normal in shape, which is not the case in real curvature.

It is seldom, if ever, necessary to give an anæsthetic for the purpose of diagnosis, but under such influence severe curves that would be fixed in real curvature disappear if they depend entirely upon hysteria, but it must be remembered that hysteria may accompany real lateral curvature.

[1] *Clinical Lectures*, 2nd edit. Edited by Howard Marsh, 1879.

Prognosis.—Presuming that all the causes can be removed, the prognosis depends upon—

1. *The age of the patient.*

If the case occurs in infancy or early childhood the prognosis must be guarded, as the distortion is often associated with extreme debility or with some constitutional disease, and under the most favourable circumstances the treatment is then generally tedious. Cases commencing between twelve and fifteen years of age are the most favourable for treatment; and some of these cases may recover even if left to themselves. But a spontaneous cure is very uncertain, and, if depended upon, the deformity is likely to increase very insidiously, and assume a permanent character, before treatment is considered necessary.

There is no age at which the deformity can be said to cease liability to increase—*i.e.*, if no means are adopted to restrain the progress of the affection.

2. *Upon the duration of the deformity.*

No absolute rule can be laid down for forming a prognosis as to the possibility of cure, with regard to the time the deformity has existed, but, generally, the longer the affection has been present the more unfavourable the prognosis.

Nevertheless, in every case, even when the deformity is very severe and of long standing, relief can always be given to the symptoms of pain or discomfort. By means of a carefully adjusted instrument the continual strain upon the structures can be relieved, and relief is thus afforded. Moreover, by such a remedy the deformity is prevented from increasing, whereas without proper support a bad case is always increasing.

The probability of improving the form of the patient's body depends very much upon the flexibility of the parts. When we find that we can alter the curves, even but slightly, by pressure with the hands, then we may confidently promise to produce some improvement by treatment. In the very severe cases, when improvement in form is not to be expected, the relief to the symptoms is, I believe, effected by relieving the pressure which is in excess upon the concavity, and by relaxing the stretching of the tissues which must exist upon the convex side of the curve.

Theories upon the Origin of Lateral Curvature.

Delpech attributed lateral curvature to a disturbance of the antagonism between the muscles of the two sides of the back; he believed that every muscle has its antagonist, and that certain groups of muscles are equally balanced by opposing groups, and that

absence of lateral curvature depends upon the equal power of both sets of muscles.

If this theory be correct, it naturally follows, as Delpech argued, that increase or decrease of muscular power upon one side of the body would give rise to lateral distortion.

Bauer refers to Dr. Werner,[1] who opposed the theory of muscular antagonism, because the muscular development upon the two sides of the body is so seldom equal.

Borcelli, also, seems to have written to the same effect.

In opposition to Werner's view, and in support of Delpech's theory, it is often urged that occupations necessitating greater use of one arm than the other give rise to spinal deflection. But this supposition is to a great extent an error, *faulty position* generally accompanying the excessive use of one or other arm, and being the cause of the deformity.

Jules Guérin advanced the theory of 'muscular retraction,' which he considered the sole cause of lateral curvature. He advocated and practised tenotomy and myotomy in all cases of lateral curvature, and published many cases which he claimed to have cured.

Considerable sensation was thus caused among the Parisian surgeons, some of whom adopted his theory and treatment. Others, among whom were Dieffenbach and Malgaigne, opposed the treatment recommended by Guérin.

Malgaigne reported[2] that of the 24 cases which Guérin described as completely cured out of 155 which he had operated on, not one was permanently cured, and that some were decidedly injured.

A Committee of Enquiry into the subject was appointed by the Academy, and they reported that Malgaigne's statements were correct.[3]

Stromeyer advanced a theory of one-sided paralysis of the respiratory muscles, which has not met with much favour.

There are few supporters in the present day of the 'muscular contraction' theory, and, as Bampfield[4] pointed out many years ago, the condition of the muscles upon the two sides of the body is not in accordance with such a view. The condition of the muscles is usually one of flaccidity upon the concave side from partial disuse, and increased development upon the convex side of a curve from muscular endeavour to keep the spine from bending farther.

[1] *Reform der Orthopædic.* Berlin, 1851.

[2] 'Mémoire sur la valeur réelle de l'Orthopédie et spécialement de la Myotomie rachidienne dans le traitement des déviations latérales de l'Epine,' par M. Malgaigne. *Comptes Rendus*, tom. xiii. Avril 1844.

[3] Adams and Tamplin tried the effect of Guérin's treatment, but were dissatisfied with the results.

[4] *Essay on Curvatures and Diseases of the Spine.* London, 1824.

These remarks refer to the formation of the primary curve, the compensating curves being formed by muscular action.

Mr. John Shaw found, upon dissection, that the muscles had atrophied upon the concave side, and he also found the nerves that supplied these muscles 'diminished to less than one-half their natural size'—a condition which he supposed depended upon the atrophied condition of the muscles.

Mr. Gay[1] dissected a case of severe lateral curvature in the cervical and upper dorsal vertebræ, convex to the left, in a young woman aged 23, who died from fever. The muscles of the chest, both before and behind, were very feebly developed and pale. 'The intercostals of the left side had lost the usual characteristics of muscular tissue'—were degenerated to a mere membranous expansion. The sacro-lumbales and longissimus dorsi on both sides were 'comparatively large and powerful.' The abdominal muscles were large, but partook of 'the general feebleness of the integral structure. The diaphragm was very powerful.' Attempts to straighten the spine at this stage of the dissection caused the lumbar fascia to become tense and resistant. This fascia, being divided transversely, extension caused only a separation of the cut fibres, to the extent of half an inch. Although all the muscles were removed, no manual force could straighten the spine. The intervertebral fibro-cartilages were thinned on the concave and thickened upon the convex side of the spine; their elasticity was lost.

Mr. Gay refers to preparations in Guy's Hospital, and to dissections published by M. Bouvier, as other examples of somewhat similar conditions.

Lateral curvature of the spinal column was at one time attributed to primary disease in the bones and intervertebral cartilages; and even in modern times Lorinser has stated[2] that this affection is caused by an osteomyelitis. The condition of the bones in lateral curvature is referred to below.

It would be tedious and unprofitable to discuss all the speculative theories that have been advanced with regard to the causation of lateral curvature, but there seems abundant evidence to prove that some debility exists as a predisposing, and that certain habits or circumstances act as exciting, causes.

Causes of Lateral Curvature.

These may be divided into *predisposing* and *exciting* causes.

The *exciting* causes may give rise to the affection when the predisposing causes do not exist, and the predisposing, if severe, will

[1] *Lond. Med. Gazette*, December 1841.

[2] See Bauer, *Lectures on Orthopædic Surgery*. New York, 1868.

allow the formation of curvature although the exciting causes are so slight that they are scarcely, if at all, distinguishable, or possibly are not present.

The *predisposing* causes are probably all circumstances which give rise to debility. This debility may act generally, or it may affect the dorsal muscles, and disenable them to retain the spine in an upright position for long periods.

The condition of the bones may predispose to the rapid formation of curves, supposing always that more pressure is allowed to bear upon one side of the spine than upon the other side.

1. In rickets the vertebræ readily give way to lateral pressure.

2. When a child suffers from general debility, and especially when the so-called scrofulous diathesis is present, the bones are probably more readily influenced than they are in health.

3. When a child is growing rapidly, curves are naturally sooner formed than when growth is slow.

We have seen that the affection occurs most frequently in girls, and at about the time of puberty, and it is very common to find some retardation of sexual development, or some derangement of the commencing menstruation.

Insufficient exercise and confinement predisposes to lateral curvature, especially in children who are growing rapidly, 'and whose spines, as Bauer has remarked, are endowed with an unusual degree of flexibility.'

When boys are affected with this deformity, they are often found to be effeminate in their conformation, 'possessing very flexible spines.'

At the time of puberty in the female the vital powers are directed so specially to the development of the sexual organs, at the expense possibly, of other parts of the body, that the dorsal muscles are very likely to become weak.

Improper diet, sedentary habits, violent dancing, and 'late hours,' have been adduced as predisposing causes; and I may add that all habits and circumstances which depress the bodily health may act as such, and especially those in which the muscles of the back are overtaxed, or in which their development is retarded.

In some families there is an hereditary tendency to lateral curvature, which perhaps indicates hereditary weakness, and when stiff corsets are used by growing girls the full development of the dorsal muscles is seriously interfered with, and weakness of the back is the natural consequence.

The influence of stays in producing local muscular debility has been variously estimated by authors. Of course in very young children stays are not worn, and therefore cannot be a cause; but, at the time of puberty, when this deformity most frequently commences, the

majority of girls wear stays, which must retard the development of the dorsal muscles. Bampfield has well described some of the causes of lateral curvature. He writes :—

'I have observed the condition and action of the dorsal muscles in the earliest stages of lateral curvature attended with muscular debility, and the following were the phenomena they represented. After the patient has kept the spine erect until the muscles are fatigued, the spinal column suddenly sinks down and bends to one side and the patient inclines to the other, to maintain the balance. In this state they remain quiescent.

'Some fashionable follies of modern education are justly accused of producing this species of curvature, especially in young females—first by establishing habits that deprive the muscles of the back of their natural exercise and actions, and thus prevent the attainment of their natural strength, or by their inaction induce debility; and secondly, whilst in this state of debility, by endeavouring to subject the spinal muscles to more exertion than they are capable of using, in the injunctions they receive to keep the body constantly erect in the standing and sitting attitudes. Thus the spinal muscles of young females are doomed to inaction by the trunks of their bodies being imprisoned in stiff stays, or their movements abridged and confined by the use of collars, braces, backboards, or by being stretched motionless on reclining boards or schoolroom floors; or they are subjected to long-continued exertion and the use of one posture, which all our muscles abhor, and soon become weary of, by being placed in education chairs or stools, the long forms of schoolrooms, or on the round stool, to practise for hours on the pianoforte or harp, with strict injunctions to keep the body quite upright, and menaces of punishment if they stoop or bend in the least. But the muscles must sometimes obey divine, instead of human laws, and when fatigued and weary in the erect posture, must generally follow the Creator's law and seek repose by allowing the body to sink into an inclination to one side or the other, and, by laying the basis of lateral curvature, produce the reverse of what human wisdom intended. Thus, from too much anxiety about the elegant and proper development of the female figure, tyrant fashion, under the apparent sanction of custom, and the specious guise of education, has usurped the prerogatives of nature, has abolished the freedom of muscular action, and has presumptuously substituted the rules of art to direct the growth and mould the form of the human figure, and direct its muscular powers! Surely the Creator never intended these restraints; nature disdains them; and He who gave us powers to maintain the spine erect, also ordained its form to be bent and its movements to be unfettered.

'Before man became subject to the influence of refined civilisation, he enjoyed the privilege of free exercise of all his muscles in the most untutored and unlimited manner, practised what attitudes he pleased, indulged in such sports and pastimes as he listed, and when weary assumed the recumbent posture he chose without being shackled by the dictates of art. Spinal deformity was then unknown to those who lived in a free state of nature, often called savage or barbarous. The growth of the body, the proportions of form, the adjustment of the figure, the turn and directions of the bones, were left to the unerring hand of nature, and freedom of muscular movements. But, by the force of cruel fashion, nature is almost forsaken, and art is so preposterous and assuming as to offer dictates and prescribe directions to form the body agreeably to its natural configuration; and parents, and proprietors of female seminaries or schools, are so silly and unreasonable as to submit to their guidance. Nay, this submission to the suggestions and dictates of art has even been made in one department of our Government; and in a great national institution for the rearing of orphan children of soldiers there is established the appointment of an exercise and figure master, with the pay of a captain in the army, who is to control and give a proper direction to the growth of the body, "to teach the young idea how *to shoot*" and elicit and confer tone on all their powers by artificial exercises of particular muscles in a numerous train of movements and list of attitudes. Against these artificial habits and customs wisdom has launched its mandates, genius has levelled its enlightening arguments, experience has pronounced its judgment, reason has fulminated its reproaches, wit has pointed its keen shafts of ridicule, and authority has proclaimed its interdictions; yet the folly of fashion increases, and its prevalence extends! In passing through the schoolrooms of the seminaries for young ladies, what can be more appalling and preposterous than to see the motionless figures of a long row of young ladies lying on inclined or horizontal planes of deal boards, "like *patients* on a monument smiling at the whitewashed ceilings," or like the mute statues on tombstones of those interred beneath, and from which we should hardly distinguish them were it not for the occasional movements of the muscles of their (should-be) brilliant eyes or laughter-loving muscles of the face, whose situation defies control and eludes confinement. The conduct of boys' modern schools is also exposed to serious objections in common with the girls' schools. Boys and girls are too much shut up in small playgrounds, like prison yards, instead of being allowed to range the valley free; or girls have small gardens to walk in, enclosed by high walls, like those of the asylums for the insane. What can be more contrary to nature's freedom of movement than

marching schools of boys and girls in rank and file, like the boys at the military asylum, instead of allowing them to move at ease in any place they prefer or are prompted to?

'Without digressing further, I would observe, instead of stiff stays, back-boards, reclining-boards, education chairs without backs, military marching, &c., let the girls and boys have no clothes or apparatus which will limit their movements, and when weary let them sit down on chairs with proper curved backs to support the spine, or lie down for rest, or, in fact, as they find most agreeable when they are fatigued, or can no longer maintain an erect attitude conveniently. Let the girls have a large field or playground; let the boys, also, have the range of the country within the sound of the school-bell. Let the girls engage in the games of battledore and shuttlecock, skipping and dancing, and all that they can play at. Let the boys play at cricket, trap and ball, shinney, fives, skipping, running, quoits, marbles, climbing trees, jumping, &c., and we shall not have many distortions of the spine; and, without intending to give offence, I will venture to express an opinion that if the amount of a captain's pay was laid out for the use of the boys at the military asylum in the purchase of cricket-bats, traps and balls, skipping-ropes, swings, shinney-sticks, marbles, quoits, &c., there would not be any occasion for exercise masters, or surgeons to cure deformities, unless arising from scrofula or accident.'

Many of the foregoing remarks regarding boys do not apply in the present days, for of late years great improvements have been made in regard to out-of-door and indoor recreations, but there is still much room for improvement in the system of education of girls. With the object of making girls 'refined in their manners,' an unnatural restraint is placed upon their movements, and they are not allowed to follow the dictates of nature—dictates which would induce them to take a sufficient amount of exercise in an unconstrained manner, to ensure the maintenance of their health and form.

It is not merely exercise that children require, but *recreation.* Young people are not benefited by long stately walks—they require freedom, ease, and play. The spine cannot be kept in a perfectly upright position for very long, and consequently it is allowed to subside in one or other direction. Insufficient out-of-door recreation acts as a predisposing cause of curvature of the spine, and errors of position which custom obliges school children to assume act as exciting causes of this affection.

The dorsal muscles cannot continue in constant action for long at a time, and if the back is not rested directly the muscles become tired, the spine subsides to one or other side, and is supported in that position chiefly by the articular processes. The frequent pressure in

one direction, for the subsidence generally takes place repeatedly upon the same side, soon causes inequality of growth and alters the position of the soft growing spine, and a slight curve once commenced is very easily increased.

Some of the chief causes of this false position are the use of forms or unsuitable chairs and unsuitable desks. Very good rules upon these matters have been drawn up by Mr. Liebreich, and I have embodied them in the following recommendations :—

1. The back of the chairs should be straight, but should reach no higher than just above the hips of the sitter, to support the loins. The back rail should be three inches deep.

2. The seat should be deep enough to support the whole thigh.

3. The feet should be supported in their natural position by a foot-board.

4. The desk should be sloping at an angle of 20° for writing and at 40° for reading. It should be placed so that the elbow can be comfortably rested upon its edge without displacing the level of the shoulders.

5. The edge of the table should be perpendicular to that of the seat, and at a level of one inch higher than the back of the chair for boys, and one inch lower than the back of the chair for girls. These variations of level can, of course, be arranged for by altering the height of the chair or desk.

For delicate girls whose spines are flexible and weak, I advise the use of a prone couch, by means of which all action of the arms on the part of the pupil tends to exercise the muscles of the back, while the spine is rested in a straight position. As already stated, this is the best position when there is any tendency to stooping.

Mr. Adams considers that the cases which occur before the age of five are probably hereditary. I have seen a large number of cases at this period of life the result of rickets. Those between the ages of seven and twelve sometimes have a history of hereditary tendency, and 'the constitutional cause seems to consist in a strumous diathesis.' Those between twelve and sixteen years of age depend often upon debility caused by too rapid growth.

The exciting causes are conditions which disturb mechanically the equilibrium of the spinal column continuously or for long periods :—

1. *Inequality in length of the lower extremities*, either from original conformation or from disease or accident, causing obliquity of the pelvis.

2. *Inequality in the weight* of the two sides of the body, as occurs, for instance, when an arm has been lost.

3. Disease or injury, producing contraction of one side of the thorax or abdomen, such as empyema.

4. Alteration in the position of the head, as when wry-neck occurs.

5. Bad habits of position (sometimes the result of the predisposing causes).

The following are some of these bad habits of position.

Some Bad Habits of Position.

1. Standing upon one leg, the right being usually selected.

2. A great deal of horse exercise without the use of a reversible saddle.

3. Sitting at too low a table for writing, so that the body is leant over upon the left arm.

4. Bad positions of sitting at various employments, such as drawing and painting.

5. Bad positions during ironing, nursing, &c., such as carrying a child frequently upon the same arm.

6. Sleeping always upon one side, with the head resting upon too high a pillow.

7. Carrying heavy weights.

8. Fatiguing attitudes, such as standing in school, sitting upon stools or forms without backs.

When an arm has been lost, the shoulders are inclined towards the side from which the limb has been removed, so that the equilibrium of the body may be restored. A similar result occurs when a weight is very frequently carried in one hand or upon one arm, as, for instance, in nursing a child.

With regard to *inequality in the length of the lower limbs*, it seems that such a condition exists much more often than was formerly believed. The researches of Drs. Hunt,[1] Cox,[2] Wight,[3] and Roberts[4] in America, and of Dr. Garson[5] in London, show that equality in length of the lower limbs is an exceptional condition.

In 54 persons examined by Dr. Cox, only 6 possessed limbs of equal length—the variations ranging from $\frac{1}{8}$th to $\frac{7}{8}$th of an inch.

Dr. Wight, of Brooklyn, examined 102 individuals, only 23 of whom possessed an equal length of leg. The average difference in length was $\frac{1}{4}$th of an inch.

The majority of the American measurements were made upon the living subject. Dr. Roberts, however, examined eight skeletons, in only one of which were the limbs of equal length.

[1] *Philadelphia Med. Times*, Jan. 1875.
[2] *American Journal of Med. Sci.* April 1875.
[3] *Arch. Clin. Surg.* Feb. 1877, and *Procds. Med. Soc., County of Kings*, Jan. 1878.
[4] *Phil. Med. Times*, Aug. 1878.
[5] *Journal of Anat. and Phys.* July 1879.

Dr. Garson carefully measured seventy skeletons at the Royal College of Surgeons, and his experiments have been made doubly valuable by being observed and revised by Professor Flower.

In only 10 per cent. of these cases were the limbs equal in length.

The left limb was found longer than the right in 38 cases (54·3 per cent.) The right was the longest in 25 cases (35·8 per cent.) The amount of inequality varied from 1 to 13 mm. (*i.e.* from about $\frac{1}{25}$th to about half an inch).

In only thirteen of these seventy did the inequality amount to 6 mm. (about $\frac{1}{4}$ in.) or over ; so that in the majority the effect upon the equilibrium of the spine would be very slight. Moreover, slight

FIG. 11.

Diagram to show the position of the Spine when the individual is standing upon one leg.

FIG. 12.

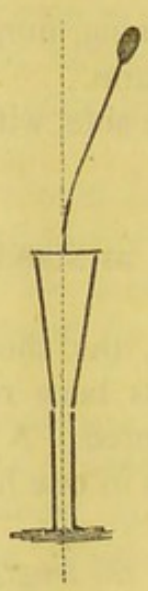


Diagram to show the position the Spine would assume (the legs being straight) if the Lumbar Curve remained fixed.

FIG. 13.

Diagram to show the dorsal curve formed by the efforts of the patient to maintain the equilibrium of the body.

inequalities in the femora and tibiæ might be compensated for by slight differences in the pelvis and feet.

To what extent these irregularities may be dependent on or independent of any morbid processes which may occur during the period of development and growth, the writer is not prepared to discuss, but he may remark that a large number of cases occur in which temporary arrest of development has caused one leg and foot to be smaller in all proportions to the other leg and foot.

This condition has been mentioned in the chapter upon club-foot, the two affections being frequently co-existent, and for the reasons there stated.

Besides the causes of arrest of development already considered,

there may be arrest of growth of the long bones from injury to one or other of the epiphyses.

Besides arrest of development, there are many other ways in which one limb may become shorter than the other, such as from a destruction of parts from joint-disease, shortening from fractures, bending from rickets, or flat-foot.

Formation of the curves. — Many observers consider that the lumbar curve is first formed. Mr. Alexander Shaw is of this opinion, and he believes that the habit of standing upon one leg, 'standing at ease,' is one of the most frequent exciting causes.

In a young person possessing flexible joints a large sweeping curve is produced, extending from the lower part of the dorsal region to the sacrum. 'Standing at ease' relieves the fatigued muscles, and in young, growing people, especially if they are not strong, the curve is likely to become permanent. While the body is supported in its oblique position, no inconvenience is experienced, but in consequence of the spine being frequently bent to one side, the bodies of the vertebræ and the intervertebral cartilages are gradually influenced. Upon the concave side the growth of the bones and cartilages is retarded, and absorption of the parts may take place from pressure. Upon the convex side of the curve the pressure is less than normal, and consequently the development of the structures proceeds without opposition. Consequently in the course of time, whenever the individual ceases to hold the pelvis obliquely, and sits or walks, the body will be bent over to the opposite side.

But as the equilibrium must be restored, and as muscular effort cannot so easily overcome the curve already formed as it can produce a new and compensating curve, the muscles upon the convex side of the primary curve act upon the upper part of the spine, and by gradually raising it, and drawing it towards the median line, bring the head into the line of the centre of gravity, thus forming a dorsal compensating curve.[1]

Several alternate curves may thus be produced ; but the primary curve may be either lumbar, dorsal, or cervical, according to the cause. Obliquity of the pelvis produces a lumbar curve first. Wry-neck will give rise to cervical curve, and frequent obliquity of the shoulders will cause the primary curve to appear in the dorsal region. The principles of the formation of curves as shown in the foregoing diagrams apply to all these cases.

When the curves are once formed, the tendency to increase is perhaps greater in the dorsal than in the lumbar region.

It is probable that all exciting causes act by disturbing the equilibrium of the spine ; and whether this condition be brought about

[1] See A. Shaw in Holmes's *System of Surgery*, vol. v.

by bad habits or by trade occupations, in all cases the dorsal curve is more commonly formed to the right.

If an individual stands upon one leg, the right is generally selected, causing a primary lumbar curve to the left and a compensatory dorsal curve to the right; and if habits or trade occupations cause obliquity of the shoulders, the right one will usually be that which is raised, and the left depressed, thus causing a primary dorsal curve to the right.

When inequality of length of the limbs exists, obliquity of the pelvis is always present, and acts in the same way as frequent standing upon one leg.

It has been already stated that the predisposing causes may alone, possibly, allow the formation of lateral curvature. The deformity is produced in such cases probably from an attempt upon the part of the patient to maintain the spine in an upright position with as little muscular exertion as possible.

If the standing attitude is assumed for long the dorsal muscles become fatigued, and the spine is allowed to 'subside' as much as possible consistent with the balance being maintained. Standing upon one leg is usually assumed for the purpose of allowing this 'subsidence'; and we have already discussed the formation of curves under such circumstances. But the fatigue of the muscles may be partially relieved by the individual allowing the spine to bend, independently of standing upon one leg; and in sitting upon a form the spine is allowed to curve in this manner.

Some of the more frequent Functional Derangements caused by Lateral Curvature.

1. Interference with the thoracic viscera.
   - Palpitations.
   - Faintness.
   - Impeded respiration.
2. Interference with the abdominal viscera.
   - Nausea.
   - Indigestion.
   - Hepatic disorders.
3. Interference with the pelvic viscera.
4. General symptoms of bad health.
5. Pain in the region of the spine.
6. Spasmodic pains.

Treatment.

In the first place the causes must be removed.

If the curvature has arisen from obliquity of the pelvis, the cause

of that obliquity must be dealt with. This generally depends upon inequality in the length of the legs; and some means must be adopted to restore the pelvis to its normal position. All fatiguing attitudes and occupations (see Exciting Causes) must be forbidden.

The general health of the patient must be treated. There may be ill-health, the result of the curvature, or the result of the debility which has been present before the curvature took place.

Treatment of the general health of the patient is of very great importance in the majority of cases. The necessary treatment of course varies with the case.

Curvature, associated with, or the result of, rachitis, must be treated for the constitutional disorder as well as for the spinal deformity.

Special Treatment.—The special means of treatment which we have to consider are—

1. *Local stimulants.*
2. *Rest.*
3. *Mechanical extension and pressure.*
4. *Muscular exercises.*
5. *Mechanical support and pressure.*

The consideration in this place of myotomy and tenotomy is purposely omitted, because such treatment has been proved to be totally unsuited to lateral curvature of the spine.

1. *Local Stimulants.*

Friction with simple or stimulating liniments and cold douches have been found useful in giving tone to the muscles of the back. Warm-water bathing has been recommended, and will be beneficial sometimes, if followed by a cold douche.

Muscle beating and kneading may also do good as local stimulants.

2. *Rest.*

Absolute recumbency—*i.e.* lying down for perhaps one or two years—has had many advocates. Such exclusive and severe treatment is injurious to the general health, and has not been found to cure any but the slightest cases of this affection.

Partial recumbency, however, when combined with other treatment, will always be beneficial in its effects, especially in rapidly growing children.

Fatigue is to be carefully avoided. The patient should lie down directly the upright position of the back cannot be maintained with perfect comfort. The couch used should be well stuffed, and so made that the attitude of the patient need not be constrained.

The position assumed during the recumbency should be that

which affords the most complete rest to the muscles of the back, while the vertebræ and intervertebral substances are relieved from the pressure of superincumbent weight. Chairs which fit into the natural curves of the back afford much more relief than ordinary chairs ; but the pressure referred to is not thus relieved.

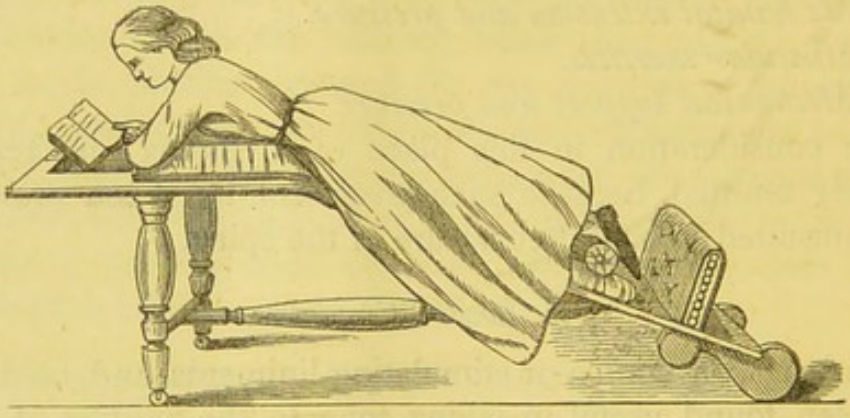
The supine position, with a small pillow in the lumbar region, may be adopted ; but the prone position possesses certain advantages over all others.

A couch should be used, made horizontal beneath the thorax, and slanting slightly from the pelvis towards the feet.

The arms can be used freely in this position, such use tending to straighten the back and to exercise the dorsal muscles ; but the supine position tends to weaken the back and produce 'roundness of the shoulders' (excurvation).

Hard back-boards should never be employed. Recumbency is useful when the curvature predominates in the lumbar region, as in

FIG. 14.



The Prone Couch. Invented by Dr. Verral about the year 1823.

that part of the back mechanical support is less effective than in the dorsal region.

Lonsdale's couch was constructed for the purpose of acting upon the most prominent curve by the gravitation of the upper and lower parts of the body.

The patient was directed to lie upon this couch for an hour or more every day, and a retaining spinal support was applied directly afterwards, so that any benefit derived from the position might be maintained. In some cases of a single curve in the dorsal region this plan of treatment might be found useful.

3. *Mechanical Extension and Pressure.*

This means of treatment has a very ancient origin, and has been employed chiefly upon the following principles.

The patient lies upon a couch, the head is fixed by a collar, or by lateral support attached to the couch, and extension is made by

springs or by weights from the pelvis. Sometimes (as in Cole's sofa) the patient lies in a prone position, and grasps a bar at the upper end of the couch, whilst extension is made from the pelvis by a belt, cords, and winch. Many of these extension-couches are fitted with an apparatus intended to cause direct pressure upon the curves. This purpose is attempted in Buehring's couch by fixing the waist in a belt attached to the couch, and then applying pads to the convexities of the two curves. The pads are worked by lateral screws. Many couches have been constructed which attempt to redress the curves by two belts, each pulling against the individual convexities by springs attached to the sides of the couch. The 'corset-lit' of Valerius resembles in appearance a gigantic lobster-shell. A case for the head, another for the thorax, a third for the lumbar region, and a fourth for the pelvis, move one upon another, and are regulated by apparatus attaching the whole machine to a table.

Tuson invented a couch which provided means for exercises as well as for extension. The muscles of the trunk generally were exercised by this machine.

Extension by means of suspension was, according to Humbert,[1] first employed by Glisson in 1580. He used to suspend children by the head and arms in such a manner that the weight of the individual, sometimes augmented by weights attached to the feet, bore equally upon the three supports.

In France and Germany this system of treatment has been very extensively employed.

In this country Mr. Stafford invented a suspending machine, by which the patient could be raised from the ground by the upper part of the body while the lower part remained suspended. Weights were attached to a belt. 'The muscles on the concave side are lengthened, while those on the convex are shortened and allowed to contract, whereby they are both put into a more favourable position to pull back and retain the vertebræ in their situation.'[2]

John Shaw employed an apparatus for relieving the back of some of its superincumbent weight while the patient was sitting in a chair for writing, drawing, &c.

Mr. Adams, writing in 1864, states that he had seen, in a private establishment for the treatment of deformities, 'a sort of hanging contrivance by which patients were drawn up by the head off the ground, and allowed to remain suspended in the air for a certain time;' and Sayre has introduced into this country[3] from America a

[1] *Traité des Deformités du Système Osseux ou de l'emploi des Moyens méchaniques gymnastiques dans le traitement de ces maladies.* Paris, 1834.

[2] *Two Essays on Diseases of the Spine*, p. 76. R. A. Stafford, London, 1840.

[3] *Spinal Disease and Spinal Curvature.* By Lewis A. Sayre, M.D., New York, 1877.

plan of self-suspension, in combination with the application of a plaster-of-Paris jacket, originated by Dr. Benjamin Lee, of Philadelphia. Dr. Lee made his patients climb a rope which passed over a pulley, 'and was attached to the patient's head by straps, passing under the chin and occiput.'

Sayre writes : 'To a hook, at the upper portion of an iron tripod about ten feet in height, is suspended, by means of compound pulleys and tackle, the iron crossbar,' to which the patient is 'attached by the head and chin collar only, and not by axillary straps. The patient is to be taught to suspend himself by means of this apparatus, and be requested to take several deep and full inspirations during suspension. Great care is directed to be taken that *the hands be kept above the head* ; so long as this is the case, the great thoracic muscles, as the pectoralis major, latissimus dorsi, serratus magnus, &c., are brought into play, and the ligaments of the neck are relieved of the greater part of the strain. If the hands be allowed to descend below the level of the head while the patient is self-suspended, there will be a risk of too much strain being thrown upon the ligaments of the neck, and of consequent serious damage. During the self-suspension some one should be at hand, especially if the patient be a child, to guard against accident from the twisting of the rope, and to see that the operation is properly conducted. When the patient has elevated the body to the highest point, and proposes to rest suspended for a time, the uppermost hand on the cord should always be that on the side of the concavity of the dorsal region.' While the patient is in this suspended position, Sayre recommends the application of a plaster-of-Paris jacket.

The result of self-extension and the plaster-of-Paris jacket in lateral curvature has not been satisfactory, and for the following reasons :—

1. The jacket is very heavy.
2. It interferes with free perspiration from the skin.
3. It interferes with cleanliness.
4. It interferes with local medical applications, such as cold bathing and stimulating liniments.
5. It prevents exercise of the muscles of the back.
6. It interferes with or prevents thoracic respiration, and so favours collapse of the thoracic walls.
7. It retards the growth of the whole trunk, and especially of the thorax, and may thus cause considerable mischief when worn for from three to six months without removal.[1]
8. Although suspension causes a partial straightening of the spine

[1] Even if the jacket be removed and re-applied frequently, still growth is not permitted to proceed, because the evil is kept up by the re-application of the jacket.

at the time, this improved position is not maintained by the jacket, for if the jacket were applied sufficiently tightly to effect this purpose breathing would be stopped.

Poro-plastic Felt Jackets.—Many of the objections raised against plaster-of-Paris also apply to the felt jackets. Their supposed porosity is a myth. I formed a cup out of this material, and kept water in it for ten days. At the end of that time I found that no moisture had penetrated beyond the surface.

All the above plans of mechanical extension are very complicated; they are irksome or painful, and often dangerous to the patient; some of them might justly be called barbarous.[1]

4. *Muscular Exercises.*

Muscular exercises are employed for two purposes—

1. To strengthen weak muscles.
2. To act directly upon the curves.

For the purpose of giving strength to the dorsal and thoracic muscles, and of improving the general health of the individual, the exercises should be so directed that all the muscles of the back should be equally brought into action. But exercises of both sides equally should only be advised, alone, when the curve or curves are very slight. In severe cases the special plan described below should be supplemented.

Exercises may be employed in the standing, sitting, or recumbent positions.

Of the many varieties of general exercises which are beneficial the following may be noted :—

The patient, sitting upon the front edge of a chair, should exercise the back by means of an elastic cord attached to a fixed point in front of him. The cord should be attached to a broad band passing round the neck or over the shoulders of the patient, and the body bent backwards and forwards so as to exercise the erector spinæ muscles and their prolongations, or the same exercise may be carried out by means of a weight and pulley apparatus instead of an elastic cord.

Various swinging exercises upon a trapeze, exercises upon parallel bars, or the use of very light dumb-bells may be advised.

Whatever kind of exercise is adopted, it should never be allowed to produce fatigue; and a suitable couch should be used by the patient to rest upon.

[1] 'We have seen a young girl who, after a treatment of ten months, had the column perfectly straight when under extension; but when extension was removed, the trunk sank again, and the deformity appeared greater than before, as might be proved by comparison with a plaster bust modelled upon her at the commencement of the treatment; and which is explained by the stretching of all the fibrous tissues by the apparatus.' Rogers-Harrison (1842).

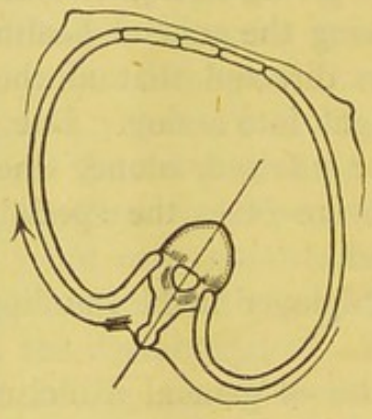
As a preventive measure, swimming is an excellent means of exercising the dorsal muscles. But as a curative means it is not good, because the requisite expenditure of muscular power is too great, except for slight cases in an early stage.

In slight cases of lateral curvature, in which muscular debility has been the predisposing cause, well-regulated muscular exercises will be highly beneficial ; but they will do little or nothing to remove curves which have become fixed.

Muscular Exercises to act directly upon the Curves.—In order to thoroughly appreciate the effects of muscular exercises upon a curved spine, it is necessary to consider carefully the exact action of the muscles which we propose to call in to our aid, and the exact position of the parts which are distorted. The exercises which have hitherto been recommended for acting directly upon the curves have been devised with the object of drawing out the concave side of the

FIG. 15.

Side of the Concavity.



curve by employing the arm of that side. Now the muscles which extend from the arm to the spine in the concavity of a dorsal curve are the trapezius, the rhomboidei, and the upper part of the latissimus dorsi, and these are attached to the *spinous processes* of the vertebræ. We have already seen that the spinous processes are directed, in consequence of rotation of the vertebræ, towards the side of the concavity, and that the rotation is the most important part of the distortion, the part which probably always occurs first, and the part which may form the chief amount of deformity.[1]

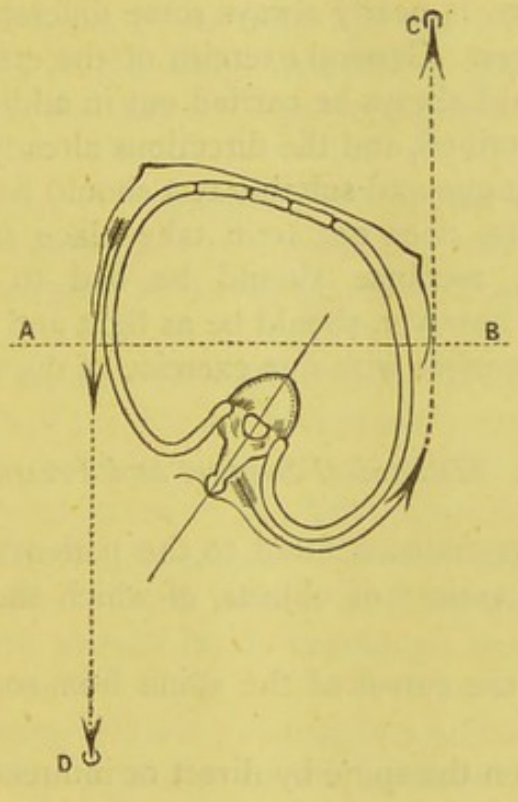
The effect of this exercise is obviously to draw the spinous processes further in the direction of the concavity, and consequently increase the rotation of the vertebræ. The arrow proceeding from the spinous process in the accompanying figure (fig. 15) will show the direction in which the muscles already referred to will act. For it

[1] Dr. Gideon Mantell's case, and the case of which I shall presently give the history (Case III.), are instances of this condition, in both of which, so great was the rotation and so slight was the lateral deviation of the spinous processes from a straight line, that the nature of the deformity had been mistaken by medical men for fatty and other tumours.

must be observed that although both arms are to be used in the exercise, yet that arm which is upon the side of the concavity is to be raised higher than the other arm, with the object of bringing into greater action the muscles which extend from that arm to the concave part of the deflected spine. The bent position of the body necessitated by this exercise would be a good one if it were not brought about by the action of the muscles enumerated above. The same position, however, can be produced by means of Lonsdale's couch and by other simple methods without resorting to the exercises just described.

The plan of special exercises which I have devised (for cases in which there is much rotation) consists in the use upon the con*vex*

FIG. 16.



side of the curve of the muscles above referred to with the object of drawing the vertebræ round towards their proper position. And upon the con*cave* side of the curve the patient has to exercise the muscles which extend from the arm to the front of the body, with the object of drawing backwards that prominent side of the thorax. The arrows in fig. 16 show the direction of the force used. A weight is raised towards the pulley *c* by the patient drawing a cord towards the body with the right hand (presuming there is a dorsal curve to the right), and the left arm is worked in the opposite direction as indicated in the figure. The pelvis must be fixed to a suitable chair during these exercises. The line A B represents the transverse axis of the pelvis.

Although this plan of exercise acts directly only upon the dorsal curve, yet the resistance of the pelvis to the action of the arms tends to twist the lumbar part of the spine in the opposite direction, and thus produces the exact action that is required. If more direct action is required for a lumbar curve the quadratus lumborum may be brought into use upon the con*vex* side of this curve.

To effect this action a shawl or wide bandage should be placed round the thorax, and to it a cord should extend horizontally to a pulley, and a weight be attached below. The weight should be raised by the body being bent over towards the convexity of the lumbar curve.

The rationale of this system is to shorten the curves upon their convexities and to rotate the vertebræ back to their normal position.

Slight variations in these exercises must be made to suit individual cases, as there is nearly always some difference in the form and nature of the curves. General exercise of the erector spinæ muscles of both sides should always be carried out in addition to the special exercises now described, and the directions already given with regard to avoidance of fatigue and suitable rest should be observed.

If improvement does not soon take place from the treatment described above, recourse should be had to some mechanical appliance, which, however, should be as light and simple as possible, and should not interfere with due exercise of the weak muscles.

5. *Mechanical Support and Pressure.*

Mechanical apparatuses, fitted to the patient's trunk, have been employed with a variety of objects, of which the following are the chief :—

1. To relieve the curves of the spine from some of the superincumbent weight.

2. To straighten the spine by direct or indirect pressure upon the abnormal curves.

3. To press upon the curves, and correct the rotation of the vertebræ.

Of the instruments which have hitherto been described, all those which are intended to fulfil Object 1 endeavour to do so by crutches, which take their basis of support from the pelvis.

Those which purpose to fulfil Objects 2 and 3 usually consist of the above framework, with an upright stem opposite to the spine, to which is attached lateral plates, which can be adjusted to the convexities of the curves.

Some instruments have two uprights, one plate being attached to each ; but in both cases the upright bar or bars can be moved

laterally and antero-posteriorly by means of rack-joints at their junction with the pelvic band.

In some instruments the crutches are connected to a horizontal bar, which is attached to a single upright at the back. The effect of these crutches is the same as that produced by those already described.

Crutches are objectionable, for the following reasons :—

The arms being connected with the trunk but loosely, the attempt to prop up the superincumbent weight by raising the shoulders is necessarily unsatisfactory in its results. If the props are raised sufficiently to act mechanically, the pain from the extremely raised position of the arms would be very severe until the nerves became paralysed—a result which has sometimes occurred. The circulation, moreover, would be interrupted.

Upon the other hand, if the crutches are only sufficiently high to be unproductive of the above evil effects, their use is limited to the occasions when the patient supports herself upon them voluntarily.

Another evil effect of the spinal instruments usually employed is that they tend to retard thoracic respiration ; whereas it should be the object of the surgeon to encourage development of the thoracic cavity.

In *post-mortem* examinations of subjects affected with lateral curvature, the muscles of the thoracic walls have been much degenerated, and the diaphragm excessively developed. This condition was well marked in the case examined by Mr. John Gay,[1] showing that respiration had been chiefly diaphragmatic. The tendency of lateral curvature is to lessen the thoracic cavity, and therefore one important object of treatment should be to encourage the expansion of the thorax.

By means of some of these instruments continued pressure may be so brought to bear upon the curves by the side plates that some reduction may be effected ; but at the same time the action of the dorsal muscles is interfered with, and so the weakness of the back is encouraged, and the natural cure is retarded.

When a spinal apparatus is necessary, it should be constructed and adapted upon the following principles :—

In *moderately severe cases*—

1. To allow freedom of action to all the muscles of the back, and, in fact, of the whole trunk.

2. To afford support to the back, in a good position, directly the muscles become fatigued.

3. To be light.

[1] *Lond. Med. Gazette*, December 1841.

4. *To be adaptable by the surgeon himself.*
5. To allow free thoracic respiration.

In *more severe cases*—

In addition to the above objects, we must employ means to unfold the curves, or, when the case is so bad and of such long standing that no improvement can be expected, we must give support to the body, and prevent further increase of the deformity.

The only apparatus [1] which thoroughly fulfils the above-described objects is that which I shall now describe, the good results of which I have witnessed in the treatment of a number of cases. This apparatus is formed as follows :—A belt (A, fig. 17) surrounds the pelvis ; a single upright rod (B) passes from this belt as high as the

FIG. 17.

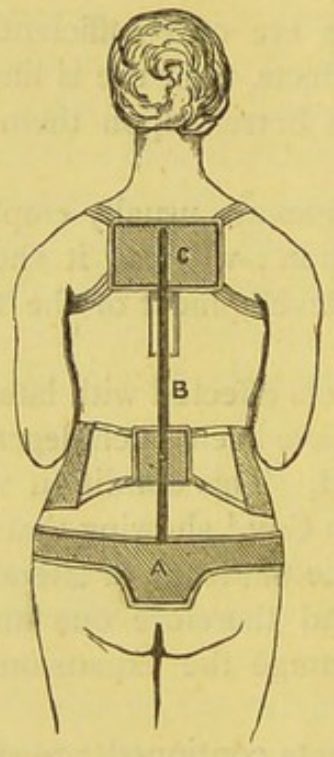
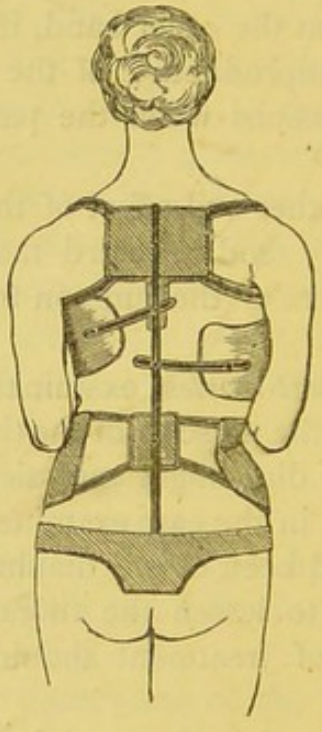


FIG. 18.



shoulders ; a pad (C), movable by a key, is attached to the upright rod ; shoulder-straps proceed from this pad, as shown in the figure ; an abdominal belt is attached by straps to a pad opposite the lumbar region, and this pad is fixed to the upright rod. The apparatus is so fitted that when the patient is seated the lower portion of the pelvic belt (A) comes into contact with the chair, so that the support in resting the back is complete.

In more severe cases lateral plates are fitted to the upright bar (fig. 18) which can be accurately adjusted to the curves. The plate upon the convex side of the dorsal curve is counterbalanced by the plate which is placed against the side of the thorax, beneath the arm of the opposite side. By this means the curve is unfolded in

[1] Devised by Mr. E. J. Chance, of the City Orthopædic Hospital.

the direction indicated in fig. 19. The advantages of this instrument over others are—

1. Its simplicity.
2. The absence of crutches.
3. Its greater adaptability to alteration in form *by the surgeon himself.*
4. Its lightness.
5. Its power of maintaining the spine in an upright position, without interference with muscular action, this result being obtained chiefly by the absence of the crutches, and by its acting without fitting into the lumbar curve.

FIG. 19.

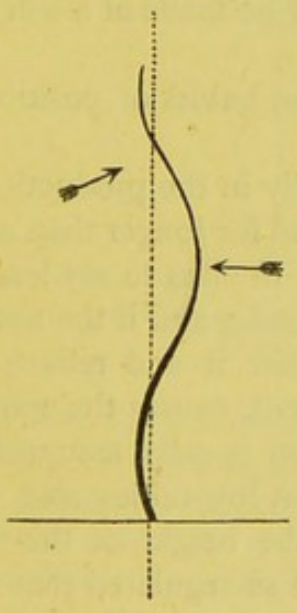
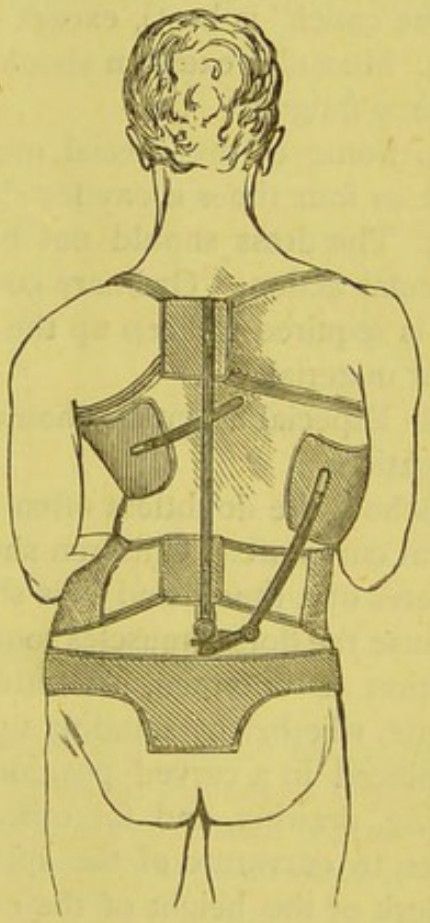


FIG. 20.



In act, by means of this apparatus a rest for the back is ready the moment the muscles become fatigued; and, moreover, the spine is thus rested in as upright a position as the curves will allow, and thus the patient has the advantages which would be obtained from resting in the most perfectly constructed chair, without the risk of ever allowing the spine to 'subside' without using the support.

In very severe cases a second movable upright may be necessary as in fig. 20.

When an instrument is used, it should always be carefully adapted

by the surgeon himself, and the pressure of the lateral plates should never be so great as to cause either pain or discomfort to the patient.

The most important point to be determined in treating a case of lateral curvature is with regard to the use of a spinal instrument. If a case is treated in the earlier stage the support may and should be dispensed with ; but the objections which have been more or less justly raised against those apparatuses which interfere with all muscular action do not apply to the support here recommended.

Treatment without Instruments.

1. The back should be rubbed with a simple liniment night and morning.

2. The patient should lie down on a soft and easy couch (a 'prone couch' is best), except when in active muscular employment.

3. Muscular exertion should never be continued long enough to produce fatigue.

4. Some of the special muscular exercises should be practised three or four times a day for short periods.

5. The dress should not be tight enough to interfere with free muscular action. Ordinary corsets are not to be worn ; but if some stay is required to keep up the dress, it should be made of a soft and pliant material.

6. Especial attention should be paid to the habits of position of the patient.

School life doubtless often assists materially in the production of lateral curvature. Children should never stand for longer than a few minutes at a time ; and girls should not stand in class to say lessons, because the dorsal muscles soon become fatigued ; and if the upright position is enforced, the attempt to maintain it and relieve the fatigue, whether by standing upon one leg or not, causes the spine to be placed in a curved position. The position usually assumed for writing, drawing, and for other occupations at low tables also conduces to curvature of the spine ; therefore the height of the table or desk or the height of the chairs should be so regulated that each individual pupil can work without having to bend the spine laterally.

Weak girls should not sit up at a table for long periods, but should do their work in the position indicated in fig. 14, p. 34.

The following cases I have selected for description as being typical of the chief forms of curvatures of the spine :—

Case I.—Posterior Curvature (Excurvation) and Slight Lateral Curvature.

Miss E., aged 7, was brought to me by Mr. Foster Palmer, of King's Road, Chelsea, September 7, 1881, presenting the amount of excurvation

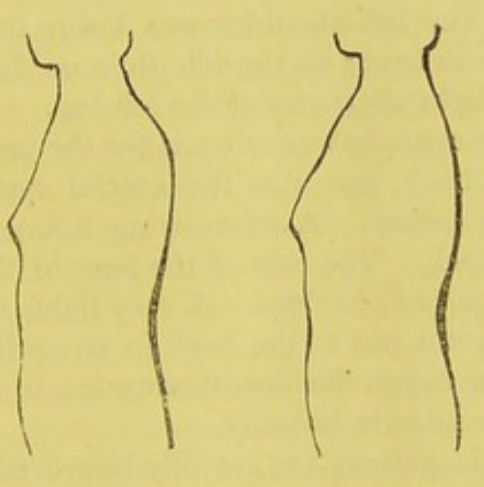
shown in the following diagram, which has been produced from a drawing of the case carefully made at the time of the first visit. There was also slight lateral curvature.

The child was delicate in build and constitution. The posterior curvature had commenced several years before, and had steadily increased. I could not straighten this part of the spine, as the curve had become fixed.

The lateral curvature, however, could be entirely reduced by pressure, and in fact the spine was very flexible in a lateral direction. The dorsal muscles were lax and weak.

The lateral curvature consisted in a curve to the left, between the first and eighth dorsal vertebræ, a curve to the right between the eighth dorsal and the second lumbar vertebræ, and a curve to the left below the second lumbar vertebræ. The result of these lateral deflections of the spine was a protrusion of the lower angles of both scapulæ, and very slight inequality in the height of the shoulders.

FIG. 21.



Outline of profile before treatment. After ten weeks' treatment.

Treatment.—I advised that the general health should be improved by healthy occupation, including outdoor exercise and tonics; that the back should be rubbed with a stimulating liniment and bathed with cold water; that the muscles of the back should be exercised, but that fatigue should be carefully avoided; and that the prone position should be adopted whenever practicable for resting.

September 16.—A light, single upright stem support was applied.

After the first few visits the case was improving so rapidly that I intended proposing having a photograph taken for the sake of record, but upon the next visit—one month from the first application of the support—the improvement was so considerable that such a record had become of no use. In another six weeks' time the posterior curvature had entirely disappeared, and the lateral curvatures were scarcely discernible.

August 1882.—This child has gradually gained strength. She remains perfectly upright, and has left off wearing the instrument for about a month.

Case II.—Lateral Curvature.

August 1881.—Miss A. F., aged 13.—Five years ago this patient suffered from typhoid fever, which left her very weak. The back has shown various symptoms of weakness ever since. In April 1880 an inequality in the height of the shoulders was noticed, and the spine was found to be curved laterally. The mother, who suffered from an extreme form of lateral curvature, knew the possible result of leaving this affection unrelieved in its early stages, and the child was taken to a surgeon, who recommended a reclining chair and low stays. The patient had used the chair whenever resting, and the stays had been worn daily without intermission, but notwithstanding this treatment the curvature had increased. The general development of the body of this child was very forward for her age. The curves consisted in a long dorsal curve to the right, and a lumbar curve to the left.

There was a considerable degree of rotation of the vertebræ, causing the ribs upon the left side of the back to protrude, especially when the patient stooped. The left shoulder was lower than the right, and the crest of the ilium was lower on the left than on the opposite side of the body. I found a slight shortness of the left leg.

Treatment.—An exercise was advised for the purpose of strengthening the muscles of the back, and also the special system already described for counteracting rotation. A stimulating liniment was prescribed for rubbing into the back. The sole of the boot of the left foot was raised to equalise the length of the legs. A very light, single upright support was adapted to afford a rest to the back in an upright position whenever the patient was not using the dorsal muscles, so that the spine should never be allowed to subside laterally.

July 1882.—This patient has steadily improved since I first saw her. The shoulders are now perfectly level, the curvatures are scarcely discernible, and the muscles of the back are much stronger. She can leave off the support at any time with perfect comfort, but I have advised that it should be worn for a few months longer.

This patient's mother suffered from a very severe form of distorted spine, her deformity having gradually developed, no treatment having been had recourse to.

Case III.—Severe Lateral Curvature.

Mr. C., aged 38.—This patient was brought to me by Mr. Azar Jones at the advice of Sir Wm. Gull, March 10, 1882. It is especially remarkable as being one of those unusual cases in which the deformity depends chiefly upon the rotation of the vertebræ, and in which the apices of the spinous processes are scarcely at all displaced from their normal vertical position (see p. 17). I have already given a description of the case of Dr. Gideon Mantell, and have described the peculiarity of the deformity in such cases. As in Dr. Mantell's, so in the case I am about to describe, several medical men were deceived by the

appearance of the deformity, and supposed that the tumour upon the back consisted of some morbid growth which might possibly, they thought, be removed by operation. Fortunately for both patient and surgeons, no operative proceedings were had recourse to. He came under the care of Mr. Azar Jones, who recognised the nature of the deformity. Mr. C. was strongly built and of tolerably robust appearance, although looking careworn and depressed. His deformity consisted in a large protrusion in the left dorsal region, extending from the upper border of the scapula to three inches below the inferior angle of that bone. The right side of the chest projected more than the left. The deformity was first noticed soon after birth. He seems to have been rachitic, for his legs were curved, but with the use of irons became straight. Not much inconvenience was felt for some years from the protrusion, but subsequently indigestion, pains in the liver, &c., and severe sciatica set in and gradually increased. About six months before I saw him he found it impossible to remain at work at an office in the City, and he spent much of his time in recumbency, as in that position he was to a great extent relieved from his sufferings. Eventually Sir Wm. Gull was called in, and, thinking that a support would perhaps do some good, sent him to see me. Upon hearing a history of this patient's case, I considered that his symptoms arose chiefly from the pressure produced by his distorted thorax, but thought it prudent to withhold this opinion until some improvement was effected. I devised an instrument with two stems, one of which ascended to a shoulder pad which was attached to the arms by shoulder-straps, and the second ascended to a shield which was adapted to the protruding ribs. This instrument was applied on March 21. Slight pressure was brought to bear upon the protrusion, the opposite and upper part of the spine being at the same time upheld. The pressure was gradually increased, and upon April 25 the patient described himself as deriving very much benefit from the treatment. His general health was improving rapidly, the sciatica had disappeared, and his digestion was very much better.

June 7.—Feels himself 'another man,' has no pain, has returned to his work, and can walk ten miles with comfort.

Case IV.—Severe Lateral Curvature and Old-standing Caries.

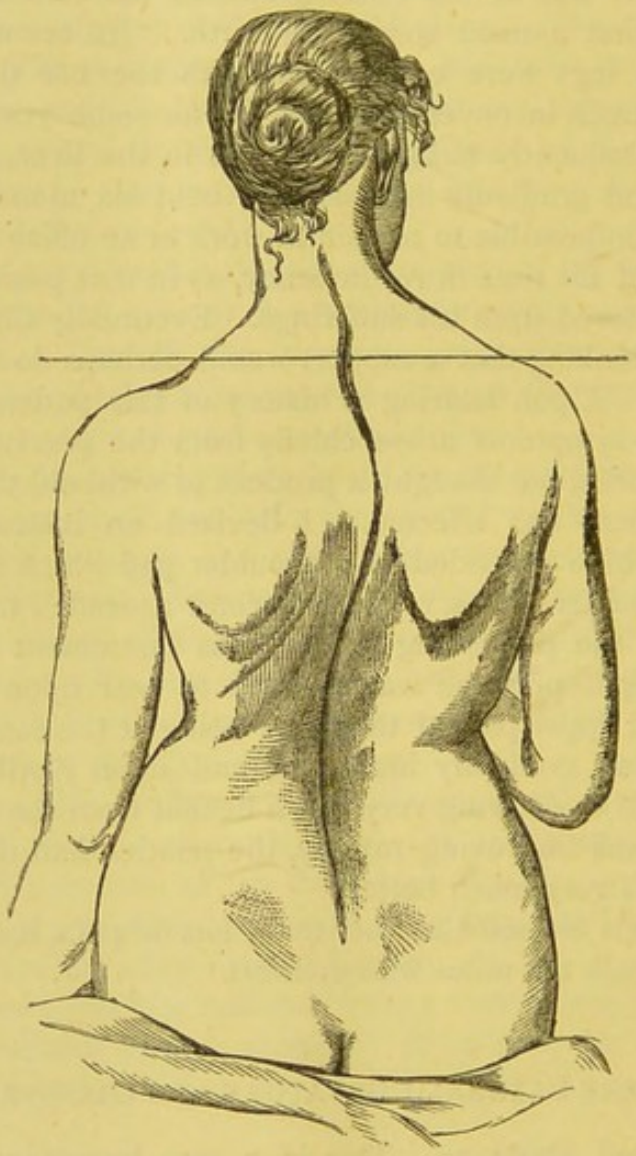
Miss G., aged about 23.—This is a very important case, because the posterior curvature, the result of caries, complicated the appearance of the deformity, influenced the symptoms, and necessitated a modification of the usual treatment. This young lady was sent to me by Dr. Mackey of Brighton. During childhood caries commenced in the vertebræ of the neck, and for two or three years the recumbent position had to be maintained entirely. In the course of time the patient was allowed to get about, and subsequently the lateral curvature appeared and gradually increased, causing in time so much discomfort that a year ago a felt jacket (so-called poro-plastic) was applied. The jacket afforded considerable relief, but was always very uncomfortable, in consequence

partly of its imperviousness to moisture, and partly from its confining the movements of the thorax and compressing the ribs.

When I first saw this patient, July 1, 1882, the muscles of the back were in a very weak condition, the natural consequence of their forced inaction from wearing the felt jacket. The curves were as represented in fig. 22, there being a posterior curve involving the upper four dorsal and lower four cervical vertebræ, the result of the caries.

There was lateral curvature forming a large dorsal curve to the right,

FIG. 22.



Before treatment.

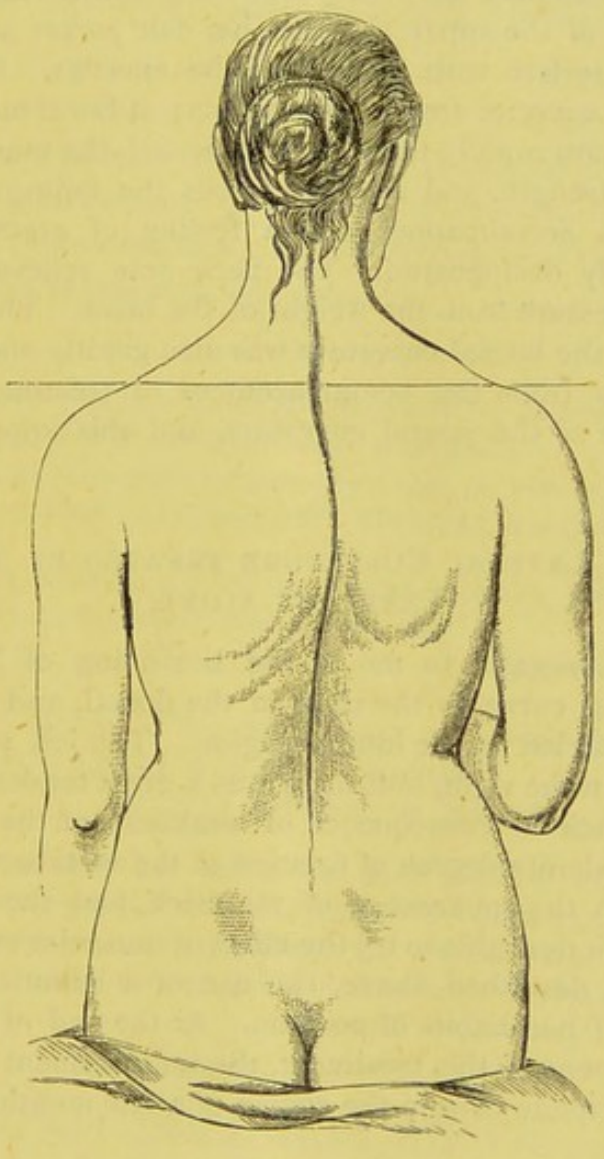
and a slight compensatory curve to the left involving the lower dorsal and the lumbar vertebræ, and an incurvation of the lower dorsal and lumbar vertebræ, the latter being the result of weakness of the dorsal muscles. The right shoulder was two inches higher than the left.

The symptoms that chiefly demanded attention, and for the relief of which I considered that treatment was especially called, were a feeling of discomfort from the weight of the head bearing upon the portion of the vertebræ which had been deformed by the caries, and the increasing

deformity from lateral curvature and the general pain and discomfort which the lateral curvature produced.

This seemed to me a case for which much good could be done. I could promise to relieve the discomfort in the neck, to prevent the lateral deformity from increasing, and to relieve the patient from pain and discomfort of the body generally, without interfering with the free movements of the ribs in respiration, or with the due exercise of the dorsal muscles. As to any improvement in the figure, any amelioration of this deformity was

FIG. 23.



After three months' treatment.

a doubtful matter, but upon careful examination I found that by means of pressure with the hands I could partially reduce the curves, and therefore I stated that the case presented favourable qualifications for improvement. The deformity in the neck from caries of course could not be altered; it was only the lateral curvature and the incurvation that I thought might possibly be lessened. In consequence of the unscientific manner in which attempts to straighten out the curves in lateral curvature have usually been made, little or no success has resulted, and consequently it has

been supposed that no improvement could be effected in these cases. For a long time I held these sceptical views upon the subject, but repeated success has shown me that by carefully regulated pressure in the simple manner already described, allowing at the same time freedom of exercise of the dorsal muscles, we may often, in young persons, effect some degree of improvement in the figure of the individual. We can always relieve the most important symptoms and prevent the patient from getting worse, and in some cases we can also straighten out, more or less, the curves.

On July 18 I applied an instrument. The patient soon realised the great superiority of the apparatus over her felt jacket as a support, and yet it did not interfere with the use of the muscles. She was able to take out-of-door exercise freely, even to play at lawn tennis. Improvement occurred more rapidly than I had expected, the muscles of the back quickly gained strength, and in a few weeks the falling in of the back, which had been accompanied with a feeling of great weakness, had almost completely disappeared. The neck was relieved entirely from the feeling of pressure from the weight of the head. The general bodily discomfort from the lateral curvature was also greatly ameliorated.

In six weeks from the commencement of treatment there was a decided decrease of the lateral curvature, and this improvement is still continuing.

Case V.—Lateral Curvature treated by Muscular Exercises alone.

Miss R. was brought to me at the beginning of November 1882. There was a long curve to the right in the dorsal, and a compensatory slight curve to the left in the lumbar region. The left shoulder was two inches lower than the right, and there was a great tendency to subsidence of the whole back in consequence of weakness of the dorsal muscles. There was a moderate degree of rotation of the vertebræ.

Judging from the appearance of the back, and the flexibility of the spine, I thought it desirable to try the effect of muscular exercises—general and special—as described above, the use of a stimulant liniment, and the avoidance of bad habits of position. At the end of one month after the commencement of this treatment, the improvement is so great that I anticipate a complete cure in the course of a few months.

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