Curvatures of the spine / by Noble Smith.

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VON ZIEMSSEN'S 'HANDBOOK OF GENERAL THERAPEUTICS'

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PREFACE

TO

THE FOURTH EDITION

I HAVE almost entirely rewritten this volume, but have retracted nothing from any statements made in previous Editions.

The chief additions are :

'The physical culture of youth, how influenced by wrongly-shaped clothes and irregular feeding.'

Additional methods of diagnosis (including the use of the Röntgen Rays).

Additional remarks upon Prognosis.

Additional details of an apparatus for mechanical treatment.

The use of Massage : and

Additional cases in illustration of treatment.

NOBLE SMITH.

QUEEN ANNE STREET, CAVENDISH SQUARE, LONDON, W.
June 1896.

PREFACE

TO

THE THIRD EDITION

The Second Edition of this volume, published at the beginning of last year, has been exhausted more quickly than I expected, so that I have not added very largely to its pages on this occasion. I have, however, given the results of the analysis of another 100 cases of lateral curvature, corrected a few errors, and made some remarks upon the Swedish 'Movement Cure.'

NOBLE SMITH.

Queen Anne Street, Cavendish Square, London, W.
January 1889.

PREFACE

TO

THE SECOND EDITION

Several months have elapsed since the first edition of this small work was exhausted, and it is nearly five years since that edition was published.

Further experience has enabled me to make considerable additions to the former volume, but, although I have cut out some parts which I have thought of less interest, I have nothing to retract from what I then wrote.

NOBLE SMITH.

Queen Anne Street, Cavendish Square, London, W.
February 1888.

PREFACE

TO

THE FIRST EDITION

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.

NOBLE SMITH.

Queen Anne Street, Cavendish Square, London, W.

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CURVATURES OF THE SPINE

CHAPTER I

INTRODUCTORY

The spine may be abnormally curved as a consequence of a variety of conditions. These conditions are: congenital deformity; accident; dissolution of portions of the vertebræ as in caries, cancer, absorption from the pressure of an aneurism or other tumour; softening, rarefaction, or inflammatory affection of the bony structure, such as rachitis, osteomalacia, osteitis deformans, rheumatoid arthritis; and long-continued posture. Posture will influence even a healthy spine in the course of time, and more rapidly a weak one. It is mainly with curvature produced by causes irrespective of inflammatory disease and pressure that I am about to deal in the following pages.

The contents of this introductory chapter are made up of two papers contributed to medical journals. They deal with the subject of lateral curvature and weakness of the spine in a general manner, and especially refer to questions which frequently come before the general practitioner.

Every medical man must meet with cases of lateral curvature of the spine, and it is, probably, often a difficult matter for determination as to the best course of treatment to be adopted.

'Growing out' of deformity.—One question that will probably occur is, 'Will the patient, if a child, grow out of the deformity?' I think that this question may be freely answered

in the negative, for, judging from the large number of severe cases which come before the notice of orthopædic surgeons, it is evident that such a favourable result is not usual.

Doubtless some slight cases do get better without treatment, or rather from treatment of the general health alone, but the very large number of severe cases which exist must have had a commencement, and therefore it is evident that *the majority of slight cases do not get well by themselves.*

If the reader is not aware how many very severe cases exist, I would ask him to observe closely the backs of young and middle-aged ladies in any public assembly. Let him watch and make a record of backs; I think he will be very much astonished at the result, and he must further bear in mind that dressmakers are remarkably clever in hiding deformity, so that moderately severe cases will pass undetected. The evidence to be gained from such observations affords absolute proof that if a few of those affected 'grow out' of curvature of the spine, the majority are not so fortunate.

The following case is one of a great many which I could record to illustrate this point.

Mr. S., aged twenty-eight, consulted me in November, 1884. He was afflicted with a very severe form of sigmoid lateral curvature. At the age of fifteen, the spine was first noticed to be crooked, but nothing but exercises were used as a remedy, because it had been said that the deformity would *get right by itself*, but instead of this the patient became gradually worse. Such a history is not uncommon.

The further increase of deformity in this case was stopped by means of a support. There was no question about the necessity of using mechanical help in this case.

[Not having seen this patient for many years I called upon him recently (1895), and found him hard at work at a printing press. He had remained in perfect comfort all the time, and was still wearing the apparatus.]

General health.—Then, if we arrive at the conclusion that unless some means be taken to interfere with the progress of slight cases of curvature, the possibility is that the deformity will increase; the next point which presents itself will probably be, 'Is interference necessary on the score of health, or is the question simply one of appearance?'

In answer to this question, I think that no doubt should exist that we ought to regard the matter from the former as well as from the latter point of view, for although in any particular and exceptional case the general health may appear to be unaffected by the deformity, sooner or later pain will occur and the general health will suffer. Of the 200 consecutive cases of lateral curvature analysed at p. 42 (which are taken from my own note-books), in all, with the exception of two or three, a marked improvement in the general health has been effected by treatment, and only these few were so well in the first instance that no room for improvement in health existed.

The great majority of cases occur either in delicate children, or at least in those who are not robust. The symptoms of ill health are often obscure; they may be *apparently* unconnected with the condition of the spine, but the general weakness will usually be found to have acted as a predisposing cause of the spinal trouble, and one of the most notable results of the treatment advocated in this volume is the improvement which takes place in the general health. I was at one time inclined to consider this improvement merely a coincidence, but its repeated occurrence led me eventually to conclude that it was attributable to the treatment of the spine.

Whatever may be the connection between the bad health and the curvature in the early stages, the relative effects usually become more clear as the deformity progresses. Pressure upon the side of the concavity, or undue stretching of the parts upon the side of the convexity, frequently gives rise to pain. Pressure may cause so great a variety of pains in the back, or the side, or down the legs, that it is impossible to give a description that would be generally applicable. Indigestion is a common accompaniment of curvature, and doubtless is the result of nerve pressure and nerve irritation. Indigestion is also produced by interference with the functions of the stomach from stooping. As the shape of the thorax changes, the space for the lungs and heart becomes reduced, and the functions of these organs are more or less seriously interfered with. Among many interesting cases of this kind I will mention one of the more remarkable.

Mr. C., aged thirty-eight, was sent to me by Mr. Azar Jones, upon the advice of Sir William Gull. He 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 shortly after birth. He seems to have been rachitic, for his legs had been curved, but had been cured by the use of splints. Little inconvenience was felt for some years from the protrusion, but as he grew up indigestion, pain in the liver, 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 William Gull was called in, who, thinking that the condition of the spine probably influenced the general health, sent him to see me. A supporting apparatus was applied on March 21, 1882. Slight pressure was brought to bear upon the protrusion, the opposite and upper part of the spine being at the same time supported. The pressure was gradually increased, and on April 25 the patient felt that he was deriving very much benefit from the treatment. His general health was improving rapidly, the sciatica had gone, and his digestion was very much better. On June 7 he said that he felt like 'another man,' had no pain, had returned to his work, and could walk ten miles with comfort.

I referred to this case in the first edition of this work, published in 1883, and I am able to state that the patient remained perfectly well in 1887.

I have met with some few patients in whom pain or discomfort has not occurred until the deformity has attained to a very severe degree and the patient has become advanced in years, but in these instances the evils, although deferred, have become at last very severe.

No one can watch the progress of curvature of the spine, nor hear the history of many severe cases, without recognising the great importance of treatment in the early stages, at a period when we can with certainty stop the progress of the deformity and can generally remove that which has already developed.

In January, 1884, I saw Miss C., aged thirteen. Her spine was slightly affected with lateral curvature. She had been treated by the *movement cure* without any permanent advantage. It seemed to me probable that a complete cure might be expected after a few months' treatment. Other matters, however, were

allowed to interfere, and treatment was deferred. In six months' time the child was again brought to me, and so rapid had been the progress of deformity, that a very severe S-shaped curve had developed. Each curve was two inches from the median perpendicular line of the back, so that if parallel vertical lines had been drawn through the apex of each, these lines would have been four inches apart. A cure was now out of the question, although by treatment the deformity was lessened.

The next practical point for consideration is the question, **'Are the means at our disposal so effective that treatment is worth the trouble and expense?'**

If treatment necessarily involved considerable interference with the liberty of the patient, or the wearing of a heavy instrument interfering with muscular action, or any other similarly objectionable procedure, then such a question would be worth considering. But as the cure, or the retardation of the curvature, can be satisfactorily accomplished without enforced recumbency,[1] without the application of any apparatus which will interfere with the development of the body or use of the muscles, without using extension machines, and without any painful or irksome methods, there ought not to be any doubt that treatment should be carried out in every case without delay.

As to the possibility of a case getting well by itself, such a result is so unlikely that it can hardly be wise to trust to it.

In dealing with a case of curvature we have in the first place to decide as to its immediate cause; *i.e.* the cause which has to be counteracted. For instance, one leg may be shorter than the other, a condition which, although only acting when the patient is erect, yet undoubtedly has a powerful influence upon the spine. I have met with cases in which the pelvis also on one side has been small, under which circumstances the influence acted when the patient was sitting as well as when erect. Girls, especially when weakly, often get into the habit of sidling themselves into a chair in such a manner that the left lumbar region is made to project to the left, and as it is upon

[1] Exceptional cases occur in which the bones are so soft and the ligaments so lax that recumbency is necessary.

the left side that a short leg generally occurs, their sitting attitude maintains the bad effect produced in the upright posture. One whole side of the body may be smaller than the other, and there may be many such conditions which must be distinguished from asymmetry caused by the curvature. Lameness or ankylosis of a hip or a knee may have the same effect as a short leg. Then again there may be the results of former thoracic disease, such as a collapsed lung or adherent pleura influencing the shape of the spine.

The limbs may be of equal length but one may be more or less paralysed ; this condition may require very careful consideration. I met with such a condition in the case of a young lady aged fifteen, whose left leg, including the flexors of the thigh, was completely paralysed. She was wearing an instrument upon the leg, without which she could not stand, and when she walked the effort of throwing forward the whole leg had caused the lumbar part of the spine to be curved very much to the right. This was a difficult case and involved considerable modifications of the leg apparatus, the most important of which consisted in an elastic attachment from the knee to a waist belt, which took the place of the paralysed flexors.

There may be an absence of one arm, necessitating a curve to compensate the balance. The curve may be *secondary* to deformity from caries in another part of the spine. There may be a congenital malformation of the spine, or we may meet with muscular contraction, such as wry neck, as a cause.

The following case exemplifies the last-named condition.

Master H., aged seven, had a severe wry neck, the spine being curved as a result. On January 7, 1884, I divided the contracted sterno-mastoid, and cured the torticollis. It was then found that the left leg was $\frac{3}{8}$ of an inch short, and a cork sole was placed inside the boot. Eight months afterwards the spine and head were both straight and the child much improved in health.

A spine may be curved from using a crutch on one side only. Miss S., aged eighteen, sent to me by Mr. Parsons, of Wimbledon, had been treated for hip-joint disease, by wearing a thick sole on the foot of the sound side, and using a crutch and swinging the diseased leg. The result was peculiar ; a long sweeping curve of the spine existed to the right, and consequently, as in all such cases, the right ribs projected backwards. Instead, however, of finding a corresponding projection forwards upon the opposite side of the thorax, this projection was present on the same side as the

posterior protuberance, the deformity having been caused by the crutch, which had pushed up the shoulder and flattened the chest laterally.

There may be paralysis of some of the dorsal muscles, the effects of which will be greatly lessened by the spine being mechanically held in an upright position.

There may be deformity caused by contraction from scars —after burns, for instance.

The assumption of bad postures by habit alone is a distinct cause. Bad postures may either depend upon disease, giving rise to pain, causing the body to be repeatedly bent to one side, or to bad habits, such as standing repeatedly upon one leg, or sitting awkwardly at a desk. Such postures are often brought about by inability to sit up or stand straight from general weakness, and this cause is a very important one; probably it occurs in the majority of the cases met with in practice.

In these latter class of cases where debility has led to the assumption of bad postures, the question of treatment is less obvious than it is in many of those described above. Of course it is comparatively easy to give better supports in the way of desks and seats, but this is not sufficient when a curvature has commenced.

Among the methods which have been employed for the treatment of commencing curvature of this latter kind is recumbency.

Recumbency, during which the superincumbent weight is taken off the spine, has a preventive tendency, but is not usually carried out in a very satisfactory manner. A child is condemned to lie in a supine position, either on a hard board, or the floor, or on a couch, for a certain number of hours every day. The enforced rest is very irksome and often interferes with healthful and natural play, and yet when the prescribed period has passed the child may sit up for a short time and undo all the good for the production of which so much trouble has been taken.

Moreover, the supine is not the best posture. In this position the dorsal muscles get no work at all. The back is probably more or less bowed backwards, and every effort to hold a book, &c., or almost any movement of the head or arms tends to make the back more round. I have seen a child with lateral curvature, whose parents informed me that they carried out treatment by such recumbency seven hours every day for seven years, and that no benefit whatever resulted.

Prone position.—The plan I adopt is based upon a different principle; I advise the prone position on a prone couch of a pattern described in another part of this book. The patient is more comfortable thus than in the supine position; the back falls into a good posture, the head is held erect. Every movement tends to exercise the dorsal muscles, and to influence the back for good. (See p. 92.)

As a rule children like the prone position from the first. The beneficial result is remarkable. The chest is expanded, and where there has been any difficulty in breathing, that rapidly improves.

I believe that the great advantages of the prone couch over all others would have become more generally known, and would be more widely recognised than they are, if the original pattern had been adhered to. The prone couches commonly made are quite wrong in shape. (See p. 92.)

Sometimes, in the prone position, when the back is very weak and the patient has been in the habit of bending the head forwards, the effort to hold the head erect gives rise to pain in the neck. This is partly the effect of muscular exertion and partly the result of straining the neck out of its abnormally curved position. This pain soon subsides. Occasionally the head requires slight support at first, and for this purpose a pillow, I find, is sufficient. Children quickly get used to and like the prone position in preference to the supine, because they can so much more easily play and read.

Another very important point as regards recumbency is that it should not be enforced for any certain length of time. So long as the child is running about and playing it is well not to interfere, but for resting, the couch should be used as much as possible instead of a chair. The practical result of this plan is that the recumbent posture is frequently and readily adopted.

Thus by relieving the spine from superincumbent weight whenever the child is not actively employed, the chief cause of increase of the deformity is removed, while at the same time the dorsal muscles are exercised in a right direction.

Exercise.—In the case of a child the ordinary play is sufficient exercise, without the taking of walks. Walking is not a very good exercise for weak children. In many cases I believe it to be very harmful, as it overworks the muscles of the back.

In very simple cases of curvature, recumbency, coupled with treatment of the general health, may effect a cure, but generally further measures are required, or at least are advantageous.

Gymnastic exercises.—The question then naturally arises as to advising gymnastic exercises, general or special. All the circumstances of the case should be very carefully considered before deciding upon this point. A great many patients are far too weak to undergo such treatment at first. In these cases gymnastic exercises will do harm by overtaxing the muscles and the weak joints of the spine, whereas a few weeks of rest will invariably be beneficial.

Exercise is very valuable in many or most cases, but it should not be advised indiscriminately. (See p. 95.)

Supporting apparatus.—Then comes the question as to the use of supporting apparatus: 'Are they to be discarded altogether, or can they be employed beneficially?'

I would most emphatically urge that all apparatus that act simply as supports, and which interfere with the development of the muscles of the trunk, should be discarded. Heavy machines built up upon the pelvis (and in this category I include plaster of Paris and poroplastic jackets) are objectionable. If a mechanical apparatus is needed it should be very light, and should simply *direct the movements of the body to act remedially.* This kind of action is infinitely more powerful for good than statical pressure.

We should look closely into the principle of construction of the apparatus, for the mechanical difficulties to be overcome are certainly very great, and account for many failures in treatment.

Extension.—Perhaps the chief examples of misapplied mechanism are the attempts which have been made to straighten spines by extension.

Among the earliest records of treatment of curvatures we find plans described for stretching out the spine, and numberless devices have been added in the same direction at various times since.

Attempts to stretch the spine have been made to act either between the head and pelvis, or between the shoulders and pelvis, or by the weight of the body in suspension. Innumerable ex-

tension beds have been invented, also gibbets and stays, all acting upon this principle. I think it is not difficult to show that the principle is wrong, in that it is mechanically defective.

In the first place, as regards extension from the head, the upper cervical region is a weak point in the spinal column, and traction sufficiently powerful to influence the curves would be much more likely to produce injury, more or less severe, to this part of the spine.

But even if we could obtain firm hold of the spine at the upper part, we should yet have very little power to pull it straight, or rather the power expended would have a very slight effect. To illustrate this fact, let us take a stout piece of copper wire or a thin iron rod, and bend it to represent the spine. Then if we hold each end with the fingers or with pincers and endeavour to straighten it by stretching it lengthways the difficulty is great; we are working at a mechanical disadvantage, and probably will find it impossible to pull the wire into a straight line; but let us support each end, and press laterally against the curve, and with much less expenditure of force the desired effect will be produced. This fact is of course not new, and no one would have thought of trying to straighten the wire in any other way than by lateral pressure, but the argument has not been hitherto applied in discussing the treatment of the spine. Lateral pressure upon the apex of the curves possesses, therefore, an immense advantage over direct extension. It may be said that we cannot press directly on the spine because the ribs on the dorsal and the soft parts in the lumbar region interfere, but the pressure that we can produce through these structures is infinitely more powerful for good than the most carefully applied extension, and it surprises me that there could ever have existed a doubt upon the subject. Moreover, this lateral pressure can, even in severe cases, be applied without interfering with muscular action. It is only in posterior curvature of the spine that extension can have much effect, and with regard to its action in such a case I cannot do better than quote Dr. Busch, in 'Von Ziemssen's Handbook of General Therapeutics,' who remarks that although extension may straighten the spine, 'as soon as it (the extension) ceases, the back subsides all the more, since its muscles and ligaments are subjected to powerful stretching, on the cessation of which they are less capable than before of preserving an upright carriage in opposition to weight. The result is consequently a very temporary one, and the after effects rather hurtful than beneficial!'

Crutch apparatus.—The attempt to correct the curves by propping up the arms is even less effective than extension; and the only way in which it acts is by inducing muscular power to influence the curves laterally.

Gibbeting.—Gibbeting is another form of attempted extension; the plan was originated by Glisson, and has of late years been reintroduced by Sayre in conjunction with the use of plaster of Paris jackets.

Jackets.—Jackets made of plaster of Paris, felt, or other material, have been very fashionable of late years, but are rapidly going out of fashion. When once applied they save the surgeon a great deal of trouble, the patient thinks and even feels that *something* is being done, and when, after a certain number of weeks or months, she finds that no improvement has taken place, or that the deformity has increased, there remains the consolation that the treatment has been very economical. Some surgeons assert that they have effected some good with jackets; if they have I am sure that such cases would have derived very much more benefit from a more careful and scientific method of treatment.

A case in point is that of Miss R. In July, 1882, when I first saw this patient, there was a very severe dorsal curve to the right, 2 inches from the middle line, and a compensating curve to the left in the lumbar region, $1\frac{1}{2}$ inches from the middle line. A poroplastic jacket had been worn for a year, causing much discomfort from its weight and impermeability to heat and moisture. The back had become so weak that the patient could hardly sit up without support, and no improvement had taken place in the curves.

The jacket was discarded, and a very light apparatus which did not interfere with free use of muscles was substituted, and with careful treatment the back soon regained strength, and subsequently became perfectly straight.

General observations.—The treatment of the various forms of curvature will be described in detail under their respective headings, but here I would remark, that although many cases are very difficult to treat, there are few, if any, in which some good may not be effected.

However severe the curves, and however advanced the patient's age, something may be done, at least, to relieve the

general discomfort and actual pain which almost invariably develop sooner or later. Arrest of the progress of the affection ought always to be accomplished, whilst in the majority of cases an improvement in position may be obtained. In the earlier stages we may remove the deformity altogether.

Medical opinion often takes the following form. A very slight case of curvature is seen, and the surgeon says: 'This case will get well by itself.'

Another patient comes; a case of severe deformity. The surgeon then remarks that 'it is so severe that nothing can be done.' This is very illogical; the bad case must have been a slight one once—originally it must have been in a condition when, according to that surgeon, the patient would 'grow out of it.' Moreover, however severe the deformity, there is no particular stage where no room for increase exists.

These cases undoubtedly deserve more careful attention than they usually receive. Severe curvatures would be very rare indeed if in every instance of commencing deformity judicious treatment were had recourse to, and I would urge that such treatment should as a rule combine the following points:—

1. Freedom of exercise.
2. Avoidance of fatigue.
3. The prone position for rest, on a properly constructed couch.
4. The avoidance of heavy instruments and jackets.
5. The counteraction of the curves by keeping the spine from falling into bad positions.

The Physical Culture of Youth: how influenced by Wrongly-shaped Clothes and Irregular Feeding

Clothes

The most potent obstacle to the proper development of the child is the clothes he wears. This is not at all a necessary evil, but, as a fact, the ordinary construction of clothes is absolutely wrong in the great majority of instances, and with at least 90 per cent. of children, including all classes, the evil I refer to exists. Many of these errors in construction of clothes are the outcome of views entertained by us of the medical profession, views which, although sound in theory, have become absolutely wrong in practice.

To begin with: We have always opposed the tight constriction of any part of the body; consequently, we have objected to tight bands round the waist, and the suspension, especially in women, of heavy clothes from the pelvis; also we have protested against tight garters round the leg—the former because they interfere with the organs of the pelvis, and the latter because they retard the circulation and give rise to or exaggerate a tendency to varicose veins. These objections, as I have already said, are founded upon sound theories, but what results have they given rise to? So much is there a fear of constricting a child, either in the waist or legs, that the clothing has been almost entirely suspended from the shoulders, giving rise to incalculably more harm than ever could arise from the former practice.

Children, especially girls, have to wear stockings, and to keep these stockings up an elastic suspender is attached, this being fastened either to a light stiff jacket or a corset which is kept up by shoulder straps, or else the suspenders are carried direct by straps over the shoulders. Then other articles of clothing are also kept up, more or less, by shoulder straps, and these straps are not placed close to the neck, where they would be less harmful, but to the apices of the shoulders, where they constantly tend to bear the latter downwards and forwards, giving rise to stooping shoulders and to a poking head, depressing the chest, and acting as a constant source of irritation to the wearer.

It is hardly necessary to point out the evils of this practice, how a posture thus engendered lessens the vital capacity, and so affects the physique and health of the body; how it favours the liability to coughs and colds, and even to phthisis; how the bending forwards of the spine, and the efforts, slight but constant, to hitch up the shoulders or to overcome this dead weight may be the starting-point of curvatures of the spine, and, as girls are subjected to a greater extent to this evil clothing, how this is probably one cause of the greater prevalence of spinal curvature in their sex.

Clothes must be fastened somewhere, and it is desirable to distribute as far as possible the points of attachment. The clothes which surround the trunk may be kept up by their attachment over the shoulder, but this should be close to the neck, as takes place with the ordinary flannel vest. No part is more fitted for the suspension of the nether garments than the hips, and the fact is well known to all of us. Every man who has to work his arms

takes care to get rid of all encumbrance about the shoulders. The sailor, the stableman, or any other worker gets rid of his braces and uses a belt, the natural indication being to leave the shoulders free for action.

If suspenders are used for keeping up the stockings, they should be fastened to the waist (but even when fastened here they may bend the body forwards from being too tight), and not to the garment which eventually takes its bearings from the shoulders. Garters may be used without fear of evil, certainly with children, for they need not be so tight as to interfere with the circulation. It is only in exceptional cases, and chiefly in adults, that garters under any circumstances become harmful.

A well-developed chest, with straight back and well-placed shoulders, is an exception in civilised countries, chiefly, I believe, as a consequence of the evils of badly arranged clothes. Children grow up with ill-developed chests and stooping figures, and with these we have frequently to deal. Even severe drilling in later years never entirely overcomes the harm thus done in youth. These results are commonly attributed to school postures, and doubtless these postures are bad enough ; but one reason why they produce so much havoc is, that the bad figures have been first of all engendered by the wearing of improper clothing.

In dealing with these children one always finds that their clothing has been fitted from a dressmaker's or a tailor's point of view, *but in the bad positions*, and any attempt to hold them upright and bring back the shoulders into a proper position is counteracted at once by the tightness of the garments across the chest. The bad influence of this wrongly-shaped clothing is commenced long before the child begins scholastic occupation, but when we come to the time of life when school commences, we are met with a combination of difficulties which it is most difficult to contend against.

Food

Another very important point is the nourishment of growing children. It is a serious accusation to make, and one which I should not venture upon had I not a very considerable amount of evidence to bear me out, that there are very few schools in this country where the children are sufficiently well fed to enable them to grow up strongly, let alone to meet the extraordinary strain upon their efforts of development caused by the immense amount of mental work which is thrust upon them. A lack of

nitrogenous diet, a lack of care and niceness in cooking, a monotonous character of food which dulls the children's appetites, all combine to bring about this bad effect.

The four chief points in which school diet fails are :—

1. Insufficient quantity of nitrogenous food.
2. Indifferent quality.
3. Indifferent cooking.
4. The long periods between solid meals.

1. That the quantity is insufficient is proved by the great number of feeble young people who are turned out from these institutions, and the fact of the large number of delicate girls and boys who come under treatment for conditions which clearly indicate the want of nitrogenous strength.

2. I might assume that indifferent quality of the food supplied is well known to most of us, but I may here mention a fact which lately came before me. At one of our largest public schools for boys, the meat had to be sent away from the table, because it was absolutely bad, several times during one term.

3. Indifferent cooking is very prevalent in schools, and the general view that the complaints of young people are not worth attention leads to this matter being overlooked.

4. The time between mid-day dinner and next morning's breakfast is seldom interrupted by any solid meal of meat, and even when meat is placed upon the table its unattractive condition repulses the appetite and it is frequently not touched.

The story of these deficiencies as regards the food of young people is probably an answer to the following questions :—First, Why is it that so many children grow up with delicate constitutions ? Second, Why is it that so many thousands develop weak and crooked spines ? Third, Why is it that tubercular disease makes so much havoc in this country ?

CHAPTER II

GENERAL DESCRIPTION OF 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 upper part of 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 probably weaken it as a supporting structure, but enable it to sustain a greater amount of violence without injury than if it were perfectly straight.

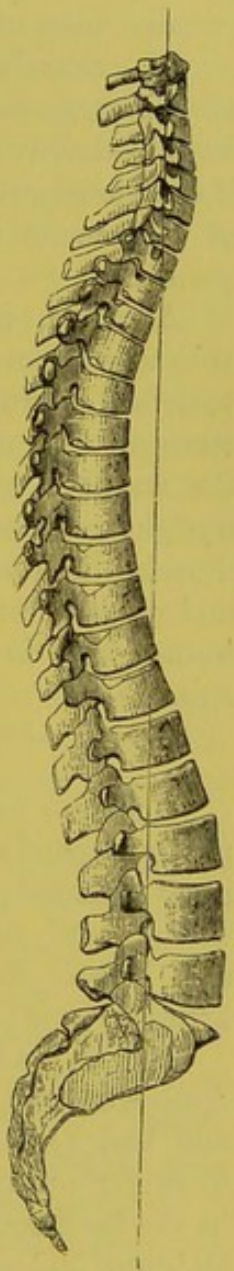
This advantage, derived from the curves, is exemplified when an individual leaps from a great height. The shock upon alighting is disseminated through the column by an increase of the curves as well as by the elasticity of the intervertebral discs.

A slight dorsal lateral curve to the right has been described as a normal condition of the spine, and many writers offer various explanations of this condition, the majority considering it the effect of muscular action; but modern observers, who have given much attention to the subject, assert that there are no obvious *natural* lateral curves in healthy persons.

The intervertebral discs together form about a fourth or fifth part 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 conformity 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, and permit the weight of the body when vertical to increase the curves and thus shorten the stature. The Abbé Fontenu found that this decrease during a day amounted on an average to $\frac{3}{4}$ of an inch, and that a night's recumbency permitted this to be regained.

I do not consider it 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 first cervical vertebra may turn towards one or other side; but the movement is chiefly between the two first vertebræ, and those below move less than might be supposed. To whatever degree the cervical portion of the spine turns the 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. Their 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, depend 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]

A few years 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 broken. I was

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

enabled, by the kindness of Dr. Barnardo, to examine 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.

It has been stated that the erect position of the spine is not maintained by *active tension* of the muscles, 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.' But 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 Undeve oped 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. It will be remembered that 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.

CHAPTER III

POSTERIOR CURVATURE OF THE SPINE (KYPHOSIS, OR EXCURVATION)[1]

This deformity may occur at any age; it is common in infancy, and generally occurs to some extent in old age. In the latter instance posterior curvature is often considered a natural result of senility, although we have plenty of examples of old people retaining perfectly their upright stature; especially soldiers. 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 temporarily removed by pressing the back in with the hand, 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 parts of the vertebræ, and so the curve becomes more or less perpetuated. The bones and cartilages are 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; the power of inspiration is lessened, and the action of the heart is impeded. These results may be described as follows.

[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.'

Effects of Posterior Curvature upon Respiration, and other Functions

In consequence of the bending forwards of the body the abdominal muscles are relaxed, and their power of action is lessened or entirely lost.

This decreases or destroys the power of abdominal respiration, and at the same time weakens the action of that most important respiratory muscle, the diaphragm.[1]

The attitude of bending forwards prevents the proper action of the ribs, and so lessens thoracic respiration, and thus posterior curvature impedes to a serious extent the powers of breathing. This lessened power of respiration not only affects the very vital process of aëration of the blood, but also interferes with the due performance of many of the functions of the abdominal viscera, for our power of acting upon the latter organs in the processes of expulsion depends upon our ability to fix the diaphragm in the first instance.

A round back generally produces a flattened chest, and a constricted space for the lungs, heart, and stomach. Much might be written upon this subject, regarding the indigestion, the impeded circulation, and the lessened capacity for respiration which ensue, but I will here only refer to the last-named effect.

Vital capacity.—We are indebted to the late Dr. Hutchinson for very valuable researches upon the movements of the chest, and upon the relations between the breathing powers and the health. Among many of the valuable facts which he published was that which showed a certain standard of what he called VITAL CAPACITY for every individual of a similar height, weight, age, and sex. The VITAL CAPACITY of an individual is indicated by the volume of air which he is able to expel forcibly from his lungs after a full inspiration. At the middle period of life, the vital capacity *necessary for health* of a person measuring 5 feet high is 174 cubic inches, whilst for one of 5 feet 10 inches it is 254 cubic inches. These measurements never vary in perfect health, and therefore, when the amount of respiratory power as

[1] It would seem that when lateral occurs in conjunction with posterior curvature the diaphragm may be abnormally developed. See p. 72 (Mr. Gay's dissection).

thus indicated is diminished, it proves the existence of either distinct disease, or, to say the least, it shows a lessened vitality.

Dr. Hutchinson also proved, and in fact it is a matter of general observation among medical men, that in people with round backs the vital capacity is very much lessened, and it seems probable that individuals thus afflicted are more liable to become consumptive than others, and have less power to resist an attack of ordinary lung disease. We, therefore, have excellent reasons for doing all we can to prevent the development of round backs, and all we can to remove them when once produced. I have found that by improving the posture, an increase in the circumference of the chest in expansion of from one to three inches has taken place in a few weeks.

The cases which I shall presently describe are instances in which the mechanical means adopted have, by increasing the vital capacity, that is, by more thoroughly aërating the lungs, removed symptoms which are very similar to those which accompany phthisis. I have made a number of experiments with the spirometer, while the subjects have been in different postures, and have invariably found the volume of air breathed greatly increase after artificial expansion of the cavity of the thorax.

Mechanical treatment of phthisis.—There can be no doubt that mechanical expansion of the chest is a most valuable means of treatment in consumption, a fact which has long been recognised. Mechanical apparatus for its accomplishment has been advocated by Dr. Sylvester, the deviser of the system of artificial respiration which bears his name, although the means he proposed were not so effectual or convenient as the apparatus to be presently described.

Symptoms in posterior curvature.—At the commencement of the development of posterior curvature there is usually some pain in the back, and a general sense of weakness in the dorsal muscles, especially after exercise.

In children the period of walking is late; or, if the child has commenced to walk, it loses its activity, and is tired after very little exertion.

The general health becomes impaired.

Causes.—*In infants* this deformity is caused by general debility affecting the back, or it may be the result of rickets. It is very frequently produced by badly shaped clothes (see p. 12).

In *youths* and *adults*, also, it may be the result of weakness,

or of long continuance in the stooping position independent of weakness. This is especially likely to happen with near-sighted children. Anything which causes the body to be much bent forward, such as contraction of muscles, as when both sterno-mastoids are contracted, will cause posterior curvature; cicatrices from burns in the neck, or (rarely) in the abdominal region; or paralysis of the muscles of the neck, allowing the head to fall forwards. In older patients the back may also be curved outwards by chronic rheumatism and by osteitis deformans, also by caries and the other diseases mentioned on page 1.

Treatment of posterior curvature.—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 fig. 2.

FIG. 2

Moulded gutta-percha back splint

The general health will also require attention. The splint is to be used until the child has become stronger, which, as a rule, quickly takes place.

In youth, treatment by drilling, various gymnastic exercises (see p. 133), active games, and cold-water bathing, may suffice to cure the deformity. The use of the skipping-rope is very beneficial, the right and left foot being alternately put forward, but in many cases (especially in girls) it is necessary to apply a mechanical apparatus. A simple instrument for this purpose, to be described presently, may be used, or a well-padded backboard with arm-straps and belt, but *spinal instruments, with crutches, should never be used.*

For recumbency the prone position is better than the supine (see p. 91).

Stafford and others have 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 posterior curvature, such treatment would be likely to cause the spine to give way laterally, in consequence of weakness of the spinal column. Another objection to this

plan is that it will often increase the deformity by inducing the patient to round the shoulders and protrude the abdomen.

Andrey 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 of curvature the patient is often unable to use the dorsal muscles for long periods, the plan is inapplicable.

Stimulating embrocations applied locally, cold-water bathing, and a generally tonic plan of treatment, should be advised.

For further remarks upon methods of exercising the spine, see pp. 82, 97, 133.

Massage is another remedy which is of great value in treatment. For description, see p. 118.

A simple apparatus.—Posterior curvature of the spine from debility is a very satisfactory affection to deal with. By using a simple apparatus, which might be called an artificial spine, an immediate improvement in position is produced, and in the majority of cases in children the spine can be placed in a natural position either at once or in the course of a few weeks. The effect upon the general health produced by this treatment is sometimes most remarkable. A child in a sickly condition, with short and hurried respiration, too feeble to sit up straight for more than a few moments, with its chest flat and perhaps with ribs indented, is, in a short time, sometimes in a fortnight, relieved of all its suffering, its appetite is restored, and it is soon enabled to walk and play with energy and freedom, and to sit with its chest expanded and spine erect. This result is moreover effected without interfering with the action of the muscles, and without pressing upon the walls of the thorax. The shoulders are held backwards by shoulder-straps towards a pad between them, which is continued downwards by a light steel rod attached below to a pelvic belt, a pad being placed opposite the lumbar region. (See figs. 31, 32.)

The principle of action of this apparatus is totally different from anything else of the kind that has ever been invented. It is the only instrument which limits its action to the time when the muscles are not being used.

It is the only apparatus which acts without interfering in the least with the action of the ribs. Its effect is, on the contrary, to constantly develop the thorax and increase the vital capacity. See p. 105 (' A New Principle in the use of Spinal Apparatus ').

Gradual adaptation.—Whilst, however, it possesses these advantages, this apparatus cannot be applied like a well-fitting garment to act without alteration. The spine cannot be forced at once into a good position and kept there, but must be gradually brought into an upright posture. At the same time room must be left for the muscles to act in ordinary movements. The only action which must be restricted is stooping, and this should be limited but not quite prevented.

When first dealing with this class of cases, my anxiety to make rapid progress led me to attempt too extensive alterations at each visit, with the result that pain was caused, and I had to retrace my steps. With some sensitive children we must proceed with very great caution, for it is very important not to produce discomfort and thereby cause a dislike to be taken to the treatment. With due care, and with experience, one learns exactly how much alteration to make at each visit, so that only comfort is produced. The following few cases will suffice to illustrate these points:—

Cases.—A young lady, aged sixteen, was sent to me by Dr. Charles Myers, of Louth, May 11, 1886. She had been very delicate since the age of four, after measles and dysentery. Weakness increased during the summer of 1885, exaggerated again during the first months of 1886. She had drooped her head forwards during the last three years. The spine formed a bow backwards from the head downwards, so that the chest was flattened, and with the exception of the slight projection of the breasts the profile line of the chest and abdomen formed, when she was sitting, a vertical line. Her appearance was that of a phthisical person, and, as several members of her family had died of tuberculous disease, it was naturally feared that this patient might be similarly affected.

She had suffered from almost constant cold and cough during the last two and a half years. Upon percussion I found some dulness at the apex of the left lung. There was pain in the region of the eighth, ninth, and tenth dorsal vertebræ, and the seventh projected slightly. There were also other symptoms which pointed to the possibility of caries, but at least it was certain that the position of the spine was affecting her health seriously.

I had a light apparatus made for her, acting upon the principles above described. I could not in this case (nor have I been able to in the majority of cases) alter the patient's habitual

posture very much upon the first occasion, for she was too sensitive to allow more than a slight improvement in position at that time.

By adjustment of the instrument at intervals of a week the back was soon brought into a straight position, care being taken never to cause discomfort to the patient. Great relief to all the symptoms was experienced almost from the commencement of treatment. In a week the dulness at the left apex had dispersed, the part being quite resonant, thus proving that probably no organic mischief was present, but that the dulness depended most likely alone upon an absence of air in that part of the lung.

The improvement in the whole health was very rapid. The cough and the pain in the back ceased, the appetite improved, and on July 27, less than six weeks from the commencement of treatment, I was able to note, ' No pain ; looks better, stouter, and brighter.' In fact, the change in her appearance and health was very remarkable. She has continued to improve, and I saw her in the summer of 1887 looking and feeling quite well, although still somewhat delicate.

Another case was that of Miss M. F., aged nine, sent to me by Mr. T. E. Parsons, of Wimbledon (September, 1885).

For many years this patient had not been able to sit up straight, and had been subject to spasmodic cough, especially in the morning before getting up. She had been seen by many eminent physicians, who could find nothing to account for the cough. The spine was bowed backwards, the spinous processes projecting considerably in the lower dorsal and lumbar regions, and the chest was much contracted.

From the day upon which an apparatus was applied, this child began to get better, and in a few weeks the cough left her, and has not returned up to the present time (November, 1891). Her health and strength had improved very materially, and in fact she was then perfectly well. About three years later I heard of her as having grown into a fine, handsome, and particularly upright young woman.

The treatment that proves so successful in these and similar cases is also of immense service in all instances of debility where the chest is contracted, and the patient too weak to resort to systematic exercises to restore the strength, because by this method the thorax is at once held in an expanded position.

In cases of incipient phthisis it assists other treatment very greatly, and may serve to just turn the scale in favour of

the patient, where a cure is possible. All exercises which expand the thorax, and thereby increase the vital capacity, are valuable remedies in the early stages of consumption, and they can be quite as easily and more effectually carried out in conjunction with the proposed treatment than without, while the good effect of keeping the chest expanded at other times than those devoted to exercises obviously acts greatly to the patient's benefit.

Chest-expanding braces, which are largely advertised, are very inferior in their effect. They draw the shoulders more downwards than backwards, and may tend to bend the spine laterally, while they possess no power of supporting the back and preventing it from bulging posteriorly. The apparatus which I have referred to brings the shoulders directly backwards and quite prevents the bulging of the spine below.

FIG. 3

The cases just recorded are those of young children, and it may therefore be interesting to know how beneficial the same treatment is in the case of adults.

Miss M., aged forty-one, sent to me by Dr. England, of Dover, had suffered great pain in her back for years. The pain was relieved by a night's rest, but commenced soon after getting up in the morning, and interfered seriously with her ordinary occupations. Fig. 3 shows the form of the back when I first saw her in January, 1885. The pain was soon cured when the back was mechanically supported. The health and strength, moreover, quickly improved, so that in a few weeks this patient was able to attend to her duties with perfect comfort, instead of being in constant pain, and she has remained since then perfectly well.

I have no record in drawing of the improved position of this patient's back, but I may state that at the end of six months no one would have called her round-backed, and her altered appearance, both as regards position and improved general health, was remarked by all who had previously known her.

There is no age at which it is impossible to straighten a posterior curvature. Such cases as the one just recorded are extremely numerous, and the result of treatment is always satisfactory.

CHAPTER IV

ANTERIOR CURVATURE (LORDOSIS, OR INCURVATION)

This affection, in which the spine is curved forwards, is found more commonly in the lumbar than in any other part of the spine, from an increase of the natural curve, but it may occur in the dorsal or in the cervical region.

It is almost always acquired, but may sometimes be seen as a congenital affection, as in congenital dislocation of the hip joints, or it may be associated with monstrosity.

Lordosis almost necessarily produces posterior curvature above the seat of the anterior bending. For instance, when the lumbar region is curved forwards, the dorsal forms a posterior projection, to restore the equilibrium.

This deformity may occur—1. In *rickets*, from tilting 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 spondylolisthesis.

5. From paralysis of the abdominal muscles, or of some of the spinal muscles.

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

7. From contraction of the psoas and other muscles.

8. From talipes equinus, causing the patient to walk upon the anterior part of the foot without the heel coming to the ground. The knees are bent, and the spine curved into lordosis in the lumbar region, while the body is thrown back to maintain the equilibrium.

9. From carrying heavy weights. Pregnancy, when advanced, causes more or less lordosis in the lumbar region from the weight carried. This, of course, disappears after parturition.

Abdominal tumour, when sufficiently large, produces the same effect, and when such an affection continues for long the

deformity may remain as a permanent affection, even after the tumour has been removed by operation. A permanent lordosis is often produced in pedlars, who carry their goods in front of them suspended from the shoulders.

1. Rachitic Lordosis

This deformity may exist simply from weakness in a rachitic child and may alternate with posterior curvature, the former occurring in the standing, and the latter in the sitting posture; or it may be the result of rachitic deformity in the pelvis, in which case the whole skeleton will probably be affected.

Fig. 4 shows a case of the latter kind; it is a copy of a photograph of a patient severely deformed and dwarfed by rickets.

Fig. 4

Lordosis in severe rickets

Treatment of rachitic lordosis.—In infants a gutta-percha splint, lined and attached to the shoulders by armlets, and to the abdomen by a bandage as advised for posterior curvature (fig. 2), forms a very good support to the protruding abdomen, and holds it back towards an upright position. Pasteboard or stiffened felt may also be used as a splint, and in either case an abdominal bandage will control the protruding part.

In some cases a light metal splint will be necessary, but when used it requires more attention from the surgeon than the more simple splint. A certain amount of recumbency may be necessary in some cases, but should be avoided if possible, because rachitic children are bad subjects for enforced inactivity indoors. Moreover, in such severe cases the viscera are probably suffering from the disease, as well as the bones, and require our careful attention.

Deformity of the pelvis.—In discussing the subject of recumbency, it is worth while to consider the effect of the various positions of the body upon a pelvis softened by rickets. An excellent article was written by the late Mr. John Wood in

the 'Cyclopædia of Anatomy and Physiology,' in which he showed that in the sitting and standing postures the pressure of the weight of the body has a great influence in producing deformity of a softened pelvis; and that the recumbent position does not necessarily give immunity from distortion.

In lying *upon the back* the pelvis becomes flattened antero-posteriorly, the commencement of the elliptical pelvic deformity 'which occurs in the majority of the softened pelves of infants.' 'The angles of the pelvis, with the spine, will also have a tendency in this posture to become *increased* by the weight of the inferior extremities.' The symphysis pubis will sink, and the sacrum become flattened. In lying *upon the side* the lateral pelvic arches yield and bend inwards.

The surgeon should, therefore, be guided in his treatment by the circumstances of the case. In boys the possibility of slight deformity of the pelvis occurring will be a matter of secondary consideration, and the benefits of exercise, when the patient is not too weak to take it, should be recognised.

In girls a deformed pelvis is of more importance, for it may, in the event of subsequent parturition, jeopardise life. If the whole frame be soft, locomotion is contraindicated, and care should be taken by the parents that no uniform position of recumbency is habitually maintained by the patient.

2. Lordosis from Congenital Dislocation of the Hips

In these cases the incurvation of the spine is compensatory to the displacement of the heads of the femora, and is caused by tilting of the pelvis. It occurs in the most frequent form of congenital dislocation—namely, displacement upwards and backwards. When the heads of the bones are dislocated directly upwards, there is little or no tilting of the pelvis.

The cause of this displacement of the hips is usually a malformation of the heads of the thigh bones, and often also of their sockets, but it has been attributed by some observers to dislocation produced at birth in breech presentations.

The evidence seems in favour of a congenital deformity being the usual cause, but I have seen a case in which the heads of the femora seemed well developed, and upon attempting to draw them downwards they met with a rigid obstruction, which seemed to be the edges of the articular cavities. I subsequently heard that the child had been born with a breech

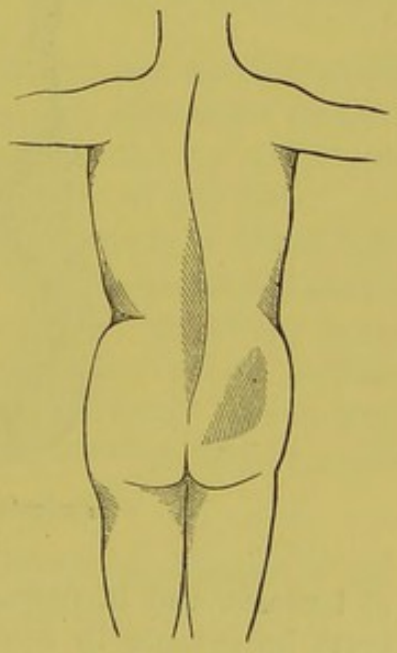
presentation and that the delivery was prolonged, and therefore infer that in this exceptional case the joints were dislocated at the time of birth.

Treatment of lordosis from congenital dislocation of the hips.—When the joints are malformed, cure of the displacement is a matter of uncertainty, or, at least, of great difficulty. Operations for relieving the contracted muscles, replacing the femora, or, if necessary, making artificial acetabula for their reception, have been performed with varying success.

Prolonged extension of the limbs by mechanical apparatus, and the retention of the bones in their proper position, has been followed by considerable success, but this is too large a subject to discuss here, and in the majority of instances we shall have to deal with the deformity without attempting to cure the malformation. Under such circumstances, our object should be to support the spine upon the same principle as we would do in the case of rickets as already described.

The patient should not be allowed to stand much, and the use of a tricycle, or a propelling horse, will afford exercise whilst it relieves the pelvis from the pressure which tilts it forward. When one hip alone is affected, a high boot upon that side will relieve the deformity, facilitate progression, and equalise the support of the spine.

FIG. 5



Congenital dislocation of right hip-joint directly upwards

It has been remarked to me that the use of a high boot might increase the pressure of the femur upwards, and so tend to aggravate the deformity, but this idea is erroneous. The centre of gravity of the body will in the erect posture be unconsciously brought by the individual to bear equally upon each leg, and for this purpose, when one leg is short, the spine is curved laterally, as shown in fig. 5, which is a copy of a sketch which I made of a patient who was the subject of congenital dislocation of the right hip-joint.

By equalising the length of the legs the pelvis is restored to a level position, and the spine is relieved from the curve and saved from deformity, a result which was accomplished in the above case.

3. Lordosis as a Compensating Curve in Caries of the Spine

This deformity usually occurs below the seat of disease, and for the purpose of this work we may consider it in that position only.

If we take a typical case, as shown in fig. 6, we observe that the spine above the angle is subject to little if any incurvation, but below that point there is a very decided amount

FIG. 6

Lordosis from caries of the spine

of lordosis, and in fixing the spine when caries exists it is of great importance to control this tendency to ncurvation by an abdominal belt fixed to the retaining apparatus. **The treatment** of this condition I have described elsewhere,[1] and it is foreign to the purpose of this volume.

[1] *The Surgery of Deformities*, 1880, and *Caries of the Spine*, 1894, published by Smith, Elder, & Co.

4. Lordosis from Spondylolisthesis

This deformity consists in a sliding forwards of the fifth lumbar vertebra, and with it the whole spinal column above, upon the sacrum, forming a considerable projection in the pelvic cavity, and a corresponding depression or incurvation in the lumbar region of the back. This dislocation was formerly considered to be the result of caries, but Dr. Franz Ludwig Neugebauer, of Warsaw, has endeavoured to prove that it depends upon a want of osseous union between a neural arch and the body of a vertebra, thus allowing a separation of the parts to take place by stretching of the ligamentous union. When this malformation occurs in the lowest lumbar vertebra, deformity is caused by the superincumbent weight of the body, and especially by any increase in the weight of the abdomen such as may happen from pregnancy, corpulency, or tumour.

As a member of a Committee appointed by the Obstetrical Society to examine and report upon a large number of specimens brought to this country by Dr. Neugebauer, I had the opportunity of verifying his statements, and our Committee unanimously adopted Dr. Neugebauer's theory of the nature of the deformity.

Treatment of lordosis from spondylolisthesis should consist in avoidance or removal of any unnatural abdominal weight; recumbency whilst that weight remains; or the use of the restraining apparatus which is described on pp. 37 and 105.

In these cases much use of the legs, even in a sitting posture with a tricycle, as recommended for congenital dislocation of the hips, might be detrimental, because the use of the psoas muscles would tend to pull forward the spine and so increase the mischief; but riding a tricycle would probably be the least objectionable use of the legs, and a hand-working tricycle would be best.

5. Lordosis from Paralysis of the Abdominal Muscles or of some of the Spinal Muscles

Whether the loss of power be in the anterior or posterior wall of the trunk, lordosis will be produced. If the abdominal muscles be paralysed, their use is superseded (when the body is erect) by the ilio-psoas muscles drawing the lumbar part of the spine forwards, while the upper part of the body is carried backwards to maintain the equilibrium.

If the spinal muscles be paralysed, the patient, to prevent himself from falling forwards, will have to carry the upper part of his body considerably backwards, and as here there are no muscles (like the ilio-psoas) to take the place of those which

Fig. 7

Paralysis of abdominal muscles. Lordosis of lumbar region predominates.

Fig. 8

Paralysis of spinal muscles. Upper part of body carried further back than in foregoing case.

have lost their power, the position of the shoulders has to be brought more backwards than in the former case, as the equilibrium is maintained in this direction by weight alone.

Duchenne first pointed out these facts, and his figures (reduced) illustrating the two conditions are here shown (figs. 7 and 8).

6. Lordosis from Ankylosis of the Hip, the Thigh being flexed

If a hip-joint be ankylosed at a right angle with the vertical line of the erect trunk, a sitting posture will allow the spine to occupy its natural position. In rising into a standing attitude the spine is curved forwards by extension of the thigh upon the trunk. In other words, in lowering the knee of the affected side towards the vertical line, the pelvis is tilted forwards and carries the spine with it. If the joint is ankylosed in an extended position, the spine will assume a natural posture in standing, and will be protruded backwards and to the opposite side in the sitting position. Ankylosis in various degrees of flexion will modify these results accordingly, and any lateral deviation from the straight line will complicate the condition considerably.

It will thus be seen that any position of ankylosis will influence the spine, but it is only when there is some degree of flexion that lordosis is produced. If ankylosed at 45° from a straight line, there will be lordosis in standing and posterior curvature in sitting. The most important cases are those in which ankylosis exists with active caries of the spine. Here every movement of the limb will disturb the spine.

Treatment of lordosis from ankylosis.—To discuss the last condition first. I will refer to a case in which the left femur was ankylosed at an angle of about 45°, the result of former disease of the joint. H. W., aged ten, was brought to me at the advice of Dr. Buzzard, December 2, 1884. The caries was centred in the four or five upper dorsal vertebræ, and the case was so severe that the child had been paralysed from his waist downwards for more than a year. By the use of a carefully adjusted fixing apparatus to the spine, and by resting the patient in the prone position upon one of the couches referred to on p. 91, he steadily improved, and in a few months regained the use of his legs. When, however, I thought it safe to allow him to begin to walk I found that the apparatus for the back failed to prevent the effect of disturbance of the spine caused by movements of the limb upon the trunk. I therefore had the instrument extended to the affected thigh, to support the spine and thigh as one firm piece. The result was most satisfactory, and two months later I was able to report that the lad was making good progress and able to walk about. (He remained well in 1894.)

We may now consider briefly the treatment of ankylosis irrespective of diseased spine. To prevent a disturbing action upon the spine, and for other reasons, it is very desirable to release the joint if possible. If the ankylosis is not osseous, this may sometimes be effected by force while the patient is thoroughly under the influence of an anæsthetic, but much caution is necessary in performing this operation under any circumstances, and more especially so when the cause of the ankylosis has been hip-joint disease. In the latter case, a considerable interval should have elapsed after cessation of the disease before any such attempt is made.

In cases of osseous ankylosis when the limb is in a very bad position, it is desirable to operate by osteotomy, replace the limb in a straight position, and allow it to unite again, and become ankylosed.

7. Lordosis from Contraction of the Psoas and other Muscles

Contraction of the muscles may arise from :

(*a*) Disorders of the nerve supply.

(*b*) Long-continued repose in the contracted position.

(*c*) Inflammatory changes in and around the muscles.

The causes of muscular contraction I have discussed elsewhere.[1]

As an example of the first variety may be mentioned the contraction which may take place in hip disease from reflex irritation, the joint remaining free in all directions except those controlled by the ilio-psoas muscles. 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.

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.

Other muscles may be contracted and thus cause lordosis.

Treatment of lordosis from contraction of muscles.—The treatment will depend upon the cause ; but a supporting apparatus will be of great advantage in many of these cases.

Division of the tendons of the contracted muscles may sometimes be resorted to.

A child, T. H., was admitted into the All Saints' Children's Hospital, Margaret Street, September 4, 1888, in whom the thighs were severely flexed upon the trunk by contraction of the tensor vaginæ femoris and sartorius muscles of both legs, producing lordosis. He was five years old when admitted, and had never walked. By subcutaneous division of the tendons I was able to improve his position so much that in 1889 he walked about the ward briskly, but preferred helping himself by holding the railings of the beds. Subsequently I still further improved his condition by dividing some deeper contracted fibres.

[In preparing this fourth edition I have asked Sister Justina, who has managed this hospital most devotedly for many years, to give me the further history of this patient. She has made inquiry

[1] *The Surgery of Deformities*, chap. i.

and informs me that he remains quite well and can walk about easily, except that he has a difficulty from one leg being shorter than the other (April, 1896).]

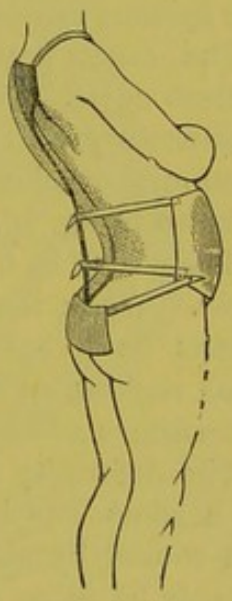
8 and 9. Lordosis from Talipes Equinus, and from carrying Heavy Weights

In lordosis from talipes equinus, and lordosis from carrying heavy weights, removal of the cause is the natural remedy for both conditions.

Supporting Apparatus for Lordosis

When it has been decided that artificial support will be beneficial a splint may be constructed on the following principles: It must take a bearing upon the upper part of the spine, preferably between the shoulders, and below upon the buttocks. The abdomen can then be supported by a belt, drawn back by straps, and attached to the firm upright part of the apparatus (fig. 9). The higher and lower the points in the back are, to which the spinal part extends, the more complete the control of the abdomen. This is a point which is generally lost sight of in abdominal supports, notably in the case of abdominal belts. The apparatus need not be otherwise than perfectly comfortable to the wearer; in fact, the surgeon may feel assured that, if not comfortable, some alteration in its adjustment is required.

FIG. 9



Supporting apparatus for lordosis

CHAPTER V

LATERAL CURVATURE OF THE SPINE

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

Description.—This deformity consists in a lateral bending 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 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 fig. 10.

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.

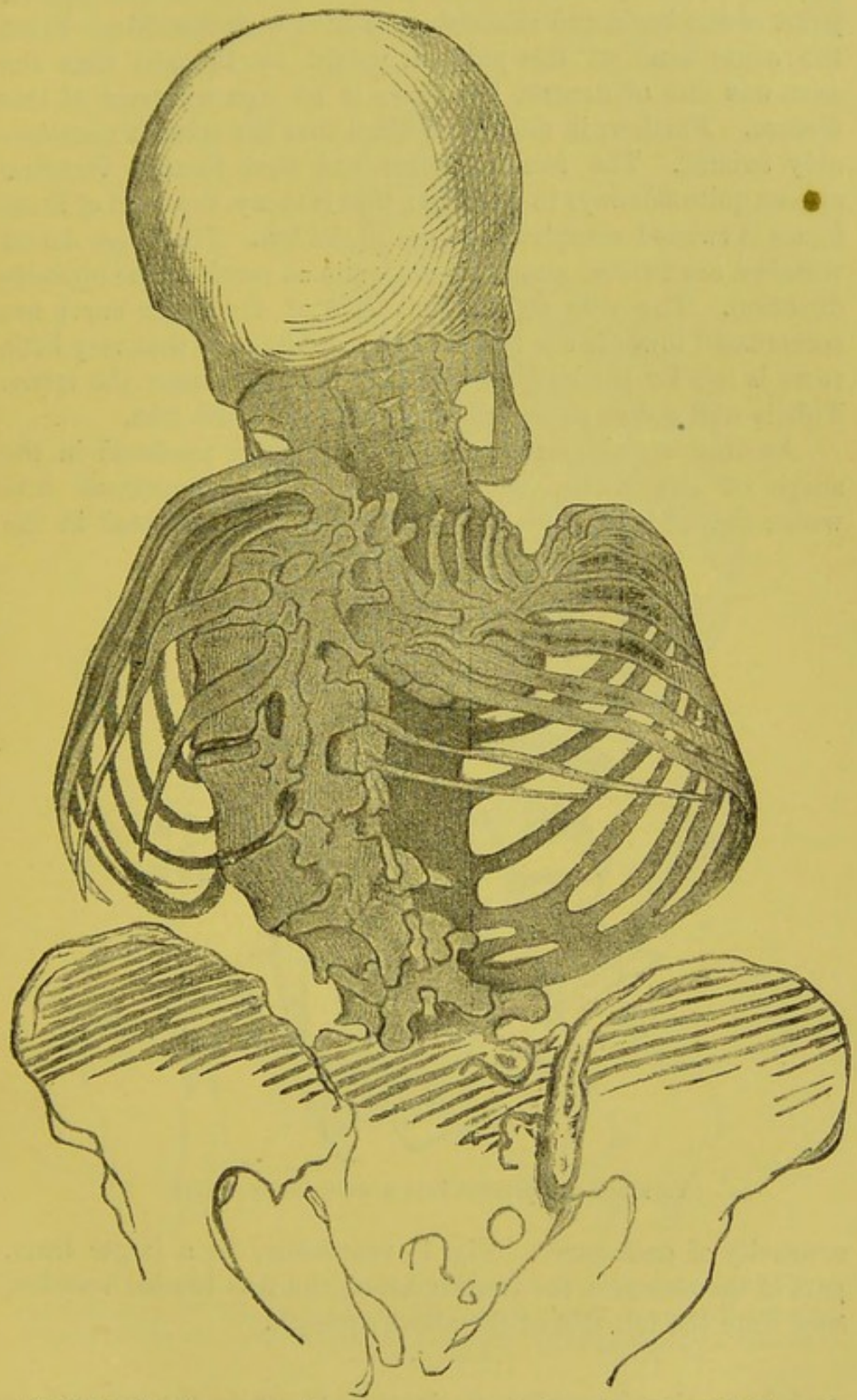
The deformity usually consists in a long arc in the dorsal, and a short one in the lumbar region. If the deformity has been caused by obliquity of the pelvis, the lumbar curve will probably be more severe than the dorsal, the latter being compensatory.

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.

I have made drawings of some of the numerous skeletons which exist in museums of severe cases of this deformity, one of which is illustrated in fig. 10. I also give a woodcut figure copied from Bouvier's atlas.

As regards the former (fig. 10), I would observe that a very noticeable feature is that the height is much decreased

FIG. 10

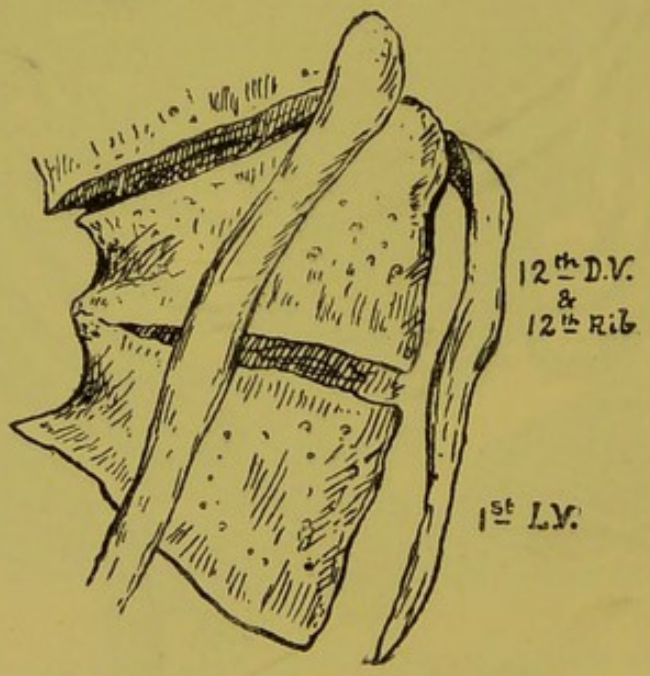


Skeleton showing severe lateral curvature of the spine, Royal College of Surgeons (No. 678)

by the deformity. The tenth dorsal vertebra is the highest point of the back, and is about on a level with the chin. From the acute bend at this point it might be thought that the case was one of CARIES, but there is no sign whatever of this disease. Further, it must be noticed that the spine is considerably twisted. The twelfth dorsal and first lumbar vertebræ appear quite sideways in position : that is to say, the front of these bones is twisted completely round to the left. The upper dorsal vertebræ are twisted almost, if not quite as much in the opposite direction. The ribs on the left side of the lower curve are compressed towards the bodies of the vertebræ, so that very little room is left for the lung on that side anywhere near the spine. This is well shown as regards the ninth and tenth ribs.

Another very important fact is the change produced in the shape of the bones, the vertebræ being compressed into wedge-shaped bodies, the narrowest parts being situated in the

FIG. 11



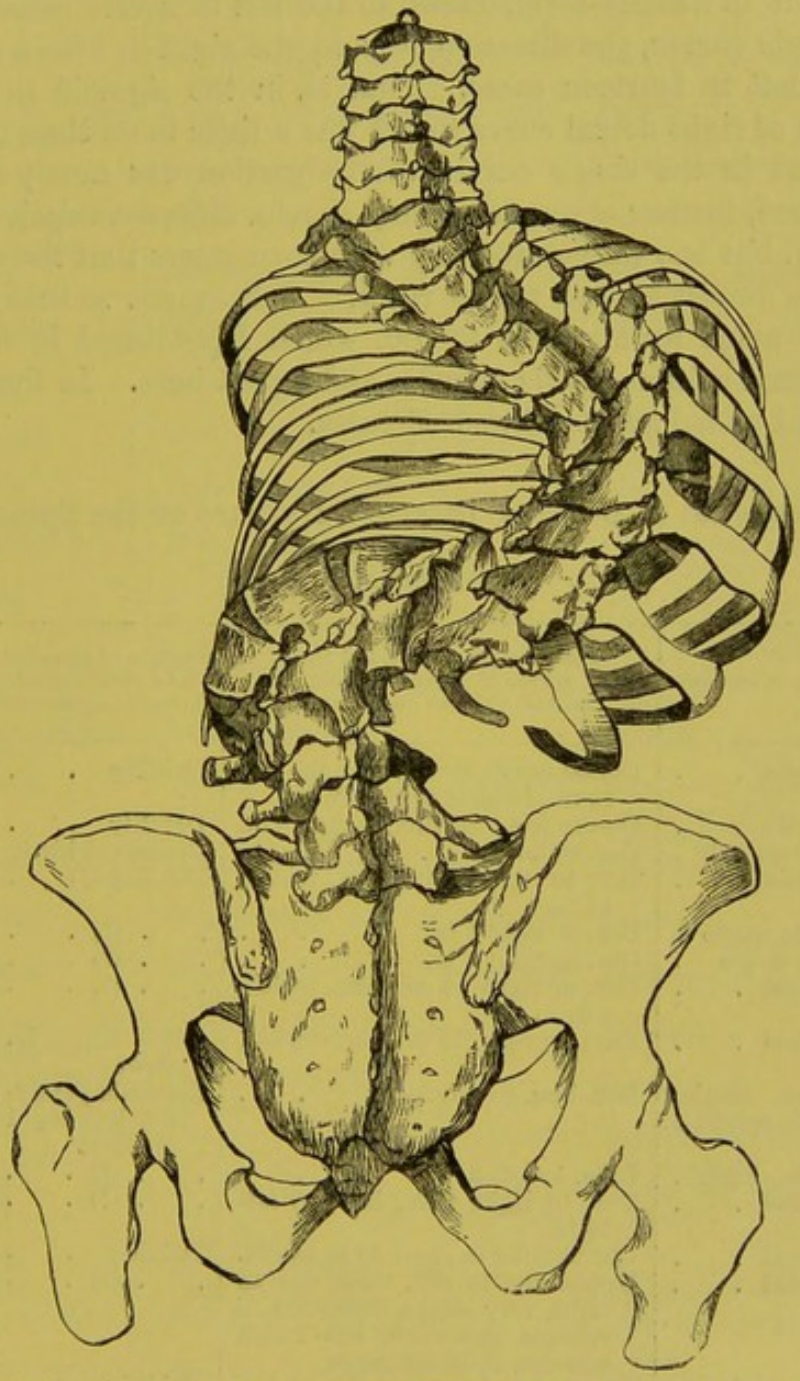
Vertebræ compressed into a wedge-shaped form

concavity of each curve. Fig. 11 represents, on a larger scale, part of the eleventh, the twelfth dorsal and first lumbar vertebræ seen from the left side of the above skeleton.

I have already published—in a foot-note to the volume on 'General Orthopædics, Gymnastics and Massage,' which I edited

of 'Von Ziemssen's Handbook of General Therapeutics'—the following statement:—'In sixty-eight of my own patients, nearly

FIG. 12



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.')

all of whom belonged to the "well-to-do" classes, the characters of the curves were as follows: Thirty-nine were sigmoid, twenty-

nine were single curves, and in two of the latter there was no deflection of the spinous processes, but rotation only of the vertebræ. Of the thirty-nine sigmoid, the dorsal curve was to the right in twenty-seven cases, to the left in twelve cases. Of the single curves, the direction was to the right in fifteen cases, to the left in fourteen cases. That is, in the sigmoid the proportion of right dorsal curve to left was a little more than two to one, and in the single curves the proportion was nearly equal. Of course, further observation may show a different relative proportion, but one cannot now say with correctness that the dorsal curve is almost always to the right.' Subsequent to that statement I made up my table to 100, which I published in full in the second edition of this volume, and repeat here. In the third edition I added another hundred cases.

Statistics of Cases of Lateral Curvature of the Spine

First Hundred

Case	Form of curves	Direction of curves, and their degree of deflection from central vertical line of spine	Possible or assigned cause, or noticeable influencing factor	Age	Sex
1	Sigmoid	Dorsal curve directed to the left 1½ in., lumbar to right ½ in.	Debility	13	F
2	Sigmoid	Dor. to left 1 in., lum. to right ¾ in.	Debility	7	F
3	Rotation only	Dor. to left	Rickets at birth	38	M[1]
4	Sigmoid	Dor. to right 2¼ in., lum. to left 1¾ in.	Debility (?)	23	F
5	Severe single	Dor. to right 1 in.	(?)	39	M
6	Long single	Dor. to right 2 in.	(?)	50	F
7	Sigmoid	Dor. to right 1½ in., lum. to left ½ in.	(?)	20	F
8	Sigmoid	Lum. to right 1¾ in., dor. slight	Right leg ⅓ in. short	18	F
9	Severe single, much rotation	Dor.-lum. to left 2¾ in.	Infantile paralysis, left leg 1 in. short	17	M
10	Severe single	Lum. to left 3 in.	(?)	50	F
11	Sigmoid	Dor. to right 2 in., lum. to left 1¾ in.	(?)	34	F
12	Sigmoid	Dor. to left ½ in., lum. to right ½ in.	Debility	12	M
13	Sigmoid	Upper dor. to left, lower dor. to right, very slight deflection of spinous processes, but much rotation of lower curve	(?)	20	F
14	Single and posterior	Dor. to left ½ in.	Debility	6	F
15	Sigmoid	Dor. to right 1¾ in., lum. to left ¾ in.	Left leg short ¼ in.	20	M
16	Sigmoid	Dor. to right 2½ in., lum. to left 1½ in.	Left leg short ¼ in.	14	F

[1] The line of the spinous processes was straight, but the rotated vertebræ pushed out the line, which projected considerably on the left side.

Case	Form of curves	Direction of curves, and their degree of deflection from central vertical line of spine	Possible or assigned cause, or noticeable influencing factor	Age	Sex
17	Sigmoid	Dor. to right 1 in., lum. to left slight	(?)	50	F
18	Sigmoid	Dor. to right 2½ in., lum. to left 2½ in.	Left leg ½ in. short	15	F
19	Sigmoid and posterior	Lum. to left 1½ in., dor. to right slight	Debility	12	F
20	Sigmoid	Lum. to right 1½ in., dor. to left ½ in.	Oblique pelvis	5	F
21	Long single and posterior	To left 1½ in.	Debility	7	F
22	Single	Dor.-lum. to left 2 in.	Left leg short ½ in.	20	F
23	Sigmoid	Dor. to right 1¾ in., lum. to left 1¼ in.	Debility	24	F
24	Single	Lum. to right 2½ in.	Paralysis of left leg	15	F
25	Sigmoid	Dor. to right 2 in., lum to left 1 in.	Left leg short ½ in.	19	F
26	Single	Lum. to right 1 in.	Right leg short ⅛ in.	8	M
27	Sigmoid	Dor. to right 1¾ in., lum. to left ¾ in.	Debility, left leg short ⅛ in.	6	F
28	Single	Dor.-lum. to left 1½ in.	Left leg ½ in. short, left side of pelvis small	15	F
29	Long single and posterior	To right 1½ in.	Left leg ¼ in. short	18	F
30	Single and posterior	Lum. to left 2 in.	Debility	23	F
31	Sigmoid	Cervical to right ½ in., dor to left 1½ in.	Wry neck and left leg ⅜ in. short	7	M
32	Sigmoid	Dor. to right 2¾ in., lum. to left 1 in.	Debility	14	F
33	Sigmoid	Dor. to right 2 in., lum. to left 2 in.	Debility	9	F
34	Sigmoid	Dor. to right 1½ in., lum. to left 1½ in.	Debility	15	F
35	Sigmoid and posterior	Dor. to right 1 in., lum. ½ in.	Debility	8	F
36	Slight sigmoid	Dor. to right ½ in.	Debility	8	M
37	Long single	Dor.-lum. to right 2¾ in.	(?)	47	M
38	Sigmoid and posterior	Dor. to right 1½ in., lum. to left ½ in.	Debility, left leg ⅛ in. short	13	F
39	Triple	Dor. to left 1¾ in., lum. to right 1½ in., cer. 1 in. (latter congenital)	Right leg ¼ in. short	12	F
40	Single	Dor.-lum. to right 4 in.	(?)	70	F
41	Single	Lum. to left 1¼ in.	Debility	12	F
42	Long single	Dor.-lum. to left 1¼ in.	Left leg ⅝ in. short	15	F
43	Long single	Dor.-lum. to left 1½ in.	Infantile paralysis affecting whole body	3	M
44	Long single	Dor.-lum. to right 2¼ in.	(?)	80	F
45	Long single	Dor. to right 2½ in.	(?)	45	M
46	Long single, much rotation	Dor.-lum. to right 2¼ in.	Great debility	9	F
47	Sigmoid	Dor. to right 1¾ in., lum. to left 1¼ in.	Debility and left leg ⅜ in. short	14	F

Case	Form of curves	Direction of curves, and their degree of deflection from central vertical line of spine	Possible or assigned cause, or noticeable influencing factor	Age	Sex
48	Sigmoid	Dor. to left 1 in., lum. to right ½ in.	Long, very flexible spine, left leg ⅛ in. short	14	F
49	Sigmoid	Dor. to right 2¼ in., lum. to left ½ in.	Left leg ¼ in. short	15	F
50	Sigmoid	Dor. to left 2 in., lum. to right 1¼ in.	Debility	15	F
51	Sigmoid, and chiefly posterior	Dor. to right 1 in., lum. to left ⅓ in.	Careless postures	16	F
52	Sigmoid	Dor. to right 2½ in., lum. to left 1¼ in.	(?)	17	F
53	Single, also posterior lumbar	Dor. to right ¾ in.	Debility	10	F
54	Single	Dor.-lum. to right 5 in.	(?)	43	F
55	Sigmoid	Dor. to right 3½ in., lum. to left ¾ in.	Left leg short ⅜ in.	20	F
56	Long single and lumbar posterior chiefly	Dor.-lum to right 1 in.	Left leg ⅛ in. short	14	F
57	Sigmoid	Dor. to right 2½ in., lum. to left ¾ in.	Debility, and left half of pelvis small	16	F
58	Sigmoid, great posterior	Dor. to right 1½ in., lum. to left 2¼ in.	Left leg ¼ in. short	17½	M
59	Sigmoid and very much posterior in lumbar region, and much stoop	Dor. to right ¾ in., lum. to left ½ in.	Debility	15	M
60	Sigmoid and stoop	Dor. to left 1 in., lum. to right 1¼ in.	Debility, long flexible spine	17	F
61	Long single	Dor.-lum. to right 2⅜ in.	Debility	17	F
62	Long single	Dor.-lum. to right 2½ in.	(?)	25	M
63	Long single and posterior	Dor.-lum. to left 2½ in.	Debility, ovarian trouble	15	F
64	Long single and stoop	Dor. to left 2 in., shoulders deflected to right side, forming cervical curve to right, 2 in. from central line	Debility	21	F
65	Long single	Dor. to left 2 in.	Debility	16	F
66	Long single	Dor.-lum. to left 2 in.	Debility	16	F
67	Rotation only	Dor. to left, side projecting 2½ in.	(?)	17	F
68	Sigmoid	Dor. to left 1 in., lum. to right ½ in.	Rapid growth	16	M
69	Sigmoid	Dor. to right 1 in., lum. to left ½ in.	Debility	11½	M
70	Single acute angle	Dor. 9th vert. to right 1 in.	Debility, right leg short 3/16 in.	10	F
71	Single	Dor. to left 1¼ in.	Left leg ¼ in. short	11½	F
72	Single	Dor.-lum. to right 1⅜ in.	Left leg ¼ in. short	15	F
73	Single acute angle	Dor. 9th vert. to left 1½ in. chiefly due to spine above point of 9th dor. vert. bending to right, much posterior curvature	Debility, scrofula	13	F
74	Long single	Cervico. dor. lum. to right 2½ in.	Debility after fever morb. cord.	12	F

Case	Form of curves	Direction of curves, and their degree of deflection from central vertical line of spine	Possible or assigned cause, or noticeable influencing factor	Age	Sex
75	Single acute .	Dor.-lum. to right 1¼ in. . .	Debility, right leg ¼ in. short	13	F
76	Sigmoid . .	Dor. to right 2 in., lum. to left 1½ in., post. curve in dor. region	(?) Since childhood	42	F
77	Sigmoid . .	Dor. to right 2 in., lum. to left 1 in.	*Right* leg ½ in. short; the only instance in which the curves are opposed to the shortening	19	F
78	Sigmoid in dorsal curve, rotation only	Dor. to left 2 in., lum. to right 1¼ in.	Commenced after strain of back some years ago	32	F
79	Single . .	Lower dor. to right 1 in., *rotation to left*	Rapid growth .	15	M
80	Single . .	Cervico. dor.-lum. to left 1¼ in. .	Debility, right leg nearly ½ in. short	18	F
81	Single . .	Dor.-lum to right 1¼ in. . .	Debility, rapid growth	13	F
82	Sigmoid . .	Cervico. dor. to right 3 in., lum. to left ½ in.	Since early childhood	16	F
83	Sigmoid . .	Cervico. dor. to right 3¼ in., lum. to left, involved in upper curve	Feeble at birth, and curvature began in early childhood, but increased very rapidly after typhoid fever at 7	14	M
84	Single . .	Dor. to right 1½ in., shoulders held 4 in. to right; the latter hysterical	. . . .	21	F
85	Sigmoid . .	Dor. cervical to left 1 in., lower dor. to right 1 in.	Debility . .	15	F
86	Single . .	Dor. to right ¾ in., excurvation .	Debility . .	13	F
87	Sigmoid . .	Cervical to right 1½ in., dor. to 1½ in.	Wry neck to left, right leg ¼ in. short, compression of *left* thoracic cavity from empyema	6½	M
88	Single . .	Dor. to left 2 in.	Congenital absence of right forearm; spine bent by holding things between stump and body, and by writing with left hand	13	F
89	Sigmoid . .	Dor. to right ¾ in., lum. to left ¾ in.	Debility . .	9	F
90	Single . .	Lum. to right 1 in. . . .	Debility and caries which appeared in a few weeks in 11th and 12th dor. vertebræ	8¾	F

Case	Form of curves	Direction of curves, and their degree of deflection from central vertical line of spine	Possible or assigned cause, or noticeable influencing factor	Age	Sex
91	Single . .	Dor.-lum. to left 1¼ in. . .	Debility from whooping cough	7¾	F
92	Sigmoid . .	Dor. to right 1 in., lum. to left 2¼ in.	Left leg ½ in. short	15½	F
93	Single .	Lum. to left and post. 3 in.. .	Ankylosis right hip, curve caused by sitting	17	F
94	Sigmoid . .	Cervical to right, long dor. to left 2 in.	Wry neck . .	14	F
95	Single . .	Lum. to left 2 in. . . .	Paralysis of left leg	18	F
96	Sigmoid . .	Dor. to right 2½ in., lum. to left 1¾ in.	. . . .	38	F
97	Sigmoid . .	Dor. to right 1 in., lum. to left 1¼ in.	Debility . .	16	F
98	Sigmoid, much rotation	Dor. to left 2 in., lum. to right 1 in.	Since age 13 .	44	M
99	Sigmoid . .	Dor. to right 1½ in., lum. to left 1 in.	Rapid growth and bad postures. Debility from whooping cough	17	F
100	Sigmoid . .	Dor. to right ½ in., lum. to left ¾ in.	. . . .	16	F

To sum up the character and direction of the curves in all these cases (100) it will stand as follows :—

Sigmoid	54	
Single [1]	46	
	—	100
Of the sigmoid the dorsal curve was directed to the right in	38	
Of the sigmoid the dorsal curve was directed to the left in	16	
	—	54
Of the single curves the direction was to the right in	24	
Of the single curves the direction was to the left in	22	
	—	46

Subsequently I recorded a second 100 cases as follows :

Sigmoid	42	
Single	54	
Triple	3	
Quadruple	1	
	—	100

[1] In three of these single curves there was rotation only, without deflection of the spinous processes from a straight line.

Of the sigmoid the dorsal curve was directed to the right in	28	
Of the sigmoid the dorsal curve was directed to the left in	14	
	—	42
Of the single curves the direction was to the right in	25	
Of the single curves the direction was to the left in	29	
	—	54
Of the three triple the lower and chief dorsal curve was to the right in	3	
	—	3
Of the quadruple the mid dorsal was to the left in	1	
	—	1

In estimating the direction of the dorsal curve, it is only right (at least in this 100) to calculate the sigmoid curves, because in the single the curves were most frequently in the lumbar region. Then we have just twice as many to the right as those to the left. I have the records of many hundreds of other cases, but the labour of analysing them is very considerable, and the result would hardly repay the trouble.

So that it will be seen that the relative proportions of direction of curves is not much altered from my former statement.

I offer these statistics as merely a contribution to the subject, and not as proving the relative proportion of curves to one another, which a larger number of records may show.

To exemplify the uncertainty of such statistics, I may add that in the Royal Orthopædic Hospital, out of 569 cases the dorsal curve was to the right in 470, and to the left in only 99, or about five to one.

Bouvier found them in the proportion of seven to one.

Age of commencement.—Lateral curvature commonly commences between the tenth and sixteenth years of age, but it often occurs at earlier or later periods of life. In some rare cases it is congenital (see p. 86). It may commence during the first few years of life, when it will probably be rachitic, and it not unfrequently occurs soon after a child begins to walk.

As to the development of the affection late in life it is difficult to form an exact opinion. We meet with all degrees of curvature in old people, and often are told that the trouble has only recently commenced, but it is impossible to be sure that there has not been some slight deflection existing for years, gradually increasing until the inevitable pain commences.

There is ample evidence, however, that the spine may begin to give way in old age, inasmuch as we see roundness of shoulders coming on late in life in people who have previously been very upright, and so it is probable that lateral curvature may commence in the same way. The majority of cases occurring in elderly people are, however, undoubtedly the result of neglect of slight weakness and curvature in early life.

Sex.—The affection occurs more frequently in girls than in boys. Out of the first one hundred cases recorded, eighty were females and only twenty males.[1] Other observers give the proportion of females to males as greater.

Features of the Deformity consequent upon the Lateral Deviation of the Spine

Rotation of the vertebræ.—I contributed the following remarks upon rotation to the London 'Medical Record' for December 5, 1882.

In cases of lateral curvature, the twisting of the vertebræ upon their vertical axes, so that their bodies turn in the direction of the convexity of the curve, and their spinous processes in the direction of the concavity, is a fact which has been recognised for many years. Dr. Dods [2] has the credit of being the first to describe this condition; and since his time the majority of writers upon lateral curvature have referred to it, and a variety of opinions as to its cause have been advanced.

Rotation has been attributed to the serratus magnus muscle, upon the convex side of a dorsal curve, acting upon the ribs as upon levers, the fulcrum of each rib being the transverse process of the corresponding vertebra. This hypothesis might be disproved in several ways; but it will suffice to remark that 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 that which 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 or sacral region.

[1] Very curiously, in my second hundred, the proportion is exactly the same. I have not made any record since then.

[2] *Pathological Observations on the Rotated or Contorted Spine, commonly called Lateral Curvature.* (London, 1824.)

Mr. Alexander Shaw [1] described rotation as the result of the changes which are produced in the articular processes by lateral pressure. He states that by pressure the oblique processes of the concave side are shortened and flattened by absorption; while, owing to the processes on the convex side escaping compression, they 'preserve their normal shape and size, and diverge from each other. The influence which this contrast in the rate of consumption of the substance of the vertebræ on the two sides may have in causing contortion to be combined with lateral curvation, will be apparent when we take into view the relative position of the processes to the central axis of the spine. They are placed postero-laterally in the vertebræ. Consequently, at the same time that the column falls sideways, a rotatory movement in a partially horizontal plane will take place upon the oblique processes of the concave side as centres or pivots; and the vertebræ will, therefore, perform an imperfect gyration with their sides, which have undergone the chief destruction, pointing forwards.'

This theory has been severely criticised. Herman Meyer [2] ('Die Mechanik der Scoliosis,' 'Virchow's Archiv,' vol. 35) opposed it 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.

Meyer performed experiments upon a number of dead bodies. In fully developed spines of adults he produced curvature without torsion. In fœtuses and children, rotation accompanied the artificial production of lateral curvature. In a girl aged fourteen the torsion produced was moderate, until the anterior longitudinal ligament had been dissected off, when torsion became perfect. In a girl of sixteen, the artificially produced lateral curvature was without torsion, until the anterior ligament was divided. Meyer thought that rotation was produced by the action of the ligamenta subflava.

Dr. H. Dick [3] considered that the rotation is the mechanical consequence of the bending of the column. 'The spine in some

[1] *A System of Surgery*, edited by T. Holmes, 2nd edit., vol. v. p. 862.

[2] I quote the translation which occurs in Louis Bauer's *Lectures on Orthopædic Surgery*. (New York, 1868.)

[3] *Medical Times and Gazette*, August 1864.

respects resembles a strong elastic stick or column, which, if pressed at both extremities more strongly than it can bear, forms a bow, and in that condition will not bend backwards or forwards, but will rotate at the central points of the bow.'

A work has lately been published by Dr. C. Nicoladoni, of Stuttgart, entitled 'Die Torsion der skoliotischen Wirbelsäule,' which advances an extraordinary theory of this peculiar twisting of the vertebræ. He describes the dissections of a large number of spines affected with lateral curvature, and he states that 'the so-called torsion of the scoliotic vertebral column is only apparent, and is rather to be regarded as an optical general impression of the general want of symmetry in the individual scoliotic vertebral bodies.' The reason of the twisted appearance is to be sought for in the successive increase and diminution of partial development in growth of the vertebral bodies. He arrives at this conclusion, partly because, in the contorted specimens which he has examined, the anterior longitudinal ligament did not pass over the most prominent portions towards the convexity, but maintained a median position. He considers that the condition of the bones which has been described as a rotation is the result of overgrowth of the body of each vertebra towards the convexity, where it is less pressed upon, and retarded development on the side of the concavity, where the pressure is greatest.

There can be no doubt that the unequal pressure causes an unequal development of the vertebræ; but that the so-called rotation is only the appearance of this unequal development can hardly be seriously entertained by anyone who has examined a dissected specimen of a spine with the vertebræ rotated, each bone being twisted in its entirety.

Dr. A. B. Judson (orthopædic surgeon to the out-patient department of the New York Hospital) has advocated a theory which 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 right or left. Dr. Judson 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. '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.'

Dr. Judson was evidently not aware that a similar theory had been advanced many years previously by Charles H. Rogers-Harrison, in a work 'On Deformities of the Spine and Chest,' published in London in 1842, who explained rotation in the same way. I will quote the two descriptions.

Dr. Judson ('New York Med. Rec.,' 1882) writes: 'The explanation offered by me is worded as follows: "The distinguishing feature of the explanation of rotation here proposed is the recognition of the fact, heretofore overlooked, so far as I am aware, that the posterior portion of the vertebral column, being a part of the dorsal parietes of the chest and abdomen, is confined in the median plane of the trunk, while the anterior

Fig. 13

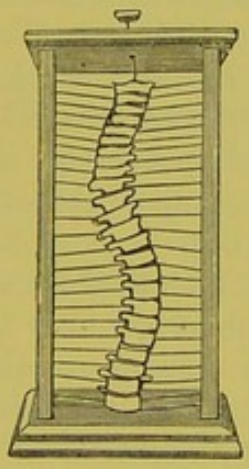
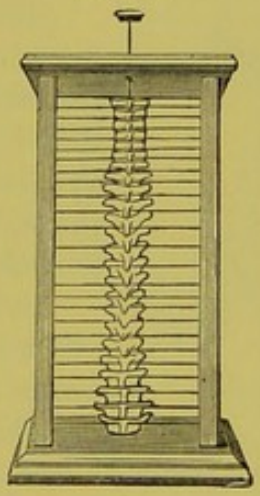


Fig. 14



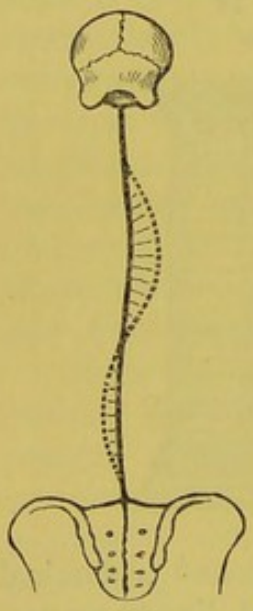
portion of the column, projecting in the thoracic and abdominal cavities, and devoid of lateral attachments, is at liberty to, and physiologically does, move to the right and left of the median plane."'

Mr. Rogers-Harrison writes (1842, p. 93): 'To conceive the cause of this extraordinary mode of derangement, it is necessary to imagine that, in a well-marked curvature of the vertebral column continuing to sustain the weight of the body, the vertebræ of the middle of that curvature are, in fact, in the same situation as if they were urged by a direct and horizontal force on the side of the concavity towards that of the convexity. In this impulsion, the body of the vertebra, isolated in its anterior and lateral parts, experiences no resistance; but the articular processes are powerfully restrained by their reciprocal

connection. The transverse processes find, in their articulation with the tuberosities of the ribs, a resistance to their deviation, which would be very weak on the part of an isolated rib, but which becomes considerable by its union with the adjoining ribs. It results from this exposition, that, behind the central part of the dorsal column, there is efficacious resistance to its lateral displacement; that before this central part there is no resistance to that displacement; and consequently the vertebra must necessarily turn on its axis to arrive at the position which observation so frequently presents.'

Although I have shown that this theory—which I believe to be the correct one—was not originated by Dr. Judson, yet it must be acknowledged that we are much indebted to him for re-discovering it, and for bringing it prominently before the profession.[1]

Fig. 15



'The bold dotted curved line is intended to show the course of the bodies of the vertebræ; the solid line that of the apices of the spinous processes.' (Modified after Shaw.)

The supposed absence of rotation in lateral curvature, the result of disease of a lung or pleura, 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.

In the few cases of lateral curvature, the effect of thoracic disease, which I have examined, there was distinct rotation of the vertebræ. The only case in which I have found more than very slight lateral curvature occurring without any sign of rotation (excluding cases of caries of the spine), was one which I believe had been produced by the patient going about with a Thomas's splint for hip-joint disease of the right side, the left foot being raised artificially.[2] A dorsal curve had been produced towards the right, and the front of the chest had been pushed forward, probably by pressure against the crutch.

Rotation produces a curved rounded swelling posteriorly upon the convex side, and the transverse processes may project to such an extent that they may

[1] Since I published the above facts, Dr. Judson has written to me and acknowledged the correctness of my description.

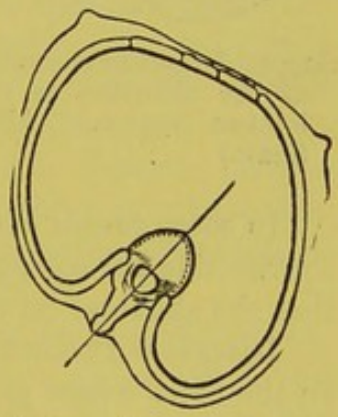
[2] Referred to in Introduction.

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. This error was made in the case of Dr. Gideon Mantell, referred to 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. In the lumbar region, the projection of the transverse processes has given rise to the same mistake.

Alterations in the general form of the thorax and abdomen.—The thorax suffers chiefly. As the spine curves laterally it necessarily shortens vertically, and as a consequence causes a shortening of the thorax and abdomen, and therefore a lessening of the vertical space in these cavities. The ribs are displaced in two ways—(1) by lateral deflection they become separated upon the convexity of the dorsal curve, and compressed towards one another on the concave side; (2) from the twisting of the vertebræ their posterior ends are also twisted backwards on the convex side, but as the walls of the thorax do not readily give way to this twisting, the angles of the ribs are much increased, as shown in fig. 10. The backward bulging of the transverse processes and muscles on the convex side of the lumbar curve is also the result of rotation of the vertebræ (figs. 17 and 18). On the concave side a reversed action is produced.

Fig. 16



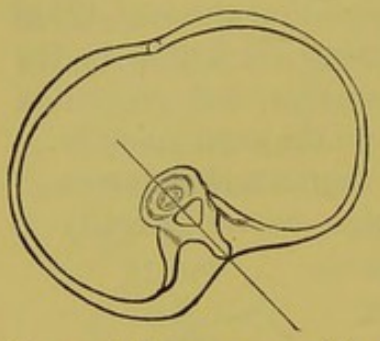
Supposed transverse section of the thorax about its middle; to show the displacement of the ribs consequent on the contortion of the dorsal vertebræ (After A. Shaw.)

At the front of the body the effect is not so marked, and although the side of the convexity is depressed, and the other side projected forwards, the degree of deformity is much less than at the back. Well-developed mammæ may exaggerate the appearance of deformity in the front of the chest or may hide it. The ribs are sometimes stunted in growth on the concave side.

Figs. 16 and 17 show the alteration in the shape of the trunk produced by rotation of the vertebræ, the thoracic cavity being chiefly affected, its cavity being compressed chiefly upon the side to which the curve is directed.

In consequence of the alteration in the shape of the spine, the nerves, proceeding from the spinal foramina, are frequently compressed, irritation and pain being produced. The shoulder-blade on the convex side is raised above its ordinary level, and projected backwards, and in consequence of the thorax upon this side being more protuberant than is natural, the posterior border of the shoulder-blade may be raised from the ribs.

Fig. 17



Supposed transverse section of the abdomen at the lumbar region. (After Shaw.)

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

Lateral curvature without deflection of the spinous processes. In the cases where projection in the back from rotation 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.[1] It is important to recognise this condition, not only in reference to diagnosis, but also with regard to treatment.

Some of the above objective symptoms of lateral curvature are more marked when one of the curves is greater than the other than when they are equal in extent; for instance, in the latter case the shoulders may be nearly level. As the tendency of this affection is to increase continually, unless relieved by treatment, 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 excision of a part of one of the clavicles had to be performed in order to avert suffocation

[1] See case of Mr. C. on p. 3; also the case of Dr. Gideon Mantell, *Med. Chir. Trans.*, vol. xxxvii.

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.

An examination of the specimens in the museums of any of our metropolitan hospitals will show how prevalent these deformities are, and how much displacement of the viscera must occur.

The lungs, heart, liver, kidney, uterus and bladder may suffer more or less from compression in bad cases; the stomach and intestines are supposed to accommodate themselves better to their altered positions, but in a great many cases pressure upon these viscera or upon the nerves which supply them produces severe indigestion and other functional troubles.

As to the general effect of this distortion, I cannot express it better than in the words of Sir Charles Bell, who observed:[1] 'Upon the whole, 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.'

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.

If the lumbar curve is severe, the ribs may press upon the crest of the ilium and cause much pain. The alteration in shape of the abdominal cavity does not as a rule interfere with parturition, but if the case be rachitic, the probability of implication of the pelvis is great. Rachitic cases are, however, fortunately rare.

In ordinary scoliosis, although the pelvis generally retains its natural shape, yet its inclination forwards will be lessened if, as we generally find, the lumbar incurvation is lessened or obliterated, that is, the pelvis becomes unnaturally horizontal.

The head is not commonly altered in shape by this deformity, except in cases commencing in childhood, and causing the head to be bent downwards on one side, when a difference of growth in the two sides of the head will probably occur. This is

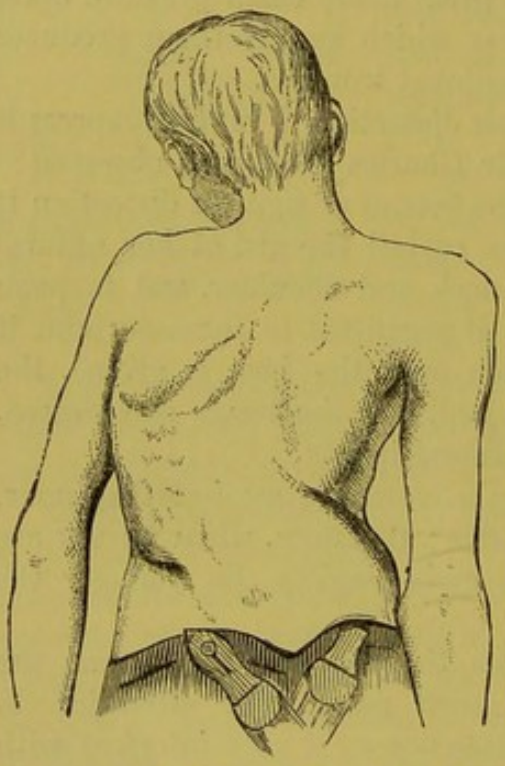
[1] *Practical Essays*, p. 125. Edinburgh, 1842.

especially noticeable when wry neck is the cause. The spinal cord is not commonly subject to compression to the extent of interrupting its functions, but the intercostal nerves are, as already stated, very liable to irritation from disturbance or from direct pressure. The aorta becomes curved in the same direction as the spine. The œsophagus keeps its usual course.

The following cases will serve to exemplify severe forms of lateral curvature (figs. 18, 19, and 20).

In the first case, Mr. K., æt. 17, the cause was infantile paralysis in early childhood. The left leg was smaller and one inch shorter than the right. Rotation was very severe. An instrument was necessary to prevent further increase of the deformity, and to enable the patient to get about better (No. 9 in table).

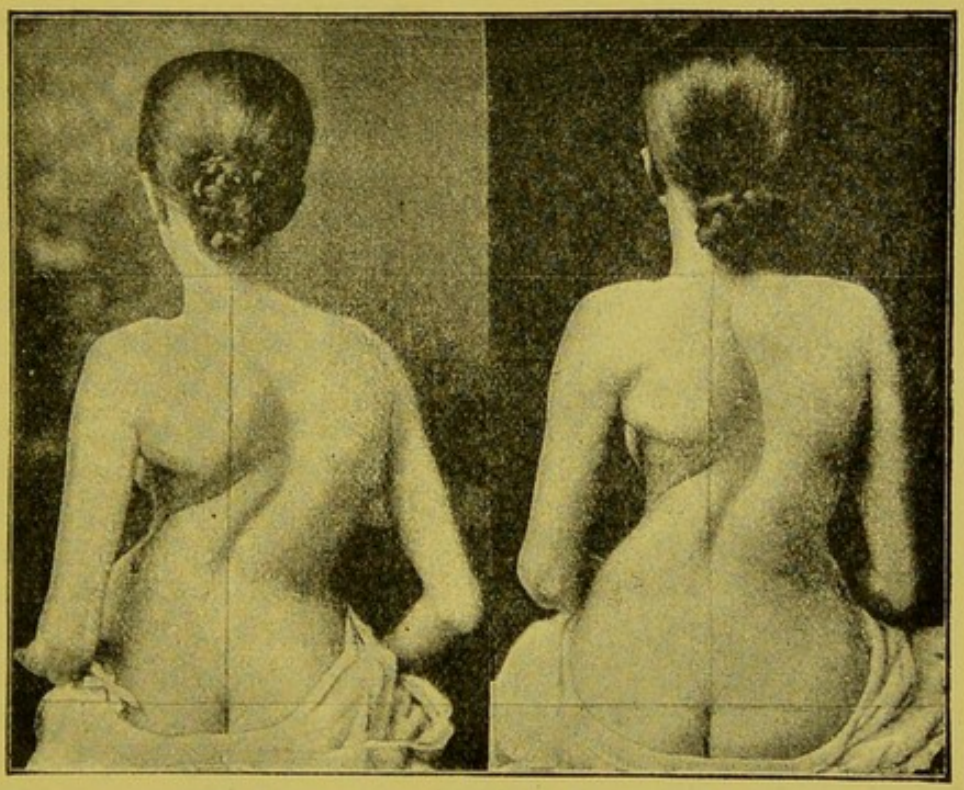
Fig. 18



In the second case, Miss M., æt. 26 (September 1886), the deformity had been first discovered at the age of seven. Nothing was advised except special exercises and rest, and she got steadily worse until the age of sixteen, when an instrument was applied which, although very heavy and complicated in construction, yet gave some relief from discomfort, and interfered with the increase of the deformity. Four years after this the instrument becoming uncomfortable it was discarded, and since then the spine had become much worse. Pain had been very severe and continuous for the last two years, except when the patient was in bed. It was especially severe in the left side in the concavity of the curve from within three inches of the spine, passing round the left side to below the breast. The general health was very bad, and there was severe indigestion. In this case instrumental support was clearly indicated, and I applied a light apparatus on September 20, 1886 (the general principles of which are described under 'Treatment'). I was able to adjust it so that the spine was immediately placed in a much better position, so that the

height of the patient's back from the level of the shoulders to the seat was raised one inch, *i.e.* from sixteen to seventeen inches, and on September 27 this measurement was increased to seventeen and a half inches (figs. 19 and 20). The instrument was felt to afford relief to pain at once. In January 1887, pain had not returned, with the exception of a few days' illness in the first week in October 1886; she said she had not felt so well for certainly over a year. She looked very much better, appetite

FIG. 19 FIG. 20



Case of severe lateral curvature (Miss M.), from photographs
The increased height and lessened degree of curvature are made plain by the parallel and vertical lines

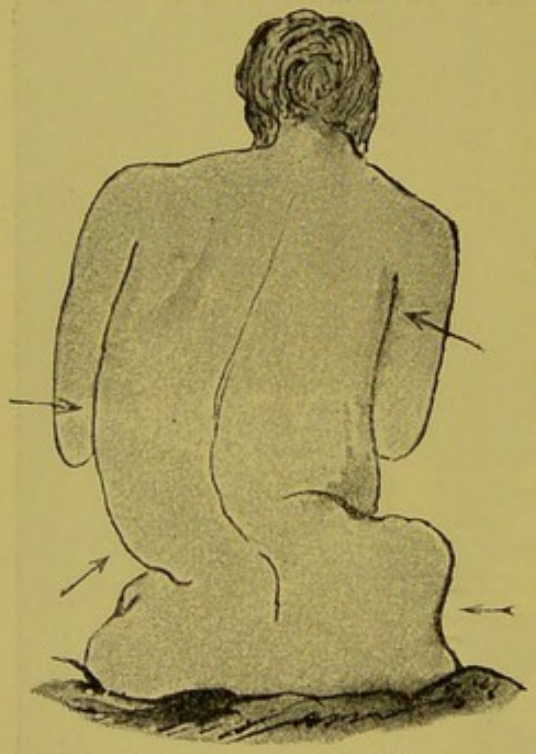
had much improved, and the indigestion had to a great extent departed. In November 1887 this patient had continued to improve. The spine was in better position, and the general health was very much better.

For the purpose of this fourth edition I wrote to this patient (May 1896) to ask as to her present condition, and she states that she continues to derive great benefit from wearing the apparatus. She now never has the pain and trouble which she constantly suffered from before.

Alteration in shape of vertebræ and intervertebral cartilages.—In consequence of the prolonged excessive pressure upon one side of the spine, 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 (see figs. 10 and 11).

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.

Fig. 21



Lateral curvature, with severe distortion in lumbar region

The thickness of the lumbar muscles, and the forward arching of this part of the column, may 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, and in many cases this part of the deformity is very marked.

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, causing an appearance of unnatural projection of the pelvis, while upon the other side will be found a projection. It is necessary to distinguish between this apparent difference in height of the two sides of the pelvis and real obliquity.

Fig. 21 represents a severe case of this kind. This patient was above middle age. Although there was great difficulty in applying an instrument, yet considerable relief from suffering was obtained by the treatment.

CHAPTER VI

THE DIAGNOSIS OF LATERAL CURVATURE

Lateral Curvature, Caries and Weakness of Dorsal Muscles

THE most important and most frequent question which arises in diagnosis is the determination whether the case is one of lateral curvature or caries. The characteristic deformity in caries of the spine is essentially a posterior projection caused by collapse of the anterior portion of the vertebral column. There may be an angular or a more or less rounded projection, the exact form depending chiefly upon the number of vertebræ involved. The direction backwards of the protruding vertebræ depends upon the fact that the disease almost invariably commences in the front of the bodies of the vertebræ or intervertebral substances, and extends backwards; and although the destruction, if unchecked, may involve one or more of the entire bodies of the vertebræ, it is very rare for the arches of the bones to be attacked, or at least attacked to a sufficient extent to modify the character of the deformity. Some cases of caries, however, occur in which the bones are attacked in other than the anterior parts, and in these instances we occasionally meet with some lateral deviation of the spine, in addition to a posterior projection. I have never seen lateral curvature from caries without some amount of posterior projection, but I have seen the latter so little characteristic of deformity from caries that it might, as far as appearance was concerned, have been the result of a lateral curvature quite unconnected with ulceration of the vertebræ.

The possibility of lateral deformity of the spine being dependent upon caries should lead the surgeon to take great care in making a diagnosis in doubtful cases. In caries, the pain is usually of a different kind, easily increased by movements, especially by stooping. In simple lateral curvature, however severe the pain, I have never seen that extreme caution in movements which *generally* accompanies caries. There is in

caries more rigidity of the spine, as regards flexion and extension, than in slight lateral curvature. The angle of deflection may be more acute, and there is the posterior projection, as well as lateral curvature. There may be projection of spinous processes in the latter condition, but there is a distinction to be made between the two when the patient stoops. In caries the spinous processes of the affected vertebræ do not as a rule separate from one another, whereas this separation can generally be felt when no ulceration of bones exists. In former editions of this work I have stated that no exact rules could be laid down for forming a diagnosis between these two conditions, but that all the symptoms must be studied. I still adhere to this opinion, and in offering the above suggestions for diagnosis I must urge that none of them are infallible; that caries not infrequently exists, and runs its course without producing the usual symptoms of the disease, and that the knowledge of the many anomalies of these cases should lead us to be very cautious in forming a diagnosis. Sometimes it is impossible to be certain, and it becomes necessary to treat the case with caution for a week or two before coming to a decision. The cases referred to below exemplify this fact.[1]

Weakness of the back may exist in young children, allowing the spine to bend in various directions, forming at one time posterior curvature, and at another one or more lateral curves. These curves are easily moved in any direction, the spine being straightened or bent with facility by the hands of the surgeon.

This condition of weakness may be the forerunner of lateral curvature, or it may denote early caries. I have met with many cases in which symptoms of this kind of weakness of the spine have existed without any signs of inflammatory mischief, but which have ultimately proved to be instances of commencing caries. An outline of the history of one of them may be instructive.

A. W., aged $8\frac{3}{4}$, began to stoop about nine months before I saw her. A few weeks before this visit pain in the abdomen was complained of, and recurred frequently. Certainly this pain was suspicious, but there was no other symptom of caries, the child moved about quite freely, and did not complain of other pain or discomfort. There was at that time no irregularity whatever in projection of the spinous processes. I treated the case upon the

[1] See also *Caries of the Spine*, by Noble Smith, 2nd edit. Smith, Elder, & Co., 1896.

principles described below. November 6, 1885, six weeks after the first visit, the spine was much straighter, and the muscles were developing. The child could sit up better, but the abdominal pain was more troublesome, and as I could not detect any local cause for it, I again examined the spinous processes in stooping, when I found a slight but distinct projection of the eleventh and twelfth dorsal vertebræ, which I did not hesitate to attribute to the existence of caries, a view which the subsequent history of the case proved to be correct.

The possibility of incipient caries being the cause of the general weakness of the spine, is a very important reason for not advising gymnastic exercises in the early treatment of very weak backs. I have known such cases treated by exercises exclusively, and the caries has developed soon after the treatment has been commenced, increasing rapidly and severely before its nature has been discovered.[1]

As lateral deflection of the *bodies* of the vertebræ in lateral curvature usually exists to a greater extent than the displacement of the spinous processes, it follows that in the early stages of the affection the commencing lateral deformity may not be seen, and thus another difficulty in diagnosis presents itself. Posterior projection generally precedes and accompanies the earliest stages of lateral curvature in the dorsal region, but in some instances there is a flattening of the back, and this is especially so in cases of rotation in which the spinous processes remain in the central line. In this latter condition, when fully developed, the flattening will necessarily be more marked on the side of the concavity. Flattening of the back will sometimes be exaggerated into a condition of anterior curvature.

In forming a diagnosis between commencing caries and a weak spine we must not expect the same symptoms as in advanced cases. Posterior projection, so important a sign of advanced caries, is usually absent in the early stages, whereas in a case of debility the vertebræ very commonly assume such a position.

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. Posterior prominence of the angles of the ribs upon

[1] In *Caries of the Spine* (*op. cit.*) I have described some of these cases.

one side and their depression upon the other indicates the rotation of lateral curvature in the dorsal region; and posterior prominence of the apices of the transverse processes on one side and their depression on the other indicates the same condition in the lumbar region.

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 in lateral curvature, 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.

Temperature.—One of the most valuable symptoms in diagnosis is temperature. In cases of active caries there is frequently a high temperature, ranging from half a degree, or normal, in the morning to 101° or more at night.

The steady persistence of this rise of temperature indicates the probability of an abscess existing somewhere, or at least of tubercular inflammation. However, it must be remembered that many cases of caries exist without any rise in temperature.

The Röntgen Rays.—The examination of the spine by the Röntgen Rays passed from the front of the body is likely to prove, or, I may say, has already proved of immense value in diagnosing difficult cases. It is, as yet, only applicable to young children or very thin older patients, as far as the dorsal and lumbar parts are concerned, but for the cervical vertebræ it can be applied in many cases in adults.

Neuromimesis

We meet with cases in which there is an apparent inability on the part of the patient to maintain the spine in a straight position associated with general hysterical symptoms. The curves are not fixed, the back can be placed in a normal position, but when left to the patient's own efforts, it immediately relapses to one or the other side, the spine becoming curved laterally.

I do not think that these cases are, as a rule, very difficult to recognise, but we may fall into error should there be some real lateral curvature or real weakness of the spinal joints existing in conjunction with and masked by the hysterical symptoms.

In dealing with hysterical patients we ought to be very careful not to overlook these real conditions although the symptoms are exaggerated by the patient. When such real

curvature exists, local treatment will certainly facilitate the treatment of the general condition, and the result of such combined remedies has, in my experience, been satisfactory.

A patient was brought to me August 6, 1885. Hannah H., æt. 21, who had 'suffered with her spine' for many years, and had been treated with plaster of Paris jackets for two and a half years, commencing four years previously. She came into the room carrying her head and shoulders considerably out of the perpendicular, and bent to the right side. In sitting, the right axilla was two inches or more outside a vertical line from the outer edge of the pelvis; she had been cured, it was stated, a few months before by 'faith,' but had soon relapsed. By moving her body into various positions I found that there was a fixed curve to the left, moderate in degree, in the lumbar region, but the bending of the body over to the right was a voluntary action, or at least governed by the patient's hysterical condition. I expressed this view freely, and said that while I recognised a slight curve which could be cured by treatment, I could not admit the necessity of the chief deformity for which I had been consulted. I spoke very strongly to the patient as to her not allowing a recurrence of the latter position. My remarks were effectual, for I saw her upon several occasions when she held herself perfectly straight, with the exception of the moderate degree of fixed curvature which existed in the lumbar region, and which was subsequently cured by mechanical treatment.

Dr. Shaffer, of New York, has discussed this subject,[1] and he urges that real scoliosis is accompanied by rotation, and a modification of the lateral flexibility of the vertebral column in the dorsal region, while when the spine is bent laterally in hysteria these conditions do not exist. He states that, 'in the simulated state there is generally an excurvated spine with a lateral deviation.' These observations quite coincide with my own experience; but it should be noted that the same relaxation and bending may occur in very weak individuals quite independently of hysteria, and an hysterical patient may possess a weak back and not be able to maintain the spine erect. I have seen some cases in which the hysterical element has been subdued by treatment of the spine, such treatment involving rest to the

[1] *The Hysterical Element in Orthopædic Surgery*, by Newton M. Shaffer, M.D., New York, 1880.

spine combined with carefully regulated massage and exercise. The versatility of hysterical symptoms renders it necessary to exercise the utmost caution in forming a decision as to the degree of the hysterical element in any particular case, and I believe that we cannot depend upon any fixed rules of diagnosis, but must be guided by experience both of the morbid state of neuromimesis and of the peculiarities of spinal curvature.

Severe double lateral curvature of the spine, or even a single curve with *fixed* rotation, cannot be simulated by an hysterical person, although it is not uncommon to find the two conditions co-existent. In hysterical or voluntary curvature of the spine bending forwards will cause rotation, but this is not fixed. The irritation produced by lateral curvature may apparently be the exciting cause of an hysterical condition, the latter being relieved or cured by treatment of the former. Deflection of the spine, the result entirely of an hysterical condition, usually assumes the form of a single curve to one or other side, and the trunk may also be bent over to the one side, so that a line drawn vertically upwards from the fold of the buttocks, the patient being seated, will pass to the side of the head or even away from it.

The chief point for diagnosis is to distinguish hysterical cases from those arising simply from weakness. In hysteria the degree of deflection of the spine is sometimes very great considering the facility with which that position may be relieved by posture, or pressure with the hands.

In an hysterical case, if pain be complained of it is generally in the region of the spine itself, and not in the course of the spinal nerves, as usually happens in true scoliosis; but, however, in the cases of weakness which are most likely to be confused with hysteria, the pain may vary in position, and upon the whole it may be very difficult or impossible to decide correctly, upon the first examination, which condition predominates. Careful record of the symptoms upon the first visit should be made to compare with those present a week or fortnight later.

Placing the patient under the influence of ether or chloroform has been recommended when the diagnosis is difficult, upon the principle that the curvature of hysteria can be straightened when the muscles cease to act, whereas a real curvature cannot be so straightened.

In some peculiar cases an anæsthetic may be of service, but

I would urge that a real curvature, which cannot be straïghtened under the influence of an anæsthetic, should in the great majority of instances be recognisable without such assistance, whereas it is those curvatures which are the result of weakness of the joints of the spine, and which could be straightened under chloroform, which are the more likely to be difficult to diagnose from hysteria not thus complicated.

In estimating the significance of irregularities of the spine and shoulders, it is necessary to bear in mind the possibility of their being caused by other conditions than curvature of the spine, especially the following.

Paralysis and contracture of muscles (erector spinæ, latissimus dorsi, trapezius, rhomboids, serratus magnus, levator anguli scapulæ, &c.) may influence the appearance of the back. *Progressive muscular atrophy* is a disease which is well known to produce deformity of the shoulders, causing deflections in the position of the scapulæ, projection of their lower angles, or spinal borders; and other irregularities.

In Duchenne's writings upon this subject,[1] various irregularities thus caused may be studied, but I would observe that many of the positions described by Duchenne as the result of atrophy of various muscles, I have seen assumed in cases of weakness of the back only. The patients thus affected have entirely recovered after treatment which has consisted in, first relief of the back from excess of work, and subsequently the employment of carefully regulated massage and exercises, and improvement of the general health. Progressive muscular atrophy usually commences in the upper extremities or, in children, in the facial muscles, and can be thus recognised; but occasionally this disease has been known to attack the muscles of the trunk in the first place, especially the lower portion of the trapezius, the rhomboids, the serratus magnus, the deltoid, and the pectorals.

At p. 33 I have already referred to this affection attacking the muscles of the back and the abdomen.

The following is abridged from the 'Selections'[2] from Duchenne's works, p. 312:

Contracture of the rhomboids, mistaken by some authors for palsy of the serratus magnus. In a case reported, while the arms rested by

[1] *Physiologie des Mouvements*, par le Docteur C. B. Duchenne (de Boulogne), Paris, 1867. Also *Selections from the Works of Duchenne*, by Dr. Vivian Poore, published by the New Sydenham Society, 1883.

[2] *Op. cit.*

the side, the lower angle of the right scapula was close to the middle line nearly on a level with the outer angle projecting beneath the skin. With much force the lower angle could be pressed into its proper position, but directly the pressure was removed the scapula sprung back into its faulty attitude. During these movements a crepitation could be heard and felt, which seemed to have its origin between the scapula and thorax. Above the spinal border of the scapula, which was oblique from within out, and from below up, a considerable tumour could be seen, caused by the contracted rhomboid standing out in relief. The inner angle of the scapula and the levator anguli scapulæ also formed another projection. The head of the patient was slightly inclined to the right, and on turning it to the opposite side pain was produced in the supra-clavicular space. This pathological attitude was identical with that which could be produced by faradising the rhomboids and levator anguli scapulæ, either singly or together, and there was no doubt that it was caused by contracture of these muscles. It was not due to paralysis of the serratus magnus, because this can take place without any tonic contraction of the former muscles.

On comparing contracture of the rhomboids with palsy of the serratus, it will be found that in the first the deformity is seen only when the arm hangs by the side, and disappears when it is raised; while in the second the deformity appears when the arm is separated from the side, and is not seen during repose.

Contracture of the rhomboids and levator anguli does not cause depression of the point of the shoulder, but causes the scapula to turn upon its outer angle, raising the bone *en masse*.

Résumé of the signs of rhomboidal contracture.

1. Elevation of lower angle of scapula which approaches middle line.
2. Spinal border of scapula is oblique from below up, and from within out.
3. Swelling of the contracted muscle.
4. Occasional crepitation in the muscle.
5. Disappearance of deformity when the patient voluntarily raises the arm of the affected side.

If the levator anguli scapulæ is also contracted, the head is inclined to that side in addition to the other peculiarities. If the rhomboids and the two upper parts of the trapezius are in a condition of contracture, there will be in addition to the other symptoms a raising of the shoulder-tip, and a turning of the head to the opposite side.

Contracture of the rhomboids restrains the humerus from reaching the horizontal position through the *teres major* and the position of the acromion. In paralysis of the upper part of the trapezius the position of the scapula somewhat resembles that caused by contracture of the rhomboids, especially if the serratus magnus has lost its power also.

However, in palsy of the upper part of the trapezius, *the tip of the shoulder is always lowered, while in contracture of the rhomboids the shoulder-tip maintains its normal level or exceeds it.* In the latter case also there is the swelling of the muscle.

Contracture of the supraspinatus or ankylosis of the shoulder-joint may place the scapula in a somewhat similar position, but the two conditions can be distinguished without difficulty.

In commencing scoliosis the faulty position of the scapula may be mistaken for contracture of the rhomboids especially, because in this stage of spinal curvature the spinal processes (may) retain their normal position.

Pathological anatomy shows that it is the rotation of the vertebral column on its axis which causes a deformity of the thorax, so that on the side of the dorsal convexity it is rounded behind and flattened in front, while the reverse condition is seen on the side of the dorsal concavity. It is the bulging of the thorax behind which causes the faulty position of the scapula.

[This description of the position of the scapula will apply to a certain number of cases of lateral curvature, but there are a great many instances of commencing scoliosis, in which a faulty position of the scapula depends chiefly upon relaxation of muscles and to a very *small* extent upon projection of the ribs.—N. S.]

Contracture of the trapezius.—Symptoms: Elevation of the shoulder-tip; scapula drawn towards spine and spinal border slightly oblique from within out and from above down; hardness of contracted muscle; clavicle too oblique from within out, and from below up.

Further, when the middle part of the trapezius becomes more contracted, there is added to the other symptoms a raising *en masse* of the scapula.

Contraction of the *clavicular part* of the trapezius bends the head to the same side and a little back, while the chin is turned slightly to the opposite side.

Contracture of the deltoid.—An isolated contraction of this muscle may cause a faulty position of the scapula. When the arm is raised away from the trunk by action of the deltoid, it weighs upon the outer angle of the scapula, producing in that bone (*a*) a tilting movement, whereby the acromion is depressed while the lower angle moves up and towards the middle line, and (*b*) rotation of the bone on an imaginary axis passing through the outer angle, so that the spinal edge is separated from the chest wall, and a depression (gutter) of varying depth is formed between this border and the thorax. In wasting of the serratus magnus, the scapula, when the arm is raised, takes a position like that caused by contracture of the deltoid. It

could not be otherwise, for in palsy of the serratus the deltoid contracts by itself (and not in concord with the serratus, as is the case normally). The two conditions cannot, however, be confounded, for in palsy of the serratus the deformity of the scapula occurs *only when the arm is raised*, while in contracture of the deltoid it is present with the arm at rest, and lessens or vanishes when it is raised. Further, the soundness of the serratus magnus might be demonstrated by electricity.

The diagnosis of congenital lateral curvature from other forms is discussed on p. 86.

Lateral curvature may be produced by malignant or other tumour, by osteitis deformans, by osteomalacia, by rheumatoid arthritis, or by the pressure of an aneurism. The characteristic peculiarities of these diseases would probably be present, and diagnosis of such conditions from caries of the spine, rather than from ordinary lateral curvature, would be necessary.[1]

Curvature caused by osteitis deformans always, as far as I know, assumes the form of posterior curvature, but it might take a lateral direction. The concurrent deformity of other bones would lead us to form a correct diagnosis.

PROGNOSIS OF LATERAL CURVATURE

Assuming that all the causes can be removed, the prognosis depends upon a variety of circumstances.

(1) *The degree of deformity.*—This is doubtless a most important point for consideration, for if the curves extend beyond a certain degree, we may be able to say without any doubt that the case is beyond absolute cure.

This degree of deformity consists in, not so much the absolute lateral deflection of the spinous processes as in the rotation of the vertebræ. Lateral curvature with but slight rotation may exist to a severe degree, even to the amount of the curves being two inches from the central line, and yet be capable of absolute cure; whereas, a departure from the central line of, say, one inch with considerable rotation may only be capable of slight improvement.

In stating these degrees of deformity it must be understood that one cannot draw any hard and fast line, as individual cases differ very greatly. For instance, we might have before us six cases of apparently exactly the same degree of deformity, and

[1] *Caries of the Spine, op. cit.*

yet the same amount of treatment in each case would be attended with very different results.

(2) *Duration of deformity.*—A slight degree of curvature which has existed for a long time is far more favourable for cure than the same amount of deformity which has only taken a short time to develop.

The explanation of this fact is that a quickly developed deformity denotes a much greater softness of bone than when the progress has been slower, a certain degree of firmness being favourable to treatment.

(3) *Age.*—During the period of growth, the younger the patient the worse the prognosis. If a young child, say, five or six years old, has a decided curvature and obvious rotation, it denotes considerable softness of the vertebræ and weakness of constitution, and at this age there is little bone formation, the vertebræ being to a great extent cartilaginous, so that our attempts to control the spine are met by great difficulties.

There is no age at which some improvement cannot be effected, improvement not necessarily very great as regards appearance, but improvement to such an extent that the patient will be relieved from pain and a feeling of weakness, and so be the better for the treatment.

(4) *Flexibility.*—The probability of producing improvement 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 great improvement by treatment. The position in which the surgeon can hold the body by pressure with the hands indicates what he ought to be able to accomplish by mechanical apparatus, and it is absolutely certain, in the great majority of cases, that that position, or a better one, will eventually become permanent.

Experience in dealing with lateral curvature makes one very careful as to prognosis. Some of the most unpromising cases will be immensely benefited, while others, which appear to offer facilities for treatment, turn out to be only partially remediable.

Pain can always be removed, and prevention of increase of deformity can almost always be effected. It is only very rarely that deformity progresses in spite of treatment. Under these latter circumstances the patients are in a very weak condition, and the

increase of deformity depends more upon their constitutional state than upon the local condition.

Prognosis is one of the most difficult subjects for accurate description, but the surgeon ought to be able to promise to do some good in any case; and considering the disastrous results of doing nothing, the patient ought to be contented with the assurance that the increase of the deformity can be stopped, that pain can be relieved, and that possibly some improvement can be effected. If the results are better than the promise, well and good.

In very severe cases, cases in which one is certain that cure cannot take place, the point is sometimes raised as to whether the deformity will increase if left to itself. I lately had a consultation with an eminent surgeon, whose opinion I greatly value, but who, I assume, has not had much experience with cases of lateral curvature. It was with regard to a lad of about fourteen years of age, who was suffering from severe curvature. The boy was strong and his health seemed fairly good.

The surgeon I refer to gave his opinion that 'nothing should be done, as the deformity would not increase.' I raised the following questions:—'Why and upon what grounds do you consider that this deformity, which has gradually progressed to its present condition, will not increase? Had you seen this lad six months ago, when the deformity was slightly less, you would doubtless have given the same opinion. Can you offer any explanation of your view that the deformity has arrived at such a stage that it is not going to get worse?' This he could not do. However, no treatment was carried out, and the patient necessarily got worse. I would refer the reader to a description of a case on p. 109, which also exemplifies this subject.

In very severe deformity, when improvement in form cannot be expected, the relief which can be given to the patient is produced by relieving the pressure which is in excess upon the concave, and by relaxing the stretching of tissues which exists upon the convex side.

CHAPTER VII

CAUSES OF LATERAL CURVATURE

Theories of 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 had its antagonist, and that certain groups of muscles were equally balanced by opposing groups, and that absence of lateral curvature depended 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.

Werner [1] was opposed to the theory of muscular antagonism, basing his objections upon the fact that muscular development upon the two sides of the body is so seldom equal.

Borcelli, also, wrote 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. This result, however, may be explained by the *faulty position* which generally accompanies the excessive use of one or other arm and thus causes 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 this affection, and published the records of 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, while others, among whom were Dieffenbach and Malgaigne, vigorously opposed it.

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

Malgaigne reported [1] 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 Inquiry into the subject was appointed by the Academy, and they reported that Malgaigne's statements were correct.

Guérin's treatment was tried in England, but the result was failure.

Stromeyer advanced a theory of one-sided paralysis of the respiratory muscles, which did not meet with much favour, and which is not supported by facts.

There are few supporters in the present day of the 'muscular contraction' theory, and, as Bampfield [2] 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 further.

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

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.

John Gay [3] dissected a case of severe lateral curvature in the cervical and upper dorsal regions, convex to the left, in a young woman aged twenty-three, who died from fever. The muscles of the thorax, both anterior and posterior, 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 lon-

[1] *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.

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

[3] *London Medical Gazette*, December 1841.

gissimus 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, the spine remained firm. The intervertebral fibro-cartilages were thinned on the concave and thickened upon the convex side of the spine; their elasticity was lost.

Dissections made by Bouvier showed somewhat similar conditions.

Lateral curvature of the spinal column was at one time generally attributed to primary disease in the bones and intervertebral cartilages, and in modern times Lorinser has been a strong advocate of the theory that this affection is caused by an osteomyelitis.

I have seen cases in which some such condition as that referred to by Lorinser has existed, leading to a rapid development of deformity.

These are exceptional cases, but as regards the majority of others I have come to believe that an unnatural softness of bones and cartilages plays a very important part in the causation of this affection.

It would be tedious and unprofitable to discuss all the speculative theories which have been advanced with regard to this subject, but there seems abundant evidence to prove that, excepting congenital deformity, which stands by itself, some condition of debility acts as a predisposing, and certain habits or circumstances act as exciting, causes.

The causes may be tabulated as follows:—

PREDISPOSING

1. Muscular weakness alone.
2. General physical weakness.
3. Softness of bones and laxity of ligaments.
4. Caries.

EXCITING CAUSES

These are mostly postural; that is, they involve long-continued bad positions, as follows:—

(1) Badly-fitting clothes.
(2) Long-continued attitudes in certain trades, school-life, &c.
(3) A short leg, lameness, or deformed pelvis.
(4) Pleurisy and other diseases altering the shape of one side of the thorax.
(5) Paralysis of muscles } leading to forced irregular
(6) Contraction of muscles } postures.
(7) Pressure on the spine by aneurism or tumour.

We may consider the causes of lateral curvature under these two divisions:—

The exciting causes may give rise to the affection when the predisposing do not exist, and the predisposing, if severe, will lead to the formation of curvature, although the exciting causes are so slight that they are scarcely, if at all, distinguishable, or possibly 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; but by far the more common cause is softness of the bones and relaxation or weakness of the ligaments, and this may be either inherent or may arise from rapid growth giving more work to the spine as regards the carrying of weight than its development is capable of sustaining. The *exciting* causes are conditions which disturb mechanically the equilibrium of the spinal column continuously or for long periods.

In rickets the vertebræ readily give way to lateral pressure.

When a child suffers from general debility, and especially when there is a family history of 'tubercle,' the bones are more readily influenced than they are in health.

When a child is growing rapidly, curves are as a rule 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. It is said to be very common to find some retardation of sexual development, or

some derangement of the commencing menstruation; but this opinion does not accord with my own experience, as, although sometimes the menstrual functions are deranged, yet in the majority of cases I have not found such to be the case.

When boys are affected with this deformity they are often found to be effeminate in their conformation, with 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 structures may perhaps consequently suffer.

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 will act in the same way.

In some families there is a **hereditary tendency** to lateral curvature, which perhaps indicates hereditary weakness. It has been stated that 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.

It has not, however, appeared to me that stays have any special influence in producing curvature except when badly shaped, and then they act in conjunction with other badly-shaped clothes in pressing the body into bad positions.

I have dealt with this subject more fully on p. 12, under the title of 'The Physical Culture of Youth,' and I would ask the reader to turn to that page and peruse the remarks upon this subject again, as I look upon them as of the highest importance.

Under the same heading I have referred to the want of sufficient nourishing food which so many children suffer from, and this cause is, I believe, greatly underrated at the present day.

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, many girls wear stays, which may retard the development of the body.

Then there are some customs in respect to rearing children which are potent predisposing causes. At an early age children are made to sit in chairs, and are urged to hold themselves up. To maintain an upright sitting posture requires a considerable muscular effort. The spinal muscles which are chiefly involved

soon get tired, and the back subsides into a backward bow, the least evil result of which, if indulged in frequently and for long periods, is posterior curvature of the spine—a deformity already described. If the spine is not allowed to bow backwards, it necessarily bends laterally, subsiding until restrained by arriving at the limit of flexion of the joints between the vertebræ held together by the ligaments. A similar position is frequently repeated till a slight permanent curve is set up. Subsequent repetition of the posture causes a gradual alteration in the joints and an increase of the curves.

It is the excess of anxiety on the part of the parent, governess, or nurse, which thus frequently gives rise to the production of the first curves. It would be far better to allow children to assume whatever position they liked, to let them rest or 'loll' about as they felt disposed.

If the backs of the chairs used were properly constructed, so that the children could rest thoroughly against them, then one great disturbing element would be absent. As a rule the backs of chairs used by children are of very little service to them as supports, and even in the present day there exist schools where the pupils have to sit upon forms without any backs at all.

Girls are too often restricted in their naturally energetic move ments with the object of making them 'refined in their manners,' and they are not allowed to follow the dictates of Nature, which would induce them to take exercise in an unconstrained manner.

Moreover, it is not merely exercise that children require, but also *recreation*. Insufficient out-of-door recreation acts as a predisposing cause of curvature of the spine, and errors of position, which school children are made to assume, act as exciting causes.

Upon the other hand, *too much* exercise has a contrary effect, and causes weakness instead of giving strength. In the present day this error is a very common one.

If the back is not rested directly the muscles become tired, the spine subsides to one or other side as just stated, 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 form of the soft growing spine, and the slight curve thus commenced is very easily increased.

At the Congress upon School Hygiene at the International Health Exhibition in 1884, I read a paper upon this subject, entitled 'Postures in School, their Influence upon Physical Development,' in which, after describing how bad postures influence the form of the body, I made the following remarks :

'Long walks in precise and stately file produce a harmful strain upon the spine and legs, whereas free movement in such games as cricket and lawn tennis afford most healthful exercise.

'After a long, uninteresting, formal walk, the girl returns to work, the muscles of her back are then fatigued from prolonged use in one direction, and when she sits down she soon allows her back to fall into a curved position.

'Over-work, by causing general fatigue, impairs the pupil's health, so that her muscles and other tissues become less able than in health to sustain the body weight. Girls seem to be very easily induced to do a large amount of sedentary work, and they readily fall into the habit of neglecting physical exercise. It is therefore most important that their studies should be carefully arranged, so as to insure a due amount of active recreation.

'Girls are said to be more restless as regards their postures than boys; but is it not that the natural restlessness of young people is more noticed in the case of girls, and more often checked ?

'We have seen that if any one posture is maintained repeatedly for long periods of time without the body being perfectly at rest, the normal development of the skeleton will be interfered with.

'The periods which may be called long, vary in accordance with the particular posture adopted. That which is a long period for one position, is a short time for another. Then, again, the periods which may be termed long, depend upon the health and natural strength of the child. A feeling of fatigue is a certain indication that a change of posture is required. I will now analyse a few typical postures.

'1. *Standing upright* for too long fatigues and exhausts the muscles, and thus weakens them. The result is a gradually lessened ability to prevent the body falling into bad postures. Standing with both feet close together is a very fatiguing attitude.

'2. *Standing upon one leg* places the base of the back in an oblique position, and thus causes lateral curvature of the spine.

'3. *Standing and supporting the body with the hands* upon

a chair, or with the back against a wall, is better than not having any extraneous support at all, but it is likely to produce roundness of the back.

'4. *Standing with the arms crossed* also makes the back round.

'5. *Standing* may produce flat feet and also knock-knees. In the latter case, the weight falls chiefly upon the outer side of the joints, and they gradually give way towards the central line of the body. Flat-feet and knock-knees, by disturbing the natural mode of progression, may induce lateral curvature, especially if one leg be affected more than the other.

'6. *Sitting with the arms resting upon too low a table* produces a round back, and when the right hand is used for writing, drawing, &c., the shoulder of the right side is raised more than that of the left, and the spine is placed in a laterally curved position.'

Upright hand-writing.—The twisted and curved position of the spine caused by writing is doubtless a very potent factor in the production of lateral curvature, and the modern system of tuition involves a great deal of writing.

Much may be done to prevent bad postures by having a suitably high and sloping desk, and by bringing the chair close up to the desk; but under the best circumstances the posture necessary for writing is not good. **The more slanting the writing the worse the position, and I would emphatically advise that upright be universally substituted for slanting writing.** Children at school should write their exercises 'sitting up' in a well-shaped chair, writing with a pencil upon a blotting-pad or board held by the left hand, and if the chair is provided with high arms so much the better. To write with ink necessitates a stooping position to allow the ink to run down to the point of the pen.

'7. *Sitting in a chair with a suitable back rest* is a very good position, but it is quite possible for the back to be made "round" while in this posture by the pupil bending forwards frequently and thus contracting the chest.

'8. *Sitting with the knees close side by side* is a very fatiguing attitude, but it is not considered elegant for a young lady to sit otherwise, unless she crosses the knees, and crossing the knees is also a bad position, and necessitates the spine being placed crookedly.

'9. *Recumbency in bed* even may involve the assumption of bad postures. The body may be bent, the knees and head approximated, causing a rounded back. The pillow may be too high, so that the spine is curved laterally in sleeping on the side, or posteriorly in sleeping on the back.

'10. *Playing upon the piano.* This is necessarily a very fatiguing posture, even when the pupil uses a well-constructed seat which supports the back, and therefore the time devoted to this practice should for weak children be of but short duration.

'11. *Violin playing* may place the spine in a bad position, especially in the upper dorsal region, although this may be obviated by careful arrangement and by using a pad fixed upon the dress where the violin rests.'

To the above bad postures I would now add the following:—

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

Inequality in the length of the lower limbs 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 fifty-four persons examined by Dr. Cox, only six possessed limbs of equal length—the variations ranging from one-eighth to seven-eighths of an inch.

Dr. Garson carefully measured seventy skeletons at the Royal College of Surgeons, and in only 10 per cent. of these cases were the limbs equal in length. The left limb was found longer than the right in thirty-eight cases (54·3 per cent.). The right was the longest in twenty-five cases (35·7 per cent.). The amount of inequality varied from one-twenty-fifth to half an inch.

I may mention that of fifty-four cases of curvature of the spine, the measurements of which I recorded, in twenty-four

[1] *Philadelphia Med. Times*, Jan. 1875.

[2] *American Journal of Med. Sci.*, April 1875.

[3] *Arch. Clin. Surg.*, Feb. 1877, and *Proceedings of Med. Soc. County of Kings*, Jan. 1878.

[4] *Phil. Med. Times*, Aug. 1878.

[5] *Journal of Anat. and Phys.*, July 1879.

one or other leg was found to be shorter than the other; and I have further observed an important fact, which probably shows that in these twenty-four cases the deformity was dependent upon the postures produced by the inequality in the length of the legs. That fact is, that in twenty-one out of the twenty-four the short leg was the left, causing a lumbar curve to the left; whereas, in the three cases in which the short leg was the right, the lumbar curve also was to the right; in all cases there was a compensating dorsal curve.

To what extent these irregularities may be dependent on or independent of morbid processes which may occur during the period of development and growth, it would be very difficult to estimate, but I may remark that a large number of cases occur in which temporary arrest of development has caused one leg to be smaller in all proportions than the other.

I have referred to this condition when writing upon club foot, the two affections being sometimes co-existent, and for the reasons there stated.[1]

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 fracture, bending from rickets, or a flat-foot.

The accurate measurement of the length of the legs is a matter of great importance. One method, which may answer the purpose, is for the patient to sit quite evenly in a chair with the back against the back of the chair. Both feet are then to be raised, and the soles and heels of the two boots compared. In some cases the pelvis is so twisted that a correct estimate cannot thus be obtained. The most certain, and in fact the most valuable method is to test the level of the two crests of the ilia while the patient stands as upright as possible with the feet close together. If one side is lower than the other, pieces of wood, or thin books, can be placed beneath the shorter leg until the pelvis is made level. The degree of deficiency will then be gauged.

Another plan for detecting a difference in the length of the legs is for the patient to sit upon the floor and draw the legs up till the heels are close to the buttocks. If one leg is shorter than

[1] *Surgery of Deformities, op. cit.*

the other, it will be shown by the knee of that side being lower than upon the other leg. By this plan, however, a lowering of one leg from a weak ankle is not indicated. The level of the crests of the ilia is the most important symptom, but the plan last detailed may be supplemented to help in elucidating the nature of an inequality.

It has been stated that the position of the aorta on the left side of the vertebral column is a cause of lateral curvature. It is described by Dr. Busch [1] as follows: 'The aorta, after it has crossed the left bronchus, reaches to the left side of the third dorsal vertebra, and then descends with a gradual curve, so that it first reaches the exact middle line on the anterior surface of the third lumbar vertebra. Sabatier was the first to point out, with reference to this question, that this position of the aorta weakened the left side of the vertebral column, inclining it to bend towards the opposite side. This question has been very enthusiastically discussed by eminent French anatomists. Cases have been observed in which, with transposition of the viscera, the spinal curve took the opposite course; but there are also cases in which no alteration took place, and others in which in a normal position of the aorta the curvature was towards the left.' . . . . 'The position of the aorta upon the left side of the vertebral column favours the production of this deformity, for there can be no doubt that, by the position and the pulsations of this great vessel, the left half of the dorsal part of the column is hindered in its growth and its capacity for resistance is lessened, and thus the spine gives way more easily to the increased pressure on the left side, as occurs with weighting of the right arm. The relation is not so simple, however, that we can talk of the aorta pressing the vertebral column to the right by its pulsations.'

These arguments are not to my mind convincing, and I do not think that our bodies, if naturally formed and healthy, will be subject to lateral curvature from the position of the aorta. I base this opinion chiefly upon the fact, shown by the table (page 42), that in a large number of cases the dorsal curve is to the left, a number which is quite out of proportion to the rare cases in which the aorta is transposed in position.

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

[1] Ziemmssen's *Handbook of General Therapeutics*, *op. cit.*

14. *Carrying heavy weights.*—When a heavy weight is very frequently carried in one hand or on one arm (as in nursing a child), the equilibrium of the body is upset, and the spine is placed in a crooked position.

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

16. *Alteration in the position of the head*, as in wry neck.

17. *A great deal of horse exercise.* A reversible side saddle upon which the rider can vary her position from left to right is often advised as a preventive of bad effect from riding. I doubt very much the advantages derived from such a practice. Perhaps if children are taught from the first to use them they *may* get used to accommodate themselves to the repeated change, but riding upon the 'off' side of a horse is naturally an awkward position, and the rider is apt to assume a very bad posture when thus placed. In the latter position it is necessary to make the horse lead with the near foreleg, while when the rider upon the next occasion changes her seat, the horse will have to change the lead. The difficulties thus involved are likely to do more harm than good as regards the posture of the rider.

I think it preferable to have a young girl taught to ride well and evenly in the ordinary position, that is, on the 'near' side of the horse. Moreover, an efficient riding master should be employed, as grooms and coachmen, however careful and experienced in their ordinary work, are seldom if ever qualified to give the necessary instruction. Saddles can now be had which allow the rider to sit evenly without twisting the body. If these precautions be taken, I do not think that riding, unless indulged in to great excess, will alone produce lateral curvature.

I have met with one case which seemed to have been produced by excessive riding. A young lady, aged twenty-six, had passed several hours every day on horseback. Curvature was produced, consisting chiefly in rotation in the dorso-lumbar region, causing a projection upon the left side of that part of the spine. There was much aching pain, and the condition had been attributed to caries and there was thought to be an abscess. The patient was treated for lateral curvature and recovered.

CHAPTER VIII

FORMATION OF LATERAL CURVES

It has been shown in the previous chapter that the frequent repetition of some irregular posture may produce permanent curvature. In this way not only may one curve be produced, but usually more than one. As a rule there are two curves, and sometimes there are several.

Some of these exciting causes act by producing *obliquity of the pelvis*. This will occur in the cases of irregularity in length of the legs.

Whether this difference in length be structural, or from congenital dislocation, or weakness of one ankle, or from any other condition, the effect is similar; also, from what amounts to the same thing, only differing in degree, the habit of frequently standing upon one leg; or the legs being equal in length, the pelvis in some rare cases may be unequal upon the two sides. Of these conditions, standing upon one leg must obviously be the least influential, because the least frequently in action. Shortness of one leg acts whenever the patient is 'upon his legs,' unless indeed in standing he rests upon the shorter leg.

Deformity in which one side of the pelvis is smaller than the other affects the spine, whether the patient be standing with legs straight, walking, or sitting down, whereas the other two conditions cease to have effect during the sitting posture.

The following diagrams show the manner of formation of curves from obliquity of the pelvis.

Of course the changes in the spinal column take place gradually and simultaneously, so that we do not see, but infer that one curve is formed consecutively to the other to compensate it in maintaining the body's equilibrium.

In 'standing on one leg' ('standing at ease'), a large sweeping curve is produced, extending from the middle part of the dorsal region to the sacrum. This curve is very noticeable

in young people possessing very flexible spines (see fig. 22). In young, growing people, especially if they are not strong, this curve, if repeatedly formed, 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 changed in shape. Upon the concave side the growth of the bones and cartilages is retarded, and absorption of the parts will take place from pressure. Upon the convex side of the curve the pressure is less than normal,

FIG. 22

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

FIG. 23

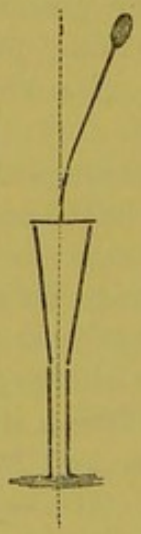


Diagram to show the position the spine would assume (the legs being straight) if the lumbar curve remained fixed

FIG. 24

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

and consequently the development of the structures proceeds without opposition. Therefore, in the course of time, whenever the individual ceases to hold the pelvis obliquely, and sits or walks, the body will continue to be bent over to the opposite side.

As, however, the equilibrium must be restored, and as the 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 (see fig. 24).

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 gives rise to cervical curve, and frequent obliquity of the shoulders causes the primary curve to occur in the dorsal region. The manner of 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 generally 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 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 arm will usually be that which is raised, and the left depressed, thus causing a primary dorsal curve to the right.

It has been already stated that the predisposing causes may alone sometimes cause 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 I have already discussed the formation of curves under such circumstances. 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' without a back, the spine is allowed to curve in this manner, and the same effect obviously occurs when a chair is used which does not properly support the back.

CHAPTER IX

CONGENITAL LATERAL CURVATURE

This is a rare condition, and when existing it may be accompanied by other severe deformities in the same individual. It may, however, occur as an independent affection, in which case there is likely to be considerable difficulty in distinguishing between it and acquired curvature.

I have examined and made drawings of specimens of this deformity in the Museums of the Royal College of Surgeons, St. Bartholomew's and Guy's Hospitals, and have found in them characteristic peculiarities which help in forming a correct diagnosis during life. A full account of these specimens, with the drawings I had made, were published in 'Clinical Sketches' for September 1895, and it will sufficiently serve the purpose of this work to give a general description of them. Absence of an entire half of a vertebra is the essential deficiency upon which the curve usually depends, the half remaining being united closely or rather amalgamated with the vertebra above or below.

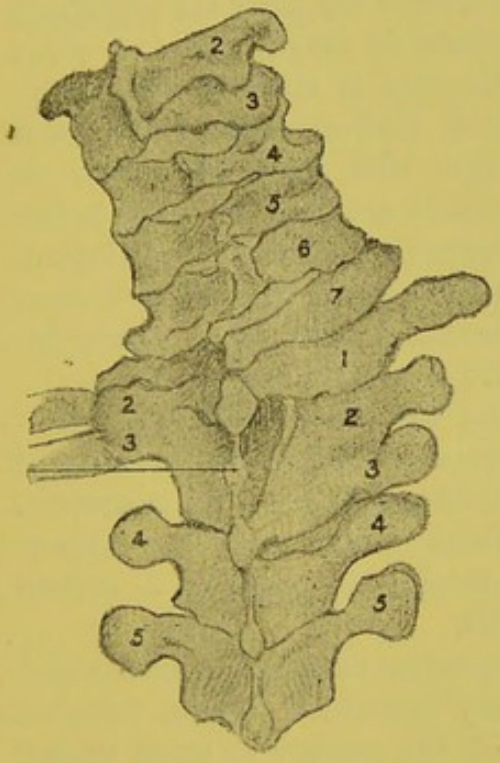
In St. Bartholomew's Hospital Museum [1] the skeleton of an adult woman, otherwise malformed, has only twelve and a half vertebræ, which are supposed to be distributed as follows: the upper two presumably cervical, the three lower lumbar, and the remaining seven and a half dorsal. The right half of the third dorsal vertebra is absent, producing a sharp lateral curve to the left. A compensatory curve, longer and slighter, exists below. In this case the deficiency produces a very slight deviation in the spinous processes, but the compensatory curve is well marked.

[1] For full description see *Medico-Chir. Trans.*, vol. lxiii., in a paper by Messrs. Willett and Walsham.

In the Museum of the College of Surgeons (2115A), in the skeleton of an adult male, the left half of the first dorsal vertebra is absent, so that the left halves of the bodies of the seventh cervical and second dorsal are in contact (figs. 25 and 26). There is also bony fusion of some of the vertebræ.

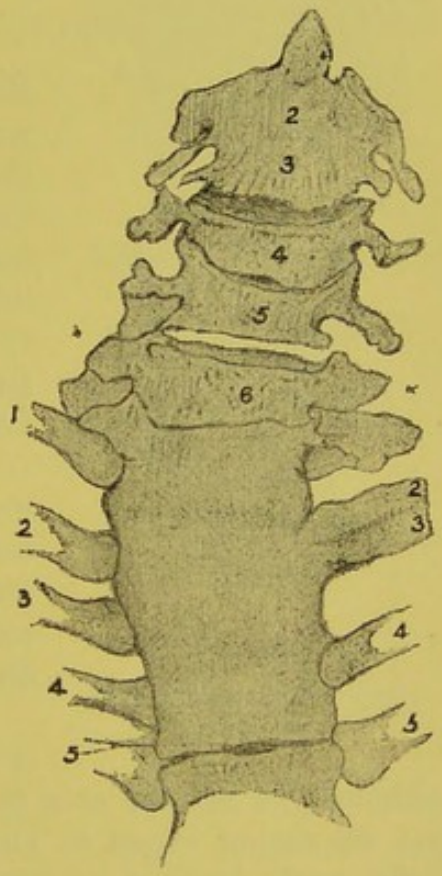
There are several specimens of similar deficiencies in the bodies of the vertebræ of cases of spina bifida, both in the

FIG. 25



POSTERIOR VIEW

FIG. 26



ANTERIOR VIEW

(Royal College of Surgeons, 2115 A)

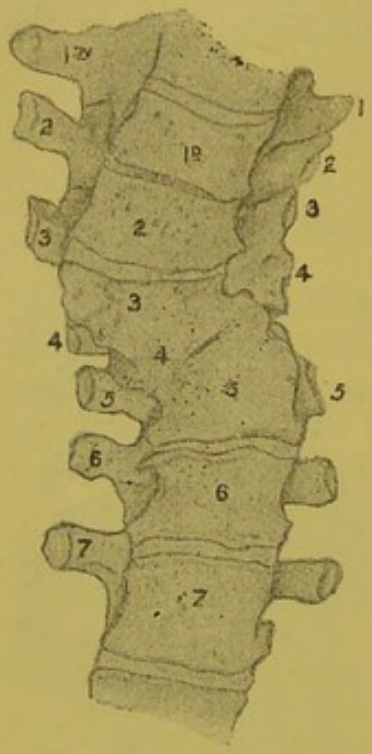
College of Surgeons, St. Bartholomew's Hospital, and other museums.

In Guy's Hospital Museum (1004 92) is the skeleton of an adult, the deformity of the spine of which is described in the catalogue thus: 'A congenital malformation of the spine caused by a fusion together of the bodies of the third, fourth, and fifth dorsal vertebræ, and the curvature of the newly-formed mass.' It is probable that there is a deficiency of the left side

of the third dorsal vertebra and of the right side of the fourth (fig. 27).

In Middlesex Hospital Museum is the skeleton of an adult female, in which the left half of the third dorsal vertebra is absent, the result being a long dorsal curve to the left below this half vertebra, and a second compensating curve in the lumbar region.

Fig. 27



Anterior View

(Guy's Hospital Museum, 1004 [92])

To discuss the practical bearing of these cases, we may in the first place conclude that it must be but rarely that such malformations occur, and more rare still that they occur in cases which are likely to come before the surgeon for treatment of the lateral curvature, because this effect is usually associated with other severe deformities or even monstrosities.

Upon the other hand, the specimens here alluded to are instances of cases which might come for treatment, and which might give the surgeon much trouble in forming a correct diagnosis.

The correct diagnosis of such a case is a very important matter, because, although we may be able to assist the patient to some extent, yet we cannot expect to alter the malformation. Our treatment would have to be directed to modifying the compensating curves.

In the cases above described I have noticed the following peculiarities. The first point is the abruptness of the curve centred in the defective vertebra, forming an angular deflection of the spinous processes; secondly, the absence of rotation in that curve. We find rotation, however, existing in the *compensating* curves; in fact, unless there is any modifying influence, these compensating curves do not differ from the curves of ordinary lateral curvature.

In the specimen at Guy's Hospital Museum, however, it is a curious fact that in the lower curve, from the seventh dorsal

vertebra downwards, the spinous processes are directed towards the side of the convexity. I can find no apparent reason for this anomaly.

In congenital curvature we might also detect other deficiencies, such as the absence of the one half of the arch, and as in several of these cases there has been ankylosis between a few of the vertebræ an unusual degree of rigidity might be noticeable. The occurrence of malformation in other parts of the skeleton, moreover, when existing, might help us.

I have met with a few patients in whom I have diagnosed congenital curvature.

CHAPTER X

TREATMENT OF LATERAL CURVATURE

General Methods of Treatment

In the first place the cause 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 method must be adopted to restore the pelvis to its normal position.

The prevalence of inequality in the length of the legs has already been referred to (p. 79). If it be due to structural defect in the length of one leg, then the deficiency may be corrected by a cork thickening of the sole of the boot of the short leg. If it depends upon a bent leg, a flat foot, a weak ankle, or other cause of an oblique pelvis, then the appropriate remedies for these conditions must be applied.

The clothes of the patient, so often a cause of curvature, must be altered if necessary, and as during treatment the chest is continually expanding, a close watch must be kept that ample space is provided.

Long-continued faulty attitudes and occupations, in which the spine is held in a crooked position, 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.

In curvature associated with any constitutional discrasia, the patient must be treated for the general disorder as well as for the spinal deformity.

Special Methods of 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 unsuitable for ordinary cases of lateral curvature of the spine.]

1. Local Stimulants

Friction, with simple or stimulating liniments and cold douches, are useful in giving tone to the muscles of the back.

Warm-water bathing will be beneficial sometimes, if followed by a cold douche.

Massage is very valuable in some cases, see p. 118.

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 cannot be recommended except in a few very exceptional cases in which the bones are so soft that absolute recumbency *for a time* is imperative.

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

In all cases fatigue ought 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 padded, and so made that the attitude of the patient need not be constrained.

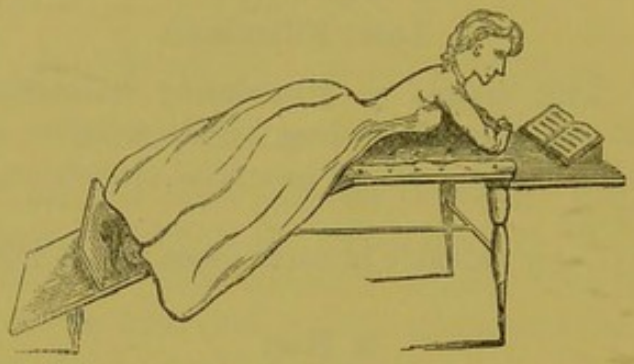
The position during recumbency should be that which allows the spine to fall into its natural shape (see fig. 1), and which affords the most complete rest to the muscles of the back, while the vertebræ and intervertebral substances are relieved from the pressure of superincumbent weight. Chairs which fit the natural curves of the back afford much more relief than ordinary chairs; but the pressure referred to is not thus entirely 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 abdomen, and slanting from the hip-joints towards the feet.

The arms can be used in this position, such use tending to straighten the back and to exercise the dorsal muscles. The supine position tends to weaken the back and produce 'roundness of the shoulders' and posterior curvature.

Fig. 28



The Prone Couch (as modified by the author)

Prone recumbency is especially useful when the curvature predominates in the lumbar region, as in that posture the curve tends to a natural position by its own weight.

Lonsdale's couch acts upon the most prominent curve by the gravitation of the upper and lower parts of the body. The curve is supported by a band suspended between two uprights. It is only suitable in very exceptional cases.

3. Mechanical Extension and Pressure

This means of treatment has a very ancient origin, and has been carried out chiefly by the following methods.

The patient lies upon a couch, the head is fixed by a collar, or by lateral supports attached to the couch, and extension is made by springs or by weights from the pelvis. Sometimes (as in Coles' 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 connecting the whole machine with a table.

Tuson invented a couch which provided means for exercises by the patient as well as for extension.

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, 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.

Sayre introduced into this country from America a plan of self-suspension, in combination with the application of a plaster-of-Paris jacket, originated by Benjamin Lee, of Philadelphia. 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

[1] *Traité des Déformités du Système Osseux ou de l'emploi des Moyens mécaniques gymnastiques dans le traitement de ces Maladies.* Paris, 1833.

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

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.

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.

There are, however, some exceptional cases of curvature in the cervical region in which extension may be useful; but if this method is adopted it should be applied when the patient is in the recumbent position, as then the effect is much greater than in the upright. It is extremely rare, however, that any greater immediate effect can be thus produced than by the apparatus to be presently described, and while the former is intermittent, the latter is constant in its effects.

Results of Suspension in conjunction with Jackets

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 free exercise of the muscles of the back.

6. It interferes with or prevents thoracic respiration, and so favours collapse of the chest 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 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 mistake. 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. It is a common practice now to have holes punched in many places in the felt, but when the jackets fit closely these ventilations are not of very great use.

Then the mechanical support afforded by a jacket is very ineffective. No accuracy of pressure can be applied, all the support being obtained at the expense of interference with the action of the muscles.

4. Muscular Exercises

Exercises are employed for two purposes :—

1. To strengthen weak muscles, and improve the general health.

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 are equally brought into action.

As a preventive of deformity, and also as a cure of the slighter cases, general exercises to develop the body are very valuable. English children, or at least boys, are brought up to take pleasure in out-of-door exercises and games, by which their health is generally maintained. Girls, however, are very frequently debarred from natural play, although in recent years

[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.

a change has taken place in this respect. In many girls' schools active games such as cricket and football have been introduced and are sometimes even carried to excess. Cycling is a most healthful exercise if not overdone.

Upon the other hand, weakly children, who are unfit or disinclined to take part with their more robust companions, are likely to suffer materially if they are forced to exert themselves too much before being carefully prepared.

Upon this subject of general development of the body, an excellent book has been written by Mr. William Blaikie.[1] I quote largely from this work on p. 133 *et seq.*; enough to show the kind of exercises which are advocated, and which I can confidently recommend as being good for healthy children, although only some of them would be suitable in the treatment of lateral curvature.

The exercises there described, although simple, are very effective in improving the strength of the body, but should not be indiscriminately followed out when there is a distinct curvature of the spine. In very weak children, in whom there exists a difficulty in sitting up straight, great care should be taken not to overwork the body, and in many cases an increase of rest is more beneficial than increased exertion. Children who are weak after some illness, or from too rapid growth, or who are constitutionally feeble, often suffer from too much exertion, either from long walks or from sitting up too much. Their muscular system is constantly being overworked, and a course of gymnastic exercises is not suited to them, but will do more harm than good. For such patients a course of massage is very useful, see p. 118.

I find that if the vertical measurement of the back, extending from the level of the shoulders to the chair (in a sitting posture), exceeds the measurement from the centre of the back between the shoulders round one arm, to the same point, the arms being drawn backwards, then the back is too long in proportion to its robustness. Individuals in whom this length of back occurs are very liable to curvature of the spine. In taking these measurements it must be remembered that such patients usually carry their shoulders very forward, thus increasing the distance round the arm considerably from that which will exist when the shoulders are drawn back.

[1] *Sound Bodies for our Boys and Girls.* Published by Sampson Low, Marston, Searle & Rivington, 1884.

As a preventive measure, swimming is an excellent means of exercising the dorsal muscles. But as a curative method, I have not, except in slight cases, found it do good.

The majority of games may be useful. In cases of dorsal curve to the right (the usual deformity) lawn tennis may be permitted in moderation, but it is very difficult to prevent overstrain. Cricket is better, and cycling is very good, as already stated, if the patient holds herself in an upright position.

In slight cases of lateral curvature, in which muscular debility has been the predisposing cause, but is not very marked at the time of treatment, well-regulated muscular exercises will be highly beneficial; but they will do little or nothing to remove curves which have become fixed.

Exercises in the recumbent position.—In the recumbent position it is obvious that the weight of the body does not act in opposition to the remedial movements, and in many cases, especially when general weakness of the body prevails, a system of exercises performed by the patient while lying down is of great service. The supine or the prone position may be assumed. Shaw's exercising plane may be used. It consists of a board or table constructed upon a slant of about one in seven, upon which a moveable board rolls. This plane may be used in various ways. I prefer the patient to rest the body either supine or prone, and repeatedly pull himself up the incline by a cord passing round a pulley at the head of the plane, and passing down to be attached to the board upon which he rests. When the pull is relaxed, the free-board rolls down the incline with the patient.

Another plan is for the patient to lie flat on the ground upon a mattress or soft rug, the lumbar region of the spine being well supported by a cushion, and exercise the arms in various directions horizontally above the head, vertically in front of the face, moving them downwards, outwards, and then up again. A great variety of these movements may be performed. Or the patient may rest upon the prone couch, and execute various movements with both the arms and legs.

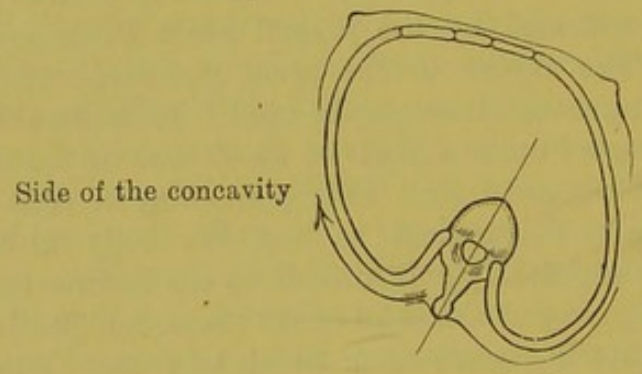
Muscular exercises to act directly upon the curves.—In order to thoroughly appreciate the effect of muscular exercises upon a curved spine, it is necessary to consider carefully the exact action of the muscles which we propose to bring to our aid, and the exact position of the parts which are distorted. 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 curve by use of the arm of that side.

Now the muscles which extend from the arm to the spine 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, and the part which may form the chief amount of deformity.[1]

The effect of this exercise is obviously to draw the spinal 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. 29



Section of thorax, showing line of action of dorso-scapular muscles

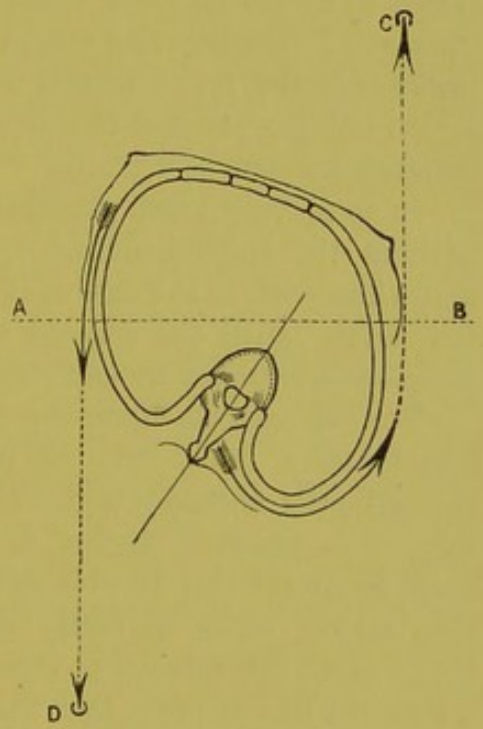
(fig. 29) will show the direction in which the muscles already referred to will act; for it must be observed that although both arms are used in the exercise, yet that arm which is upon the side of the concavity is raised higher than the other arm, with the object of bringing into greater action the muscles which extend from that arm to the concave part of the deflected spine. The lateral bend of the body necessitated by this exercise would be beneficial if it were not brought about by the action of the muscles enumerated above. This lateral bend, however, can be produced by other simple methods without resorting to the

[1] The case of which I have already given the history (p. 3) is an instance of this condition, in which, so great was the rotation and so slight the lateral deviation of the spinous processes from a straight line, that the deformity had been mistaken for a tumour.

exercises just described, and without the deleterious effect thus caused.

The plan of special exercises which I have devised for acting upon the rotation consists in the use—(1) upon the convex side of the curve, of the muscles above referred to, with the object of drawing the vertebræ round towards their proper position; and (2) upon the con*cave* side of the curve of 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. 30 show the direction of the forces used. An elastic cord is attached to the hook C, and the patient draws it 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 patient must sit firmly in a chair in as upright a position as possible during these exercises. The line A B represents the transverse axis of the pelvis.

FIG. 30



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 needed for a lumbar curve the quadratus lumborum may be brought into use upon the con*vex* side of this curve.

The object 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, as a rule, be carried out in addition to the special exercises now described, and the direc-

tions already given with regard to avoidance of fatigue and suitable rest should be observed.

In performing these exercises the patient should sit in a chair, and it is of the utmost importance that the surgeon should in the first place determine the best height at which the hook should be placed to which the elastic cord is to be attached, and he should also see that the effect is beneficial.

The patient, firstly, has to be taught to move the shoulders towards the centre of the back, while the spine is held as erect as possible, or in some cases held with the opposite shoulder raised so as to curve the trunk slightly towards the side of the concavity. During the action of the arm either forwards or backwards the trunk should remain as steady as possible, the action being restricted to the muscles of the arm and to those between the arm and trunk.

In some very weak patients this movement cannot be made without the spine bending or twisting into various positions, and when such is the case it is better to defer the exercises for a few weeks until the patient is stronger, a result which with judicious treatment we can generally insure.

For the exercise upon the convexity, the hook should in the first instance (as a rule) be placed on a level with the top of the patient's shoulder while sitting, but often it is necessary to vary this position higher or lower before the desired effect upon the curve can be obtained. It is remarkable how plainly this action, when correctly performed, affects the curve. In slight cases the spinous processes may be drawn completely into a straight line at once, and the projection of the ribs depressed towards a plane with the opposite side, showing that the vertebræ are rotated towards, or into their normal position. Of course this effect only lasts as long as the muscles are held in contraction, but the value of the exercise is thus proved, and the practical result is eventually a permanent lessening or removal of rotation.

In the exercise upon the front of the thorax the effect is less evident. The patient, in a sitting posture, draws the elastic cord forwards from a fixed point on or about a level with the shoulder on the side of the dorsal concavity, this point being situated behind the patient. This plan brings into use the muscles between the arm and the front of the thorax (the

pectoral muscles), which thus tend to pull the front wall of the thorax, unduly prominent on this side, backwards. Here, as in the former instance, the surgeon must *see* that the effect is beneficial before he allows the exercise to be practised.

I have sometimes recommended both these exercises to be performed at the same time, the one arm drawing forwards against the resistance, and the other backwards, but, as a rule, I have not found this plan so effective as the exercise of one arm at a time. The patient's careful attention is required to steady the trunk while each exercise is being practised, and if both arms are used, each in an opposite direction at the same time, the trunk is almost sure to be wrongly twisted. When there is a tendency to bend the upper part of the trunk towards the side of the concavity it is occasionally a good thing to make the patient rest the arm of that side on the back of a chair, but I prefer that the patient should be able to steady the trunk independently of any extraneous support. If, upon trial, the exercises are not well done, that is, if their effect is not satisfactory because the spine is bent as a whole in wrong directions, then it is better to wait a few weeks, as advised above for weak patients, while general treatment, combined with partial support of the spine, or at least the avoidance of strain or tiring exertion, is carried out. To act upon a lumbar curve is a more difficult matter. The patient may stand and support herself by resting both hands upon the back of a chair, and while keeping the trunk rigidly as upright as possible, abduct the leg, held stiff, upon the side of the convexity. In this movement the patient should pull in the waist on the side of the convexity, so that after about six efforts she may feel probably a muscular pain at that point.

Another plan is for the patient to do this exercise, or a modification of it, while lying in the prone position. If a lumbar curve exists alone without any compensating dorsal curve, then while standing upright the patient may place a hand on the hip, or rather grasp the waist on the side of the convexity, and bend the body backwards over the hand.

All or any of these exercises should be performed about six consecutive times, three or four times a day at first, and gradually increased.

The peculiarities and varieties of spinal curvatures are so

great, and the patient's manner of performing any particular movement so varied, that the exact way of acting upon these cases must depend upon circumstances; and I venture to repeat that the surgeon must study each case, and observe the effects upon the curve of any particular exercise he may recommend, before allowing it to be carried out by the patient.

The use of the trapeze is often recommended, and in some cases, or rather in some stages of treatment, this plan of exercise is very useful. The use of parallel bars, and raising the body from the ground by the hands placed on two chairs, are also very good exercises.

The Swedish Movement Cure

The so-called Movement Cure is an elaborate system of exercises, which of late years has been much extolled to the neglect of all other measures. Alone, it has little or no effect in removing fixed curves. By its means the muscular system and general health of many patients are benefited, as they are by other carefully regulated gymnastic exercises, especially passive exercises.

In a few slight cases, where no severe change in the form of the bones or other tissues has occurred, permanent good may result, but with patients who are more severely affected, the benefits are very transitory.

At the end of the course the patients are sometimes brought to hold themselves in a better position, or, one may say, to make the best of their condition. The effect appears at the time very good, but as the patients cannot devote their whole lives to carrying out the system they soon relapse into their former condition, and the very severe, expensive, and tedious process proves to have been a failure, while valuable time for more effective treatment has been lost.

The treatment recommended in this volume consists in a combination of muscular development, mechanical pressure, and partial rest, improvement in position being maintained by adaptation of the apparatus to be described. The special exercises, when such exercises are desirable, have already been explained; they have been found more effective in acting upon rotated vertebræ than any movements used in the Swedish system.

Another point in reference to the 'movement cure' is of great importance. When we have to deal with a patient whose spine is only slightly curved but whose general health is feeble and who has a difficulty in sitting up straight—a case for which it might be thought this system would be appropriate—a danger exists, that instead of commencing lateral curvature, the condition may be one of incipient spinal caries.

If caries exists, one cannot imagine a much more harmful procedure than to subject the patient to a system of gymnastics. Several cases have come under my care where caries has been rapidly increased by such treatment.

Then it must not be forgotten that muscular weakness is by no means the only cause of curvature of the spine. In a large number of cases the bones are unnaturally soft, and until normal conditions are restored, active exercises are calculated to do more harm than good. If, under such circumstances, we can keep the spine straight until its osseous and ligamentous structures have consolidated, it will be a very easy matter to develop the muscles should they then be deficient in strength.

Then, again, with very weak children, the ordinary movements of play are quite as much exercise as the patient can tolerate with benefit. In fact, as already urged, a period of greater rest is often, in combination with support, conducive to a gain in strength.

Lastly, those few cases which would be permanently benefited by the 'movement cure,' will derive an equal amount of good from the treatment here advocated at a tenth part of the trouble and expense.

CHAPTER XI

TREATMENT OF LATERAL CURVATURE—(*continued*).

5. Mechanical Support and Pressure

MECHANICAL apparatus fitted to the patient's body have been used 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 correct the rotation of the vertebræ.

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

Those which purpose to fulfil Objects 2 and 3 usually consist of the same framework as the others, that is to say, with an upright stem opposite to the spine, with the addition of 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 all 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.

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 will be very severe until the nerves became paralysed—a result which has sometimes occurred. The circulation, moreover, may be interrupted.

Upon the other hand, if the crutches are not sufficiently high to be productive of the above evil effects, their use is limited to the occasions when the patient supports herself or himself upon them voluntarily.

Another evil effect of the spinal instruments usually employed is that they tend to interfere with thoracic respiration. 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 and not retard it. It is plainly observable, in the majority of the sufferers from lateral curvature, that the chest is flattened and the respiration shallow. Further, it has been shown by *post-mortem* examinations that the muscles of the thoracic walls may be much degenerated, and the diaphragm excessively developed. This condition was well marked in the case examined by Mr. John Gay, showing that respiration had been chiefly diaphragmatic.

By means of some of the instruments here referred to, 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 weakness of the back is produced, and the cure is retarded.

A New Principle in the use of Spinal Apparatus

Until I issued the first edition of this work no description of the use of spinal apparatus for the purpose of developing the muscles, while it prevented the back from being placed in bad positions, had ever been to my knowledge published. In studying the subject of treatment of lateral curvature, two facts presented themselves to me very strongly. First, that however much could be done by general and special treatment without instruments, yet there were a great many cases in which some sort of mechanical apparatus was absolutely necessary, if we were to give the patient any material relief from the symptoms, or stop the progress of rapidly developing deformity. Secondly, that the various apparatus in common use were objectionable because very inefficient in their action, very heavy, very expensive, and often eventually harmful to the wearers.

It seemed to me that what was wanted was an apparatus which would prevent the spine from falling into bad positions, or

rather would tend to force it towards a normal one without interfering with the action of the muscles or the development of the chest.

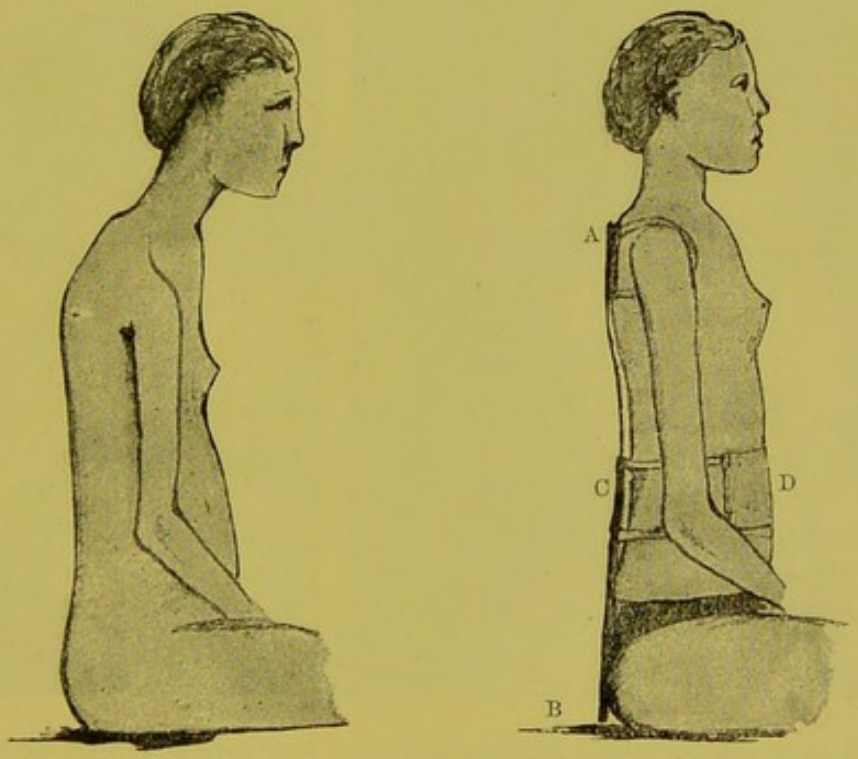
The instrument which I have used with remarkably good effect now for many years [1] is not an instrument-maker's machine which is fitted on closely by him and altered by him, but is a very simple apparatus, affording a means by which the surgeon can bring pressure or support to bear upon any part of the trunk he likes. The exact form of the instrument is perhaps of less importance than the principles of application, and I have improvised an apparatus by which these principles have been carried out when the perfect instrument has not been at hand. These principles may be described as follows:—The first object is to keep the spine in as upright a position as possible in an antero-posterior direction, for, as it is a well-known fact that flexion (stooping) increases the deformity, and especially increases the rotation of the vertebræ, on the other hand, extension (uprightness) lessens the deformity. To effect this object patients are often made to lie down, or rest in chairs which fit into the lumbar curve, and so support the spine in a good position. Spinal instruments usually fail to a great extent in this respect because they depend upon crutches for propping up the body, and crutches would have to be very high and painful, as well as detrimental in other ways, if they kept the spine sufficiently upright. The means by which this purpose can be effected is the use of shoulder-straps which act from before backwards, and not from below upwards. In weak backs the tendency is for the spine to bulge back in the lower dorsal and lumbar regions, and it is certainly desirable to control this projection. Instruments, as usually made, either leave this part unsupported, or they curve into the hollow and act as permanent supports. The tendency of the latter machines is to relieve the muscles of the back from action and to conduce to degeneration and ultimate weakness of these muscles.

To overcome this evil effect I discard rigid stays and restraining spinal instruments (including felt and other jackets), and arrange the light support above referred to so that a small pad is placed opposite the lumbar region to restrain the back from curving posteriorly. In slight cases it will be observed that when the patient stands erect the back is straight, or nearly so, and the natural lumbar curve is formed. When, however,

[1] Based upon one invented by the late E. J. Chance.

the patient sits down, the spine immediately bows backwards and the lateral curve takes place. If we can prevent this bowing backwards we retard the increase of, or remove, the lateral curve. The pad is so arranged that it does not act when the patient is holding herself erect—when, in fact, it is not wanted—and so the dorsal muscles are allowed to act, but directly the spine is permitted to subside, then the back comes in contact with the pad, and is prevented from bulging any further. As the case proceeds this pad is gradually brought nearer to the natural position of the spine, and thus a back which at first pro-

FIG. 31 FIG. 32



Position of patient before and after the application of the simplest form of apparatus

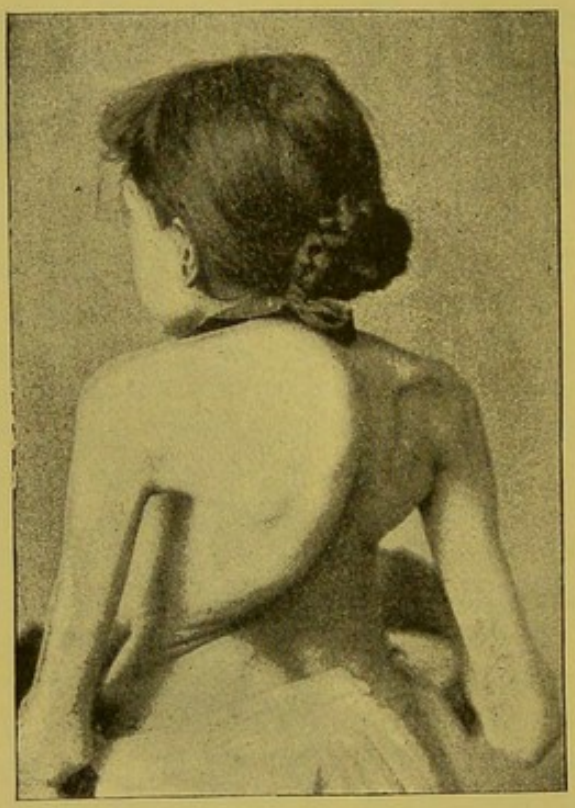
truded very considerably is brought by degrees into a natural position. Never, however, is the pad placed so forward that it retains the spine in one position; on the contrary, there is always room for action of the muscles.

The apparatus is comparatively light; it is felt as a great support and help by the patient; it does not interfere in the slightest with bodily development; it allows perfect freedom of use to the muscles, and upon the whole is fully appreciated by the patient on account of the comfort derived from using it, and the rapid benefits to the general health.

The simplest form of apparatus has no side plates.

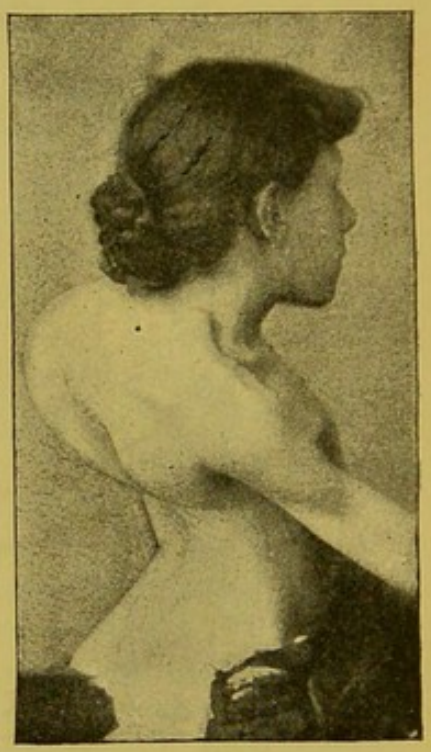
When it is applied it has the good effect shown in fig. 32, the chest being expanded and not pressed upon, the supporting bar reaching from the level of the shoulders A to the seat B, the soft shoulder-straps acting directly backwards, the square pad in the loins, C, preventing the back from protruding posteriorly, a pelvic belt retaining the lower part of the apparatus in position and

FIG. 33



Patient seen from behind and slightly from the left. The rotation is so severe and the ribs so bent that they form a prominent projection backwards, throwing the right shoulder into the shade

FIG. 34



The deformity seen from the right side, showing the lordosis acting as compensation to the upper projection

pressing from before backwards. The belt D restrains the abdomen from coming too far forwards in standing. This band is never made very tight, but the body is balanced between this belt D and the pad at C. In sitting (when the back ought to be rested) the body rests against the pad C. In standing or walking the body ceases to rest against C, but is restrained from coming forwards by the belt D. There is no interference with the use of the muscles of the back, or of any other muscles, but

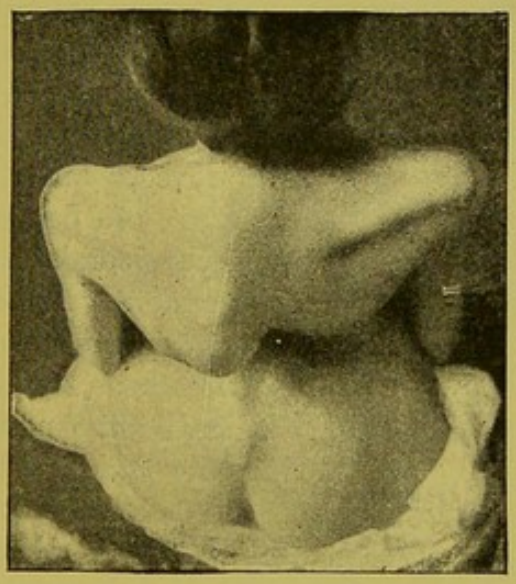
a support is always ready to restrain the body from falling into a bad posture when the muscles cease from acting.

Every part of the apparatus is capable of being altered in any direction by the surgeon himself.

This apparatus will overcome slight lateral curvature upon the principle of extension, which always helps to obliterate a curve, but when the later deflection is more severe, side pieces are required.

I will now describe an extremely severe case to exemplify the use of the apparatus under such circumstances. Figs. 33, 34 and 35 represent the patient when I first saw her in March 1890. She was aged seventeen. Her mother stated that there was no

FIG. 35



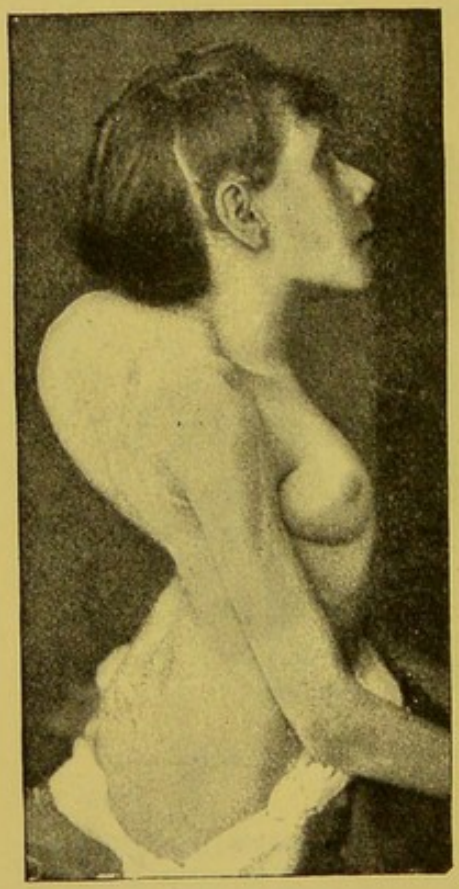
The deformity seen from above, looking downwards

deformity at birth, but at three years of age it was noticed that the back was weak. The parents were assured that the child would grow out of the weakness, so nothing was done until seven years later. At the age of six she was taken to a children's hospital, and from there was sent to an instrument-maker, but in consequence of his charges and other difficulties nothing was done. Soon after, at the age of seven, she was laid up with an illness, and the doctor who attended advised that no instrument should be worn, as she was not likely to get worse. In spite of all these opinions the deformity steadily increased, and was still increasing rapidly when it arrived at the condition shown in

figs. 33, 34 and 35 (facsimiles of photographs). During the previous two years the patient had been subject to severe attacks (called bilious), beginning with sickness and vomiting, lasting for many days, often for a fortnight, and occurring at intervals varying from a month to three months.

The foregoing history made it perfectly clear that the use of a mechanical support to prevent a further increase of the deformity was imperative. The manner in which this was effected is described below. As soon as the apparatus was applied, the patient felt the comfort of support, and this comfort was more thoroughly appreciated a few days later. From this time the bilious (?) attacks almost ceased, and when occurring they have been so slight that the patient has not been laid up with them. Her general health has greatly improved, and although the degree of deformity rendered any considerable alteration of it impossible, yet there is sufficient improvement in this respect to be noticeable. It will be seen that in fig. 36 the patient is in a decidedly better and less constrained position than in fig. 34. The chest is considerably developed and there is much less lordosis.

Fig. 36



The mother and father of this patient are still living. She is one of fifteen children; nine have died from inflammation of the lungs, one from hydrocephalus, and the other four, who are living, are in comparatively good health; but the brother, aged thirteen, is said to be delicate in his chest, and cannot run like other boys. The grandmother, grandfather, and grand uncle on the mother's side are said to have died of consumption.

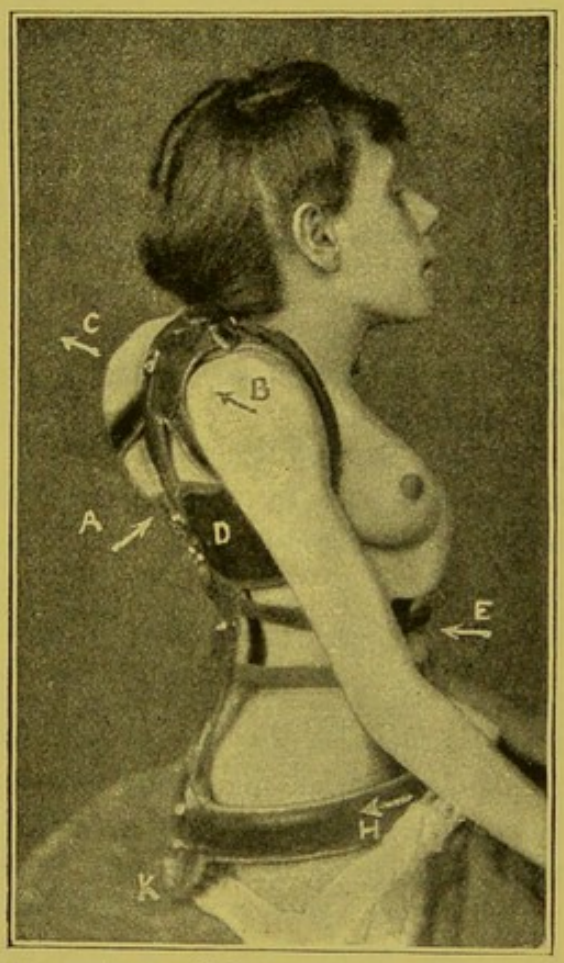
July 1892.—The patient is now in fairly good health, feels perfectly comfortable, and states that she has felt so from the very commencement of the use of the instrument.

Principles of application.—This severe case required a

rather elaborate support, but yet it will be observed that no pressure was applied to the front of the thorax.

In fig. 37 the arrows show the direction of the support of the pads and straps. A indicates the direction of pressure obtained by a moulded pad on the left side, hardly visible in the photograph. This pad grasps the projection shown in figs. 33 and 35. Arrows B and C indicate the direction of support of the shoulders backwards and a little upwards. D shows a pad supporting the thorax laterally on the right side. E and H indicate the direction of support in these parts, the belts acting also by retaining the apparatus in position. The lower end of the instrument, K, rests on the chair when the patient is sitting, and this supports the whole back on the instrument. The shoulders are drawn backwards by soft straps which allow free movement of the arms upwards, downwards, and backwards.

FIG. 37



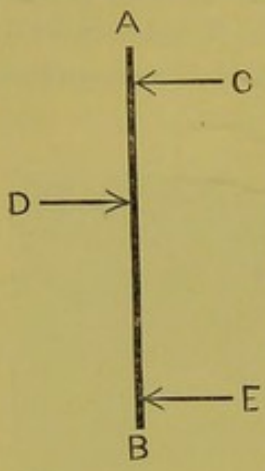
Apparatus applied to severe lateral curvature, showing directions of pressure

Thorax developed and not compressed. — It should be observed that *the chest is left perfectly free from pressure*, and that consequently the thorax is induced to develop very considerably—a most important point in these cases, as embarrassment of the breathing is a common accompaniment of severe lateral curvature. Development of the chest in this manner greatly increases the 'vital capacity,' and is in this respect alone a great help to the improvement in health of the patient. The chest, in fig. 32, should be compared with its position as seen in fig. 31.

One very important principle upon which this treatment is

based is, that the apparatus is not carried by the patient as a *dead weight*. It is kept in place by pressure upon those parts where pressure is required. For instance, first we wish to draw back the shoulders. Secondly, we wish to support the spine from curving backwards. Thirdly, we wish to press upon the sides which protrude; and fourthly, we wish to retard the abdomen from coming too far forwards. These points of pressure act in opposition to one another, and keep the instrument in place. There is no need, then, to build up on the pelvis, or lace tight round the waist, and this plan of counterpressure is effected without any great force; in short, the pressure is gentle but effectual—effectual because it acts by leverage. This principle is exemplified by holding a rod, A B, in mid air, simply by pressing with the finger tips in the direction of the arrows C D and E, fig. 38.

Fig. 38



Every part of the apparatus is capable of being altered in any direction by the surgeon himself, and I will now describe how this can be done.

Details of Construction of the Supporting Apparatus

The best material.—Steel is the lightest and in every respect the best material that can be used as a basis. I have tried other metals, and especially aluminium. Aluminium is very inferior to steel in respect to strength, and it is without elasticity—a very important point. I have also tried the various bronzes which are so useful for some engineering purposes, but they compare very badly with steel for making spinal apparatus.

The tempering of the metal.—It has been the custom with surgical-instrument makers to use hardened steel, so that any alteration in the form of the apparatus that the surgeon may wish made in the course of treatment has to be effected either by numerous rack-joints, or by passing the metal through the fire, bending it, and again tempering it to hardness. These procedures are tedious and unsatisfactory.

Rack-joints add considerably to the cost of the apparatus, they add to the weight, they are apt to get out of order, and they are limited in their range of action. Undoubtedly, in some

orthopædic apparatus rack-joints are necessary, but very seldom are they required in spinal instruments.

Softening in the fire and re-tempering is a very unsatisfactory procedure. It necessitates the patient being without the instrument for a time, and therefore it necessitates an interruption in the treatment, and also probably a partial relapse. It involves the patient in endless expense and trouble, and it prevents the surgeon from making the alterations himself at the time when he sees their necessity.

The plan which I have adopted is entirely different. Every piece of steel is so tempered that I can alter it in any direction with the aid of wrenches, and yet it is strong enough not to be bent by the patient so long as no unreasonable strain is put upon it. The advantages of this plan are as follows:—The necessary alterations can be made by the surgeon while the instrument remains in its place on the patient. These alterations can be repeated as many times as necessary, while the patient is before the surgeon, until a satisfactory modification is effected. It is hardly necessary to add that a far better ultimate result can be thus attained than by the procedure which I have referred to above, while the patient is saved from going backwards and forwards between the surgeon and the instrument-maker, with its attendant great trouble and expense. By the plan advocated, more practical results may be attained in one visit than would probably result from half a dozen visits under the other system.

The padding of the apparatus.—The foregoing remarks apply to the basis of the instrument. Every part which touches the patient should be carefully and softly padded. The shoulder straps especially should be well stuffed, and some waterproof protective material should cover the part of these straps which lies in the axilla.

Other alterations by the surgeon.—The upright spinal bar of the instrument is attached to the pad above and to the pelvic belt below by means of a slot and studs, so that as the spine becomes straighter and thereby longer, the length of the instrument can be increased to the extent of at least two inches, this being done by degrees as necessary. Further, should it be found necessary to increase the length beyond these two inches, a new bar can be substituted without any great trouble or interference with the course of treatment.

This arrangement for easily substituting a new part is carried out in every portion of the apparatus. Should it be

necessary to replace one of the side plates or the top pad, or the back pad, or even the pelvic belt, each one of these parts can be changed in a few minutes, and while the patient is before the surgeon.

From the above description of the facilities afforded for all kinds of alteration and modification, it will be apparent that the few changes referred to are only examples of what may be done by any ingenious and practical surgeon himself. The combined application of surgical and mechanical knowledge to meet the peculiar difficulties which present themselves in the treatment of lateral curvature of the spine cannot fail to effect better results than have hitherto been the outcome of divided responsibility and divided action.

The result of this plan of treatment is that patients with backs so weak that they cannot sit upright for more than a moment will, in a very short time—say a month, or in a shorter period—show a very decided increase in power. Backs which have been quite flabby to the touch have become hard and muscular in a few months.

The apparatus should be put on the first thing in the morning and not taken off until the patient retires to bed.

It will easily be understood that such an apparatus does not lead a patient to depend entirely upon its use; that is to say, at any time in the process of treatment the support may be thrown aside, and the patient be, to some extent, the better for having used it.

Considerable care and discretion have to be exercised in adjusting the back pad, for if we attempt to improve the position too much at first, it will hurt the patient, and in fact be intolerable. It is of the utmost importance to avoid producing pain or discomfort, and I find that when a case is not proceeded with too rapidly, the result is invariably relief of adverse symptoms, such as aching or acute pain, if such exist.

The back pad is retained in its place in a very simple manner, and when it is in use, *i.e.* when the back rests against it, that part is supported, first, by the shoulder straps already described, which tend to draw the arms back and develop the chest; secondly (at the lowest part), by the pelvic belt. None of the straps need be buckled very tightly.

In the less severe cases this apparatus in its more simple form will enable us to effect a cure; but when the lateral curving is very marked something more must be done, and lateral plates must be applied to counteract the lateral curves. Here at least, it may be thought, the principle of allowing freedom to the muscles must be abandoned, but it is not so. The lateral plates, if properly adjusted, will take effect, while the muscles of the back are allowed to act freely. I always advise the patient to endeavour to 'get away' from the lateral pressure. If patients hold themselves so that the pressure is relieved, they effect by muscular action more than the plates can produce by statical pressure; and when the patient is not making this exertion, the plates support the back from falling into a wrong position. Not only do the lateral plates prevent the spine from falling into a more curved position, but they guide the patient in muscular efforts, for without the apparatus the patient would not be able to draw in one curve without increasing the other.

This freedom of muscular action overrides the objection sometimes raised against the use of lateral plates, that they cannot affect the spine very much because they have to act (in the dorsal region) through the ribs. The moderate pressure applied does not bend the ribs, and the pressure is well transferred to the spine itself.

The practical results of this treatment confirm the theoretical, although it must not be supposed that good results can be obtained very easily. Mechanical aptitude and considerable mechanical knowledge are absolutely necessary to the surgeon who would straighten a curved spine.

It is unreasonable to expect success if we delegate to instrument-makers the devising, the adaptation, and the adjustment of instruments with which we aim at solving a very difficult surgical problem. The knowledge of the physiology of the movements of the parts affected, of the anatomy, and the nature of the pathological changes which take place, is required before the operator can form a judgment as to how best to apply and adjust mechanical apparatus.

If the surgeon possesses the required knowledge, both medical and mechanical, he must not even then expect to deal with such patients without considerable difficulty.

No two cases are exactly alike; no two cases progress in the same way. I know of no surgical affection which requires so much the application of our knowledge to meet individual

peculiarities as these of lateral curvature, and I suppose that this is the reason so few surgeons have had the courage to persevere in treating them.

To sum up my advice upon the subject of instrumental treatment, I may add that 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.
4. To be adaptable by the surgeon himself.
5. To allow free thoracic respiration.

In *more severe cases*—

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

The advantages of an instrument such as I have described over others are :—

1. Its simplicity.
2. The absence of crutches.
3. Its adaptability to alteration in form *by the surgeon himself*.
4. Its lightness.
5. Its power of maintaining the spine in an upright position without interfering with muscular action, without pressing at all upon the front of the chest, and therefore without interfering in the least with free respiration.

By means of this apparatus a rest for the back is ready the moment the muscles become fatigued, and the spine is rested in as upright a position as the curves will allow.

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

6. Treatment without Instruments

The most important point to be determined in treating a case of lateral curvature is with regard to the use of a spinal instru-

ment. If a case is to be treated without one, the following plan may be followed:—

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

2. A course of carefully regulated massage should be carried out (see next page).

3. The patient should lie down on a soft and easy couch (a 'prone couch' is best), or sit in a chair constructed in accordance with the natural curves of the back, when not actively occupied.

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

5. Some of the exercises already described (p. 95), should be practised three or four times a day for short periods.

6. The dress should not be tight enough to interfere with free bodily action (see p. 12).

7. Special attention should be paid to the habits of position of the patient.

8. All writing and drawing, or other occupations which necessitate a constrained posture, should be given up.

School life, doubtless, 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 back soon becomes 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 occupations at low tables also conduces to curvature of the spine, therefore the height of the table or desk or the height of the chair should be so regulated that each individual pupil can work without having to bend the spine posteriorly or laterally.

Delicate children should not sit up at a table for long periods.

The posture necessitated by ordinary writing is probably that which causes more harm to the spine than any other, but the system of upright writing so ably advocated by Mr. Jackson is calculated to reduce this harm to a minimum. I have referred to this subject in another part of this volume, but I take the opportunity of advising the reader to obtain Mr. Jackson's publications upon this system of upright writing, with which I

have become acquainted only since urging the advantages of substituting upright for slanting writing in the second edition of this book. For ordinary school work (exercises, writing from dictation, &c.) the use of a pencil is better than a pen and ink, because with a pen a forward position is necessary to allow the ink to run to the point; moreover, with a pencil there is no difficulty in making the up stroke.

Massage

In former editions of this work I referred to massage as being of 'immense service in some cases,' but I gave no details as to its application. My reason for dismissing this plan of treatment in so few words was as follows :—

I had found the results of massage so variable that definite deductions as to its exact usefulness could not be made. In a few cases remarkably good effects were obtained, while in others there was no benefit, and in some the patients were made rather worse than better by the treatment.

The massage had been carried out in the usual way, being left more or less to the discretion, or rather the indiscretion, of some well-trained and reputable masseuse. Since that time I have adopted a different plan. I have obtained the services of some reliable nurses who have satisfied me as to their skill in massage, and have personally directed their operations, not only giving particular directions in each individual case, but also superintending the massage with each patient upon the first occasion, and have watched the effect from time to time, often modifying the exact procedure, or have interrupted the treatment for a time when the effects have appeared to be too exhausting to the strength of the individual.

The objects of massage in lateral curvature of the spine.— These are various. When we have to deal with those exceptional cases in which weakness of muscles is the chief feature, the advantages of massage are obvious. When we meet with (the more common) cases of laxity of the spinal articulations, cases in which the muscular weakness is, perhaps, less pronounced, then the object of massage is to bring more nourishment to all the tissues involved, and so to produce a strengthening result. When the curves are very pronounced, we may apply massage with a certain degree of pressure upon the convexity of the curves with the object of pushing them into

a straighter position; and with elderly patients, when there is much pain, and where any mechanical treatment is not well tolerated, a short course of massage will generally relieve the irritability, and allow of more effective remedies being used.

Details of massage for lateral curvature.—The shortest course of massage which I have found beneficial is three weeks, but in many instances a more extended application of this method may be carried out with benefit.

The best and most comfortable position for the patient during each application of the massage is upon the prone couch already described (p. 92), because in this position the back assumes its natural antero-posterior curves. The next best position is lying prone upon a bed or mattress with a pillow beneath the abdomen. I find that the use of a lubricant is less fatiguing to the patient than dry massage, and the best medium is deodorised coca butter.

Massage may be used in different stages of treatment :—

(1) In the early stages, should the patients be exceptionally weak.

(2) During the progress of treatment, to hasten the general effects.

(3) At the end of other treatment, to ensure the good effects obtained by other remedies.

(1) Massage in the early stages should be applied with great gentleness at first. Care must be taken not to press upon the concavity of the curve, as such pressure would be very likely to increase the rotation. The convexity of each curve should be supported by one hand, while the other parts are operated upon gently, but the extent to which this support is carried out should be regulated by the surgeon.

In applying massage to the convexity, gentle pressure may be applied, but in these early stages the less that is attempted in the way of correcting the curves by this process the better.

(2) During the progress of treatment of the curvatures, that is to say, after perhaps three months' mechanical and other treatment has been carried out, massage may be useful to hasten the progress, and can then be applied with somewhat more firmness than in the early stages.

(3) When, after a certain period of treatment of a case of curvature, the spine is found to be straight, the muscles fairly well developed, but the body not quite so robust as one could

wish, a course of massage will often ensure the permanence of the good effect.

Fuller details it would be difficult to give, because each patient presents characters peculiar to herself. In all cases the surgeon ought to watch the progress of the treatment, seeing the patient at intervals according to his discretion.

Weir Mitchell treatment.—I have met with a few cases, not above one or two per cent. of the whole, in which, after several months of treatment, although the spine has been placed in a perfectly straight position, the bodily strength (robustness) has not improved to my satisfaction. In these patients there seems to have been an inherent weakness which ordinary remedies, such as fresh air, good feeding, and tonics have been incapable of altering.

Under such circumstances I have adopted the Weir Mitchell system of massage, rest and feeding, not for the sake of overcoming a neurasthenic condition, but with the object of improving the nutrition of the individual. The results have been most satisfactory, and the patients have been able to give up all special treatment soon after the course has been carried out.

CHAPTER XII

TYPICAL CASES

I HAVE selected the following cases for description as exemplifying various kinds of curvature of the spine :—

POSTERIOR CURVATURE (EXCURVATION) AND SLIGHT LATERAL CURVATURE

September 7, 1881.—Miss E., aged seven, was brought to me by Mr. Foster Palmer, of King's Road, Chelsea, presenting the amount of posterior curvature shown in the following outline, 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 at the time, 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 deviation 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 vertebra. 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.

Treatment.—I advised that the general health should be improved by healthy occupation, including out-of-door 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 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.

FIG. 39

Outline of profile before treatment

FIG. 40

After ten weeks' treatment

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

In preparing this fourth edition I have written to Dr. Foster Palmer about this patient, and he replies that she is 'perfectly well and strong . . . rides a bicycle . . . and seems . . . almost incapable of fatigue. There is certainly no visible distortion.'

LATERAL CURVATURE

August 1881.—Miss A. F., aged thirteen.—Five years before being brought to me this patient had had typhoid fever, which left her in a very weak state, and this weakness was especially noticeable as regards the back. In April 1880, an inequality in the height of the shoulders had been noticed, and the spine was then 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, 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 advanced for her age.

The curves consisted in a long dorsal bend 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. The left leg was ¼ inch shorter than the right.

Treatment.—An exercise was advised for the purpose of strengthening the muscles of the back, and also the special system of exercises 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. The simplest form of apparatus was used.

July 1882.—This patient had steadily improved since I first saw her. The shoulders were perfectly level, the curves scarcely discernible, and the muscles of the back were much stronger. She could have given up the support at this date without much risk of relapse, but for the sake of precaution she wore it for a few months longer.

In 1887, five years after treatment had been discontinued, this patient remained perfectly well and straight.

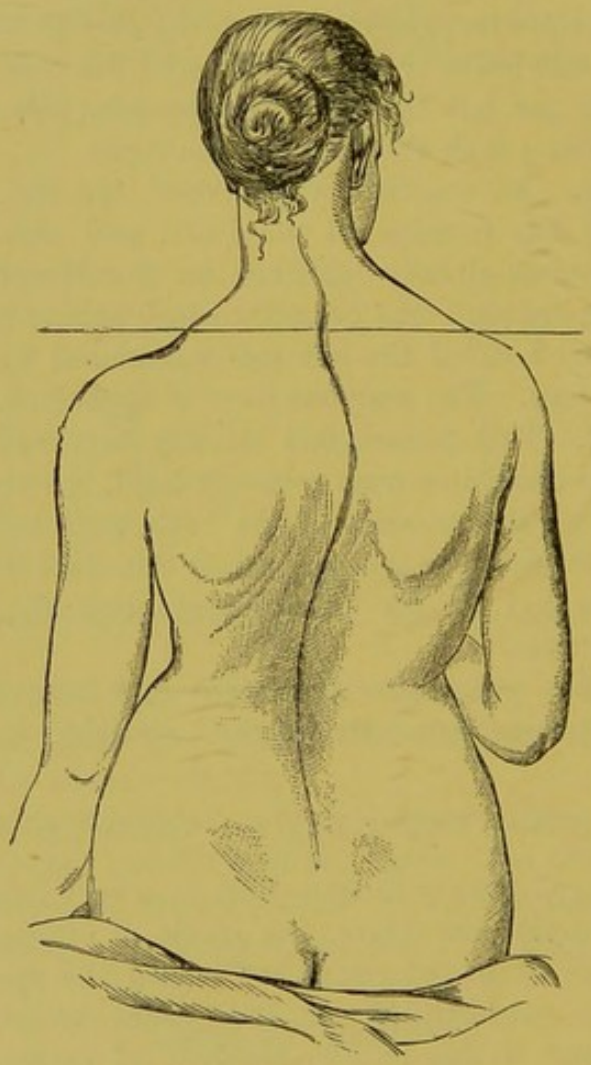
Severe Lateral Curvature and Old-standing Caries

Miss G., aged twenty-three.—This is a very important case, because a posterior curvature, the result of caries, complicated the appearance of the deformity, influenced the symptoms, and necessitated a modification of the usual treatment. This patient 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 before I saw her a felt jacket had been 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. 41, there being also a

FIG. 41



Appearance of back, July 1, 1882

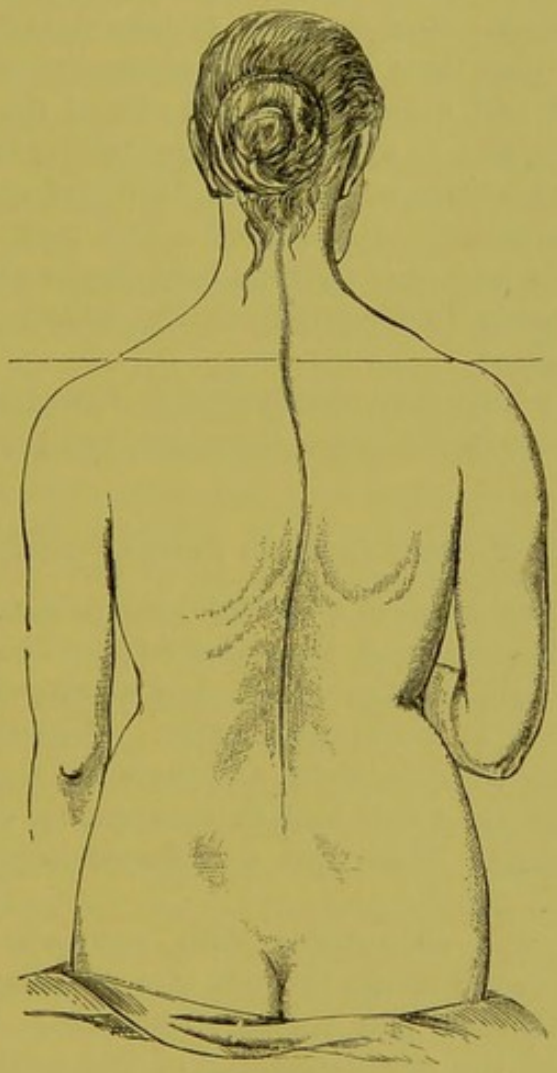
posterior curve involving the upper four dorsal and lower four cervical vertebræ, the result of the caries.

There was lateral curvature forming a large dorsal curve to the right, and a slight compensatory curve to the left involving the lower dorsal and the lumbar vertebræ, and lordosis 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 which chiefly demanded attention were as follows: a feeling of discomfort from the weight of the head bearing upon the portion of the vertebræ which had been deformed by

FIG. 42



After three months' treatment

the caries; the increasing deformity from lateral curvature, and the general pain and discomfort which the curvature produced.

This was a case in which much good could certainly 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. As to lessening the deformity, I expressed my doubts, but thought it

possible something might be done in that respect. The deformity in the neck from caries could not of course be altered; it was only the lateral curvature and the lordosis that I thought might be benefited.

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 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 reduced.

In six weeks from the commencement of treatment there was a decided decrease of the lateral curvature, and the improvement continued.

Lateral Curvature treated chiefly by Exercises

Miss R., the daughter of a London medical man, 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 muscles and joints. There was a moderate degree of rotation of the vertebræ.

Treatment was commenced with exercises—general and special—as described above, the use of a stimulating liniment, and the avoidance of bad habits of position. At the end of one month after the commencement of this treatment the improvement was very satisfactory, but it became apparent that by using the light form of apparatus, as described, the cure could be hastened. This course was therefore taken, much to the patient's comfort.

In October 1887 the spine was found to be absolutely straight and strong, the apparatus having been discarded some months.

The following six cases were included in a paper which I published in the 'British Medical Journal,' December 12, 1885.

Lateral Curvature from Congenital Absence of a Forearm

A young lady, aged thirteen, sent to me by Dr. Hare (Sept. 14, 1885). The spine was curved, as shown in fig. 43. The left shoulder was very prominent, and the ribs below the right scapula were depressed. The whole thorax was much more twisted than can be shown by this sketch. The condition was undoubtedly the result of absence (congenital) of the right forearm.

Fig. 43

The child had always used the rudimentary member by pressing it against her side, even holding and using a knife in this manner. This action bent her side inwards, and consequently curved the spine to the left. The excessive use of the left arm for writing and other occupations tended, moreover, to increase this condition, a fact which was clearly demonstrated when the patient placed herself in the posture she usually assumed for such occupations.

The treatment consisted in the prohibition of further use of the rudimentary arm by pressure against the side; the attachment of a leather case to the arm, to the end of which a knife or pen could be fixed; the avoidance of all stooping postures, and the use of a light apparatus to assist in bringing the spine into a straight position. The latter result was rapidly effected; a distinct improvement occurred even in the first few weeks of treatment, and in a few months the spine was almost perfectly straight. A prone couch was used with great benefit. The child's work at school was not much interfered with.

It should be understood that the curve, as shown in fig. 43, was not temporarily assumed by the patient, but that it required very strong pressure with the hands to lessen it in the least. Yet by keeping up this pressure mechanically and constantly the actions of the body were repeatedly brought to bear in straightening the spine, for there was no interference with the use of the muscles.

Lateral Curvature the Result of Wry Neck

Upon the advice of Dr. George Rice, of Derby, a little boy, aged 6½ years, was brought to me with a curvature as shown in fig. 44. There was rather severe wry neck, and also a con-

siderable depression of the anterior part of the thorax on the left, the result of previous empyema. To the latter conditions the curvature was chiefly attributed; but as the wry neck was undoubtedly an important factor in at least the maintenance of the deformity, and also on its own account demanded relief, I divided the tendons of the sterno-mastoid. After the operation the child rested quietly in bed for a week, and then the spine was found to be perfectly straight and the head upright.

Fig. 44

Fig. 45

In another fortnight the head remained perfectly normal in position, the neck could be moved freely and strongly in all directions, and scarcely a trace of the curvature remained. It might be thought that, in this case, the curvature could have been temporarily removed by altering the position of the child, but, on attempting to do so, I found the spine too firm to be much altered, and for this reason I did not expect so rapid a cure (fig. 45).

Lateral Curvature caused by Paralysis of a Leg and Thigh

Miss T., aged fifteen, was brought to me in July 1883. There was a severe lumbar curve to the right, as shown in fig. 46, with great depression on the left side, as shown by the shading. The curve had been caused by the efforts of the patient to throw forward her left leg in walking; the use of this leg having been entirely lost, years ago, from infantile paralysis. The curve had developed gradually from the time of her first efforts at progression. The only use that could be made of her left leg was as a prop; and, as the ankle was the only joint which was supported mechanically, the limb was very inefficient, even in this

Fig. 46

limited capacity. The paralysis included the flexors of the thigh, so that in progression, after each step taken with the right leg, the left had to be swung forwards by the pelvis, thus causing the patient to tilt the pelvis laterally on the spine, and produce the curve. This patient had been treated by the 'movement cure' for three years, not only for the benefit of the leg, but with a view to straightening the spine. It was impossible that exercises could accomplish the latter while the cause remained, unless, indeed, all attempts at progression had been suspended. The treatment I advised consisted first in efficient mechanical support of the leg, to prevent so much of the effort in walking being thrown upon the spine. With some variations in these mechanical arrangements to suit the case as it progressed, the ultimate apparatus consisted as follows. The leg was made into a more perfect prop, by extending the instrument from the foot to the thigh, and so supporting the flail-like knee-joint. This joint was made stiff for walking, but could be released for sitting down. A firm pelvic belt was applied, and an india-rubber band extended from the front of the right groin to the knee of the paralysed (the left) leg. This elastic band took the place of the paralysed flexors and helped to draw the leg forwards in progression. The result of this treatment was excellent, both as regards lessening the curving of the spine, and giving comfort to the patient, the former effect being observable directly the apparatus was applied. The previous treatment by exercises had occupied three years, and, beyond improvement in the general physique of the body, no benefit had been derived, neither improvement of the powers of the leg nor permanent improvement of the curved spine; nor do I think any other result could fairly have been expected.

Lateral Curvature treated by Special Exercises alone

Mr. C., of Newcastle, aged twenty-five, consulted me on March 15, 1883, for a curvature, as shown in fig. 47. He was strongly built and of active habits. The curvature could not be removed by immediate pressure. The left leg being shorter than the right, I directed that the difference should be compensated in the boots. For direct treatment of the curve, I advised him to exercise with an elastic cord night and morning for five minutes, upon the principle already described (p. 97). This treatment, I may here repeat, consisted in bringing into

action the muscles which connect the right arm to the spinous processes of the vertebræ involved in the dorsal curve, with the object of rotating the vertebræ back into their normal position. On the left side, the pectoral muscles were to be exercised

Fig. 47

Fig. 48

with the view to counteracting the forward projection on that side. On October 16, 1884, this patient called upon me again, and I found no trace whatever of the curvature (fig. 48).

Lateral Curvature with much Debility and Contraction of the Muscles of the Right Scapula

Miss R., aged eight, brought to me in February 1884, upon the recommendation of Dr. Robert Barnes, presented a sigmoid curvature, of which the apices of the curves were each one inch from the central line (see fig. 49). Moreover, in profile, the back bulged out in one big bow, and she was quite unable to sit up straight. The right shoulder was decidedly higher than the left. This child was extremely delicate, and had been reared with great difficulty. Her weakness was so great when a baby, that it had been thought impossible to rear her. Exercises fatigued her to quite a remarkable degree. I advised more rest, and devised measures for supporting the back when resting, instead of allowing it to bulge out. Perfect freedom of action of the muscles when the child was playing about was provided for by the adoption of looser clothes. The use of a prone couch was recommended, and the general health was attended to.

In three months' time the spine was quite straight, and the child could sit up with perfect ease. The general health had improved. During the treatment I found that the malposition of the scapulæ did not depend entirely upon the curved spine.

The elevators of the left shoulder were extremely weak in action, and the right scapula was held up in an abnormal position by muscular contraction. The small rhomboid was so shortened that it occupied a perfectly level position between the spine and its attachment to the scapula, and was very tense. The trapezius and the levator anguli scapulæ were perhaps involved, but the rhomboid was decidedly the chief offender.

Fig. 49

Fig. 50

The muscles of the left shoulder were restored to action by rubbing with stimulating liniments, and subsequently by gentle faradisation. The condition of the right shoulder could have been altered by section of the contracted muscle.

Fig. 50 shows the spine as it appeared a year later, perfectly straight, but the right scapula not extending lower than the upper border of the fifth rib.

Lateral Curvature of long standing

Mrs. W., aged sixty, consulted me, April 1883, upon the advice of Dr. Knaggs, of Huddersfield. She had been obliged of late years to wear special corsets to relieve her from the pain caused by a slight lateral curvature, dorsal to the right, and lumbar to the left. The stays she had been wearing hurt her very much from the pressure of crutches which they possessed, and did not give sufficient support to the spine.

I had a corset made reaching to the level of the top of the shoulders, with shoulder straps, but without crutches, and with two flexible steels in the back, one upon each side of the spine, thus carrying out the principle of the instrument described on p. 105. This apparatus gave her perfect comfort, a result which, a year afterwards, had been maintained.

Lateral Curvature caused by Ankylosis of the Knee Joint in a bad position

Miss K., aged eleven, was brought to me, November 1882, for treatment of a severe lumbar curvature to the right, as shown in fig. 51. The right knee was ankylosed in a bent position, the result of disease of the joint, but the patient walked tolerably well on the front of the foot. It was thought that the bent knee caused about two inches of shortening, but when the foot was raised to this extent the curve in the spine was not much altered. I found that the shortening was greater than had been thought,

Fig. 51

Fig. 52

and that it required five inches raising of the foot to place the pelvis in a normal position. This at once straightened the spine (see fig. 52), for permanent changes in shape had not taken place, although doubtless they would have done in time. A peg attached to the sole of the boot answered the purpose excellently, and the patient has been able to get about more comfortably than before. I may mention that the question of operation upon the bent knee was discussed, but we considered it undesirable at the time.

CHAPTER XIII

A SYSTEM OF MUSCULAR EXERCISES [1]

In the care of healthy children out-door games generally suffice to develop the muscular system and to maintain the general health, but under certain circumstances, in bad weather for instance, a system of gymnastic exercises is useful in maintaining bodily strength, and then the plan described by Mr. Blaikie may be followed out with advantage. The exercises which I have selected from Mr. Blaikie's book will serve this purpose, and may also be useful as adjuncts in the treatment of spinal curvature.

Fig. 53

For developing the Chest and counteracting drooping of the Head

Directions.—1. The pupil to stand with arms folded behind, and with one foot about eight inches in front of the other.

2. The head to be drawn back, and tipped as far down behind as possible.

3. The chin to be held high, as in fig. 53.

4. To rest thus for a moment and then stand up straight again.

[1] From *Sound Bodies for our Boys and Girls.* By William Blaikie. London: Sampson Low & Co., 1884.

5. To repeat this exercise six times.

To breathe deep, full breaths all the time; indeed, always, when exercising, breathing slowly, and with as large breaths as possible.

This is enough the first morning. In the afternoon this exercise is to be done six times. It is a common mistake with beginners to work too hard at first, so that they 'get lame and sore in the muscles they overwork, when, if they would begin with only a little exercise each day for the first week, and then do more the next week, and more yet the third, their muscles would gradually get used to the work, and would be all the time getting stronger, so that in a month they could work almost as hard as they liked, and not be hurt by it at all. However, if the muscles do get sore, that is a small matter, and usually in a day or two the ache goes away, and does not come back.'

GETTING STRAIGHT AND ENLARGING THE CHEST

Mr. Blaikie continues as follows:—

'What has this tipping the head back done?

'Several things. It has set the back of the neck at work—for there are muscles in the back of the neck which draw the head backwards. So it has helped to make the back of the neck strong, and shapely too. Also it has thrown the chin up high.

'Well, what does that do?

'Why, *you cannot raise your chin high up without lifting the whole front of your chest at the same time.*

'Try it and see. Hollow your chest and waist in, drawing your chin down, and leaning your head over forward, so that you look down at your feet. Sit, stand, or walk habitually with your chin down in this way, and you will soon cramp your lungs and stomach, till, by-and-by, you will get weak. Yet hundreds of thousands of people, whose work keeps them indoors, sit so for the greater part of each day. But now raise the chin up as high as you can, until your eyes look up at the ceiling right over your head. Hold your chin that way a moment. You feel at once that your chest stands out fuller than usual. Or, put your hand on the front of the lower ribs, and, as you draw your chin up, you will at once feel your whole chest swelling outward and forward.

'*In short, whatever draws your chin downward—unless the*

head is held far back at the same time—tends to make your chest flat and small; while whatever lifts the chin well upward, is sure to help make your chest large and full. All your life it will pay to know this by heart.

'And what good does it do to make the chest large and full?

'It not only improves its looks, and so also the looks of its owner, but it makes the lungs inside of the chest larger and stronger, and thus helps to keep away consumption and other lung disease, and so, often, to save one's life. It also gives the heart, stomach, and other vital organs more room, so that they can work more freely. It makes it easy to sit or stand erect, tones up the general health, helps to prolong life (while cramping of the chest tends to shorten it), and it brings a feeling of spirit and vigour, which a delicate or sick person often longs for, but does not know.'

[Before many exercises can be done with benefit to act specially upon the back, the arms must be brought into good working order; I would therefore advise the whole course as given in the small book now being quoted to be followed out. Some of the more useful are given below.—N.S.]

'PART II.—THE ARM

'TO MAKE YOUR FORE-ARMS STRONG.—FIRST FORE-ARM EXERCISE, OR GRIPPING

'**Directions.**—1. Hold your right hand out in front of you, as if you were going to shake hands.

'2. Shut it tightly, drawing the thumb and each finger in as closely as you can; in other words, shut your fist.

'3. Now open it till each finger is out straight again.

'4. Repeat this exercise twenty times with each hand.

'Why, that is easy enough. Well, if you should do it again, and keep on till you have done it a hundred times, may be it would not prove such play after all. While you are thus shutting and opening your right hand, catch hold of your right fore-arm with your other hand, and feel how it is at work. Why, it seems as if the whole fore-arm was very busy. And so it is. But now just put your left hand on your right arm again, but this time on your right upper-arm, not on the fore-arm. Keep

on opening and closing your right hand as before. Why, you can hardly feel the upper-arm move at all. It is pretty plain now that we know one exercise at least which sets the fore-arm at work. Of course, a hundred such grips each day at first will be too many, and will make the fore-arm ache. Twenty each day for the first week will be enough. The second week go on gripping for a whole minute without stopping, and now you will find that fifty such grips—for they must all be vigorous ones—are very little harder to do than twenty were at first.

Fig. 54

'After the second week, practise this gripping for a whole minute once or oftener each day.

'THIRD FORE-ARM EXERCISE, OR CROSS-TWISTING

'**Directions.**—1. Take a stick, cane, or piece of broom-handle, of hard wood about half as thick as your wrist is wide, and as long as your arm.

'2. Catch the stick with both hands and hold it out in front of you, as in fig. 54.

'3. Hold the chest well out, and the chin up.

'4. Breathe deep, full breaths.

'5. Hold the stick as tightly with both hands as you can.

'6. Now twist it strongly with your right hand, so as to turn it away from you; but at the same time twist it with your left hand, so as to turn it towards you.

'7. Repeat this exercise three times.

'This makes one hand twist it just the opposite way from the other, and thus both hands twist crossways. *Of course, the harder you twist with one hand, the more work it makes for the other*, and the less the stick really moves.

'For most boys and girls three such twists each day will be enough the first week six the second week, and ten after that.

'But they want to be good hard twists, no make-believe affairs. This will take less than a minute each day; but it is grand work for the fore-arms, and will soon begin to increase their size and strength.

'THE BICEPS MUSCLE

'Now let us do something for the *upper-arm*.

'Take any convenient weight in the right hand—for example, a heavy book, a dumb-bell,[1] a brick, or pail of water, though a dumb-bell is the most handy.

FIG. 55

'Let your right hand, with this weight in it, hang easily at your side. Now raise it slowly and steadily till you get it as near as you can to your shoulder, as in fig. 55. Keep your right elbow near your body all the time. Now lower the weight slowly till it is at your side.

'Raise it again. This time, as you raise it, grasp your right upper-arm in front with your left hand, as in the figure, and feel the muscle at work.

'While the right arm hangs down, this muscle is soft; but as you raise the weight, this muscle begins to swell and harden till the weight gets near your shoulder, and then is larger than ever.

'*Indeed, this is the chief muscle which raises your hand.* Hence it is one of the most useful. Whenever you lift anything enough to bend your elbow, this muscle does much of the lifting. You can scarcely touch your hand to your head, or put food into your mouth, without using this muscle.

'Hence this very useful part deserves a little extra notice, so we will call it by its Latin name (the only one in this little book)—the *biceps* muscle.

[1] 'All the dumb-bells needed for any exercise mentioned in this manual are: for each boy a pair, each of which weighs about one-fifteenth as much as he does; and for each girl a pair, each weighing about one-twentieth as much as she does. They usually cost about five cents a pound. [As shown in these figures, the dumb-bells look large unless they are made of wood—or wood weighted with lead or iron.]

'Now, the heavier the weight you lift to your shoulder, the more this biceps muscle will harden.

'Also notice that, while you thus harden it, the back of your upper-arm does not harden at all. This shows that the exercise you are taking sets the biceps at work, but not the rest of the upper-arm.

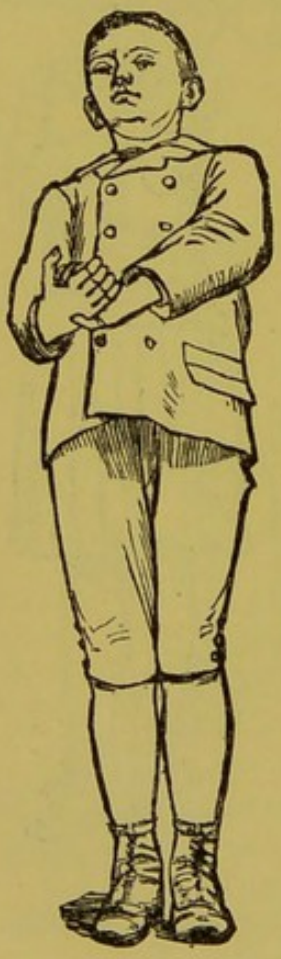
'SECOND BICEPS EXERCISE, OR HAND CURLING

'**Directions.**—1. Stand erect, with the chin always turned upward.

'2. Hold your right hand down at your side, not quite as low as you can, but bend your elbow a little.

'3. Breathe slowly and deeply.

FIG. 56



'4. Place your left hand in your right hand, as in fig. 56.

'5. Bear down firmly with your left hand.

'6. At the same time, lift strongly with your right hand, until it is up in front of your right shoulder.

'7. Lower your right hand to your side, then bear down on it with your left hand, and lift up again as before.

'8. Repeat this five times.

'9. Rest a little.

'10. Place your right hand in your left, in exactly the same way, and this time curl with your left hand five times, until you get it up in front of your left shoulder.

'Now what have we been doing? Almost exactly the same thing as in the First Biceps Exercise.

'There we curled a dumb-bell up to the shoulder, our biceps muscle doing most of the work. Here we curl another weight—heavier than the dumb-bell—up to the shoulder by exactly the same motion, and by using the same muscle.

'You do not want to bear on with your upper hand as hard as you can, simply because that makes the weight too heavy, and the work too hard at first, when your muscles are weak and soft, and not used to hard work.

'Each day the first week bear down in this way, with your left hand on your right, five times without stopping. Bear down vigorously, but not as hard as you can.

'Repeat this five times daily the first week. Each day the second week bear down ten times with your left hand on your right, without stopping. Rest a little. Then bear down ten times with your right hand on your left without stopping. After the second week, bear down in this way fifteen times daily on each hand.

'THIRD BICEPS EXERCISE, OR DOUBLE CURLING

'In the First Biceps Exercise we had only one dumb-bell, using it first in one hand and then in the other. Now try one dumb-bell in each hand.

'A HOME BAR.—FOURTH BICEPS EXERCISE, OR PULLING UP

'Before leaving the famous biceps muscle—the one so popular in the arm of a strong man, and so handsome in the arm of a comely woman—let us notice one other simple exercise, not for the school-room, but for home use, which will help make this muscle strong and well-shaped. It will need a small piece of apparatus that may be made thus:

[A description for making 'cleats,' or sockets, is then given. These are to be screwed on the jambs of the door of your room at home, and up about as high as you can easily reach, and two more level with your shoulders.]

'Take an old pitchfork-handle, or buy a new one. Cut it just long enough to fit easily into the two cleats, and make the ends square, so that it will not turn around in the cleats. Now you have a good horizontal bar ready for use, or a trapeze can be used.

[A bar so made serves the purpose, but is not so elastic or pleasant to use as the longer horizontal bar made for gymnasiums.]

'**Directions.**—1. Stand under the bar.

'2. Grasp it with both hands.

'3. Tip your head back, and hold it there.

'4. Now try to pull up slowly till your chin touches the bar.

'Well, some of you can do it, but more cannot. Never mind that. Now do this:

'1. Catch hold of the bar as before.

'2. This time give a little spring, and put your chin over the bar.

'3. Hold yourself so, long enough to take a good, full breath.

'4. Now lower yourself just as slowly as you can, until your feet touch the floor.

'5. Rest a minute.

'6. Now jump up again, and place your chin on the bar; then lower again very slowly.

'Do this twice daily the first week, and four times daily the second week.

'For this calls into action the same muscles as pulling up does, and is making them stronger all the time.

'PULLING UP—*continued*

'Early in the third week, instead of springing up to the bar, try now to pull yourself up once from the floor until your chin touches the bar. Very likely you will find that now you can do it once. But, if not, then return to the springing up, and practise that five times each day through the third week.

'By the fourth week you will be nearly sure to find that you can at last pull yourself up slowly once, till your chin touches the bar.

'If so, then pull up once daily for a week. Twice daily the second week; and as many at a time each day after that as you comfortably can. *This is great work for your biceps muscles.*

'THE BACK-ARM

'We have thus far been making our fore-arms strong. Also our biceps muscles, or the fronts of our upper-arms.

'One part of the arm remains, namely, the back of the upper-arm. Let us call it *the back-arm.*

'Here lie some of the muscles with which we push. Also some of those with which we pull, whenever we draw our elbow back past our side.

'*If the back-arm is not of good size, any arm, when the elbow is not bent, is almost sure to look slim, no matter how large the biceps muscle is.*

'FIRST BACK-ARM EXERCISE

'**Directions.**—1. Stand about two feet from the side of the room, facing the wall, each pupil being three or more feet from the next one.

'2. Keep your heels together.

'3. Turn your toes a little outward.

'4. Put your hands against the wall as high as your shoulder, as in fig. 57.

FIG. 57

'5. Turn your chin upward.

'6. Breathe a deep, full breath, and hold the air in, by not letting it out through your mouth or nose.

'7. Without taking your hands off the wall, bend your elbows, and fall slowly forward, till your chest touches the wall.

'8. Keep your heels down firm on the floor all the time.

'9. Hold the body and legs always straight and stiff.

'10. Now push slowly back again, till your arms are straight, and you are nearly erect, as in fig. 57.

'11. Also let the breath out through your mouth or nostrils as you go back. Drop slowly forward again, taking care to breathe the deep breath, and to hold it in when you start, and to keep your chin up.

'12. Touch your chest to the wall again, as before, facing the ceiling.

'13 Repeat this exercise five times, without stopping.

'SECOND BACK-ARM EXERCISE

'**Directions.**—1. Place two chairs about two feet apart.

'2. Stand about three feet from them, and place one hand on each chair.

'3. Step back one or two steps, keeping your hands on the chairs.

'4. Bend the elbows gradually, and lower yourself gently till the face is down nearly level with the hands, as in fig. 58.

'5. Keep the head well up.

'6. Hold the body and legs always stiff and straight.

FIG. 58

'7. Now push up until your elbows are straight again.

'8. Repeat this five times.

'At first it will not be easy for you to keep your body and legs straight, because some of the muscles which would help hold them so are not yet made strong. But by a little practice of this movement these muscles soon get more strength, and in a few weeks you can hold yourself as stiff in this way as any one.

'The first week, then, bend down in this way only five times each day, without stopping. Each day the second week do this exercise eight times. And each day the third week, ten. And daily, right along after that, do as many as you can with comfort.

'This exercise is much harder than it was to push against the

wall, as in the First Back-arm Exercise, for, as you see at a glance, and as you feel by trying it, this brings nearly half the weight on the hands and arms. And the parts of the arms which do most of the lifting, when you thus raise and lower nearly half of your body, are the back-arms.

'When you get so that you can push in this way fifty times without difficulty, you will find that your back-arms are getting to be of pretty good size, and that they look better than they did a while ago; indeed, that the whole arm seems larger and better shaped than before—as it really is.

'Thus far we have been getting our back-arms strong, without any tools in our hands—nothing but a floor or the ground to stand on, a wall to push against, and two chairs or desks to rest on. We have also been pushing our hands out directly in front of us. But now let us remember one thing, that whenever we push any weight or anything else with our hands, whether in front of us, at our sides, or above our heads, not our biceps muscles, but our back-arms are at once busy, and do much of the work.

Fig. 59

'FIFTH BACK-ARM EXERCISE, OR DIPPING

'**Directions.**—1. Stand between two desks not over two feet apart. (It would be better for this exercise to have them only about sixteen inches apart.)

'2. Place one hand on each desk, and stand erect.

'3. Hold the chin up as high as you can.

'4. Breathe a deep, full breath, and hold it, keeping the lips shut.

'5. Now lift your feet off the floor, and lower yourself slowly, by bending your elbows, until your knees nearly touch the floor, as in fig. 59.

'6. Then push slowly up until your arms are straight again.

'7. Keep your chin up high all the time.

'Not one boy in five, not one girl in twenty-five, can do this once. Yet whoever cannot do it at least three times has rather weak back-arms.

'But these are just the ones who need plenty of work of their back-arms, until they get them of good size and strong.

'Remember, that because a back-arm, or any other part of the arm, is large, is no sign that it is strong, simply because the muscles may be both soft and fat, and *soft and fat people are seldom strong*. It is the quality, the firm, good fibre, as well as the size, that you want, in order to have strong, useful arms. And to have them well shaped, each part of them must be well developed, instead of only some parts.

'FIRST INNER BACK-ARM EXERCISE

'Before leaving the back-arm, we will have one or two exercises for the inner side of it, because this part is not brought much into play in the above back-arm work.

'**Directions.**—1. Stand beside your desk.

'2. Hold the chin up high.

'3. Place your right hand on the forward corner of the desk next you.

'4. Press hard against the desk with your hand, as though trying to pull the desk backward.

'5. As you pull, put your left hand behind you, on that part of your upper-arm next to your body.

'Before you begin to pull, this part of your upper-arm will feel soft; but the moment you pull, it hardens at once, and feels firmer the harder you pull.

'PART III.—THE SHOULDER

'FIRST FRONT-SHOULDER EXERCISE

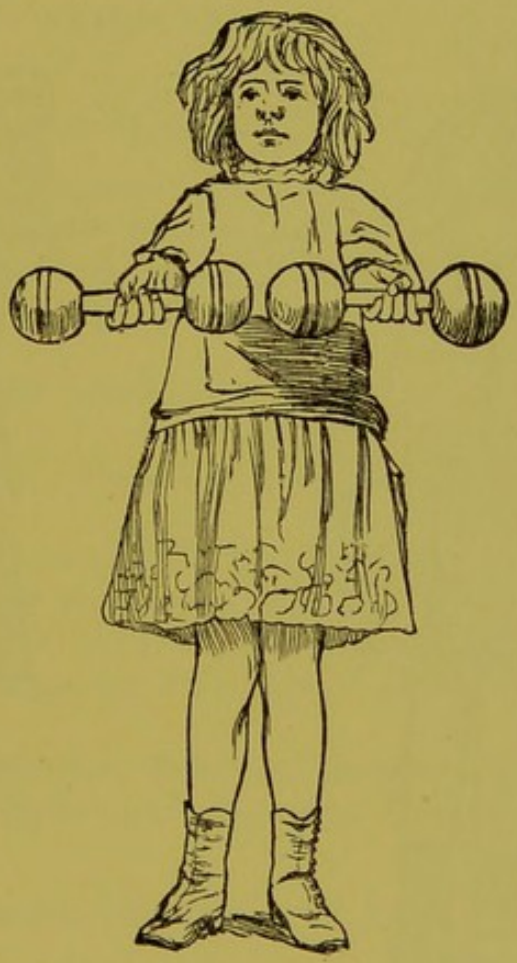
'The arms, as we know, are not separated from the body, but are attached to it; and there is little work any part of them can do which does not, at the same time, set some parts of the body at work.

'We will begin with the front of the shoulder, a part where few school boys or girls are nearly as full, well-shaped, and strong as they should be. Indeed, if you look at a class of forty or fifty boys in a school-room (unless it is at West Point), you will see at once not only that most of them tend to sink in a little just at the front of each shoulder, but that their coats

have wrinkles in them in this part, the boys have held their shoulders forward so much.

'Let the same boys practise a few exercises which take hold of them at the front of each shoulder, and also tend to draw their shoulders well back, which the very filling up of these muscles helps much to do, and you will see that, long before the end of a year, these wrinkles are nearly or entirely smoothed

FIG. 60



out, and that their coats fit them better at the front of the shoulders, and look better there than they did before. And in this respect the same thing is as true of girls as of boys.

'Let us, then, try a few exercises for the front of each shoulder.

'**Directions.**—1. Stand with a dumb-bell in each hand.

'2. Keep the chin up.

'3. Hold the dumb-bells out in front of you, about as high as your waist, as in fig. 60.[1]

[1] The dumb-bells shown in fig. 60 should be of wood.

'4. Keep your elbows straight and parallel.

'5. Take a full, deep breath, and hold it.

'6. Now lift the dumb-bells slowly upward, out in front of you, till they are as high as your shoulders, as in fig. 61.

'7. Hold them there till you count five, not bending your elbows.

'8. Now slowly lower them, at the same time gradually letting out your breath.

FIG. 61

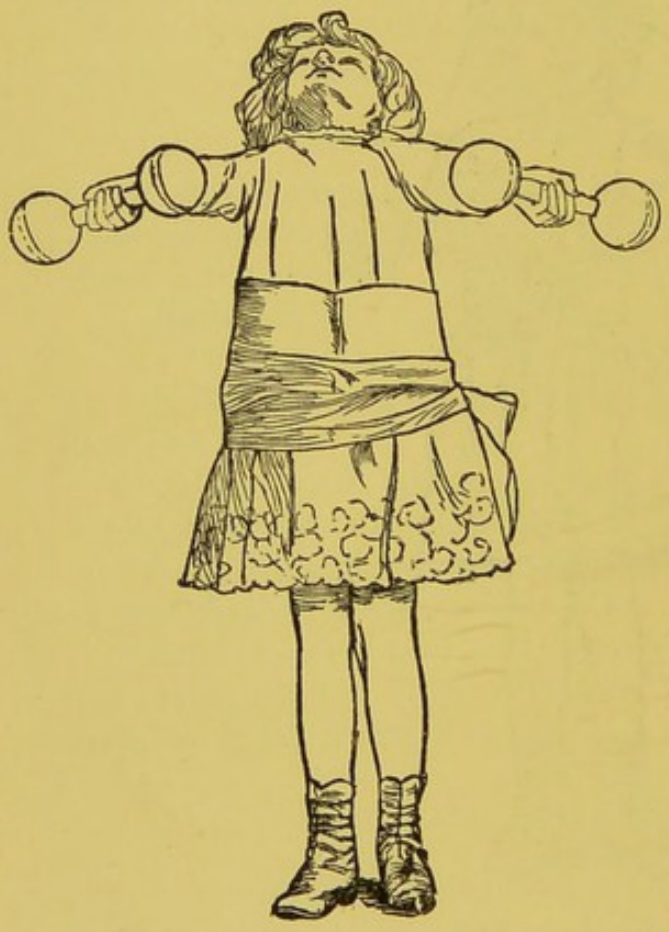


FIG. 62

'9. Lift them up again exactly as before, and lower again. Do it in all four times without stopping.

'Do it four times each day the first week, seven times daily the second week, and ten times each day after that right along.

'SECOND FRONT-SHOULDER EXERCISE

'**Directions.**—1. Take a dumb-bell in each hand.

'2. Hold them straight out in front of you, about as high as your mouth, as in fig. 62.

'3. Keep the elbows straight.

'4. Keep the arms parallel.

'5. Hold the chin up above the level.

'6. Now walk slowly up the aisle, then down the next aisle, and back to where you started, keeping the dumb-bells out in front of you all the way, as just described.

'Carry them in this way over the same distance once each day the first week; twice each day the second week; after that three times each day right along.

'THIRD FRONT-SHOULDER EXERCISE

'**Directions.**—1. Take a dumb-bell in each hand.

'2. Stand with the left foot forward about eight inches.

'3. Hold the dumb-bells up in front of your shoulders.

'4. Hold your chin up high, and breathe your chest entirely full.

'5. Now strike swiftly out in front of you with your left hand.

'6. Draw your left hand back till it is near your left shoulder again.

'7. Next strike out in the same way with your right hand.

'8. Then draw it near your right shoulder again.

'9. Now strike out again with your right hand, and then with your left, until you have struck out five times with each hand.

'Strike in this way five times daily the first week, eight times each day the second week, and ten times daily after that.

'FIRST SIDE-SHOULDER EXERCISE

'**Directions.**—1. Stand erect.

'2. Hold the chin up high.

'3. Breathe a full, deep breath.

'4. Let the air pass out slowly through your nostrils.

'5. Now take two more such breaths.

'6. Shut your fists.

'7. Now strike sharply with your right fist straight up over your right shoulder.

'8. Bring it quickly down till level with your shoulder.

'9. Then strike upward in the same way with your left fist over your left shoulder.

'10. Keep on in this way, first with your right hand then with your left, till you have struck upward five times with each hand.

'Strike thus five times with each hand daily the first week, ten times daily the second week, and twelve times each day after that.

'Now you are at steady exercise for your shoulders that will make them stronger, little by little, before a year has gone, just as you are sure to be further on at the end of the year than you were at the beginning in arithmetic, geography, geometry, or whatever else you are studying.

'SECOND SIDE-SHOULDER EXERCISE

'**Directions.**—1. Stand erect.

'2. Keep the chin up very high.

'3. Breathe three slow, very full breaths.

'4. Instead of pushing up the dumb-bell first with one hand and then with the other, raise both at the same time as high as you can.

'THIRD SIDE-SHOULDER EXERCISE

'**Directions.**—1. Hold the dumb-bells up high over your head —one in each hand—and look at the ceiling directly above you.

'2. Slowly breathe in a large, deep breath, and hold it in, keeping the lips shut.

'3. Now slowly lower the dumb-bells out sideways, until your arms are out straight at your sides and level with your shoulders, as in fig. 63.

'4. Hold them there till you slowly count five.

'5. Now lift them slowly upward in just the track they came down, never once bending your elbows.

'6. Hold them over your head a moment.

'7. Now breathe out through the nose—not through the mouth.

'8. Repeat this five times without stopping, keeping the chin up as high as you can all the time.

'This is enough for the first day, and each day the first week. The second week, do it seven times each day. After that ten times each day in school, and as many more every morning

and evening at home. *For a little smart work with any muscles even for only one minute, mornings and evenings, helps out the school exercises greatly, and, in a few months, you will see what a difference it will make in the size and strength of the muscles*

FIG. 63

so used. If any one wants to get ahead even faster yet, a few minutes each afternoon may be spent at this work.

'As will be seen later, there is scarcely any better chest-expander than this exercise.

'FOURTH SIDE-SHOULDER EXERCISE

'**Directions.**—1. Hold the dumb-bells out at arms'-length at your sides, as in fig. 63.

'2. Do not bend your elbows.

'3. Now walk slowly up the aisle, turn down the next aisle, and return to the place whence you started, being sure to keep the chin all the time turned up high.

'4. Breathe as slowly and deeply as you can all the time you are walking.

'Hold the dumb-bells in this way, and walk this same track once a day the first week. Walk it in the same way twice each day the second week, without stopping; and daily, after that, three times, without stopping.

'FIFTH SIDE-SHOULDER EXERCISE

'**Directions.**—1. Hold a dumb-bell in each hand, as high overhead as you can.

'2. Keep the chin up all the time, and the elbows always straight.

'3. Breathing slow, full breaths, walk slowly up the aisle, down the next aisle, and back to the place from which you started.

'Walk the same distance in this way daily the first week, clear around the room daily the second week, and around it twice each day after that right along.

'You will now begin to find that you have muscles on the sides or corners of your shoulders if you never discovered it before.

'PART IV.—THE UPPER-BACK

'FIRST UPPER-BACK EXERCISE

'**Directions.**—1. Stand erect, with the chin up high, a dumb-bell in each hand, and your arms straight out in front of you as high as your shoulders.

'2. Draw one elbow smartly backward, and hold it there.

'3. Now do the same with your other elbow.

'4. Repeat this exercise ten times with each elbow.

'Do it ten times daily the first week, fifteen times a day during the second week, and twenty times daily after that right along.

'SECOND UPPER-BACK EXERCISE

'**Directions.**—1. With a dumb-bell in each hand, and breathing slowly and very deeply, raise both hands behind you.

'2. Breathe as deeply as you can, and hold your breath in all the time the dumb-bells are up.

'3. Keep the elbows straight, hold the head back, and be sure to keep the backs of your hands turned upward all the time you are thus raising the dumb-bells back of you.

'4. Repeat this six times.

'Raise the dumb-bells in this way six times daily the first week, ten times each day the second week, and as many times daily after that as you can with ease.

'*This is fine work for the back of the shoulder and the whole upper-back;* for holding your head back thus stiffly sets at work the back of the neck and the middle of the upper-back, and raising the dumb-bells behind you sets at work the back of your shoulders and all across the back just under your arms—indeed, about the whole of the upper-back.

'THIRD UPPER-BACK EXERCISE

'**Directions.**—1. Hold the dumb-bells straight out in front of you.

'2. Breathe slowly, and very deep, full breaths.

'3. Now swing the dumb-bells slowly around behind you, as far as you can, keeping them all the time about as high as your shoulders.

'4. Do not bend your elbows at all.

'5. Hold the dumb-bells for a moment as far behind you as you can.

'6. Now swing them around in front of you again, not bending your elbows.

'7. Swing them back as before.

'8. Repeat this six times.

'Do this six times daily the first week, ten times daily the second week, and fifteen times each day after that right along.

'*This exercise develops not the back of the shoulder only, but the whole shoulder.*

'FIRST HOME EXERCISE FOR THE UPPER-BACK AND TO BROADEN THE SHOULDERS

'Let us look, while passing, at two very simple exercises for the upper-back, which can be practised at home for a minute or two daily if you have a horizontal bar or the rung of a ladder, or other good piece of wood, hung a little higher than you can reach.

'**Directions.**—1. Place the bar about three inches higher than you can reach.

'2. Then spring up and catch a firm hold of it with both hands, keeping them close together, with your knuckles turned away from you, but with your finger-nails turned towards you.

'3. Keep the chin up as high as you can, and slowly breathe very large breaths.

'4. Remain hanging in this way without bending your elbows, and with your body hanging straight down, until you slowly count twenty-five, all the time breathing just as slowly and fully as you can.

'5. Then drop easily to the floor, always landing on your toes and soles—never on your heels.

'Each day the first week hang thus until you slowly count twenty-five, and daily the second week until you slowly count fifty, and a whole minute each day after that right along.

'*This is capital work both to expand the chest and broaden the shoulders*, and, after the first month, can scarcely be practised too much out of school. You will be surprised after the first month to find how long you can hang in this way. One man claims that he made his chest three inches larger around in one month just by this exercise.

'PART VI.—THE SIDES

'FIRST SIDE EXERCISE

'We are now nearly through with the arms, shoulders, neck, and back.

'Before trying some work for the front of the body and for the legs, let us look at the sides of the waist. Whenever you have to hold yourself up erect, these side muscles are among those which help keep you so; and whenever you lean over to one side, you at once set them at work, for they help to keep you from falling over.

'**Directions.**—1. Stand with your arms a-kimbo, and your chin up.

'2. Have the feet about a foot apart.

'3. Now lean slowly far over to the left.

'4. Rest there a moment; then rise till you are up straight, and instead of stopping there, keep moving your body till it leans over as far to the right side.

'5. So sway over first to the left side, and then to the right, till you have gone each way six times.

'Sway that many times each day the first week, and ten times each day the second week, and fifteen times daily after that.

'You will soon find that this exercise, besides making these muscles stronger, also makes it easier for you to stoop over sideways than it used to be, unless you have already done similar work.

'SECOND SIDE EXERCISE

'**Directions.**—1. Take a dumb-bell in your right hand, and hold it up high over your head.

'2. Stand with the chin up high all the time.

'3. Breathe a full, deep, slow breath.

'4. Now slowly lower the dumb-bell, not down to your right shoulder, but across, above your head, and down over your left shoulder, as low as you can, till it touches your shoulder, letting your body tip over to the left.

'5. Hold it there till you slowly count ten.

'6. Now bring it back up over-head again. Then do the same with the dumb-bell in your left hand.

'7. Do this five times with each hand.

'Repeat this five times each day the first week, eight times daily the second week, and twelve times daily after that right along.

'This will be found harder work than the last exercise, especially for the muscles at the sides.

'THIRD SIDE EXERCISE

'**Directions.**—1. Hold the dumb-bell in your right hand, across over the left shoulder.

'2. Hold the chin up high all the time.

'3. Keeping the dumb-bell there, breathe slow, deep breaths, and walk steadily up the aisle and down the next one, till opposite the starting-point.

'4. Then change the dumb-bell into your left hand, hold it over your right shoulder, turn and walk back to the starting point.

'Repeat this walk daily the first week. The second week, with the dumb-bell in your right hand, walk as before, daily up the aisle, down the next aisle, and back to the starting-

point before you change hands. Then change and walk the same distance with the dumb-bell in the other hand. Daily after that walk once around the room, holding the dumb-bell in the same way in the right hand. Then go the same distance with the dumb-bell held in the same way in the left hand.

'It will not take long to see, or rather to feel, that this exercise is stretching your sides, and making them stronger in a way quite unusual to many girls and boys. And this very stretching, done thus carefully, and increasing little by little, will not only bring strong and shapely muscles on the sides of the waist, just above the hip-bones, but will also benefit the stomach, bowels, and other vital organs, by giving them more room and ease of action than they have when the body is at all bent down or the waist drawn in, as it is far too often by most boys and girls when they are sitting down, and even when standing or walking—and by most men and women, too, for that matter.

'FIRST CHEST EXERCISE

'**Directions.**—1. Take a dumb-bell in each hand, and stand with the chin as high as you can.

'2. Do not bend the knees at all.

'3. Curl the dumb-bells.

'4. Then push them high up over your shoulders.

'5. Hold them there a moment.

'6. Breathe a deep and full breath.

'7. Hold your chest out full, and gradually lower the dumb-bells far out sideways, without bending the elbows, until your arms are level with your shoulders.

'8. Hold them there till you count ten.

'9. Keep the chin up high all the time.

'10. Then raise them overhead again.

'11. Repeat this five times.

'Do this exercise five times daily the first week, eight times daily the second week, and ten times each day after that.

'This is excellent work to enlarge and raise the chest itself, as, for instance, to take a flat or hollow chest and make it high and full, and to build up and strengthen the muscles across the front of the upper part of the chest—and these are, to most of us, very important things.

'SECOND CHEST EXERCISE

'**Directions.**—1. Take a dumb-bell in each hand.

'2. Stand erect.

'3. Face the ceiling right overhead.

'4. Breathe slow, deep breaths.

'5. Curl both dumb-bells, not in front, but as far out at each side of you as possible, and without touching the elbows to the sides.

'6. Repeat this six times.

'There is no need of urging you to hold the chest out in this exercise, because you cannot help doing so if you practise the exercise as directed.

'With light dumb-bells, beginning with a few strokes daily, and gradually doing more as the muscles in use get stronger, you not only avoid hurting the chest, but you bring it great benefit; and not only the chest, but you benefit nearly all the vital organs in the body as well.

'Curl the dumb-bells in exactly this way six times each day the first week without stopping, ten times daily the second week, and fifteen times each day after that.

'Also, if you have dumb-bells at home (as it would be well to do), you will get on all the faster if you do the same thing there each morning and evening.

'One thing more. If in curling in this way six times daily the first week you found that you took three breaths, though you tried to breathe deeply and slowly, now see if in the second week you cannot curl ten times in the same number of breaths, or even in two breaths.

'THIRD CHEST EXERCISE

'**Directions.**—1. Stand in the aisle, between two desks, or benches, not over two feet apart, and put one hand on each.

'2. Now, keeping your hands on these desks, walk backward two steps, and stand there.

'3. Keeping your chin up, and your body and knees at the same time stiff and straight, gradually bend your elbows and lower your body till your chest touches your thumbs.

'4. Push slowly upward, then lower again.

'5. Repeat this five times.

'Do this five times daily the first week without stopping, ten times daily the second week, and fifteen times daily after that.

'At home, to get this same exercise, simply place two strong chairs about two feet apart, put one hand on the seat of each, and follow the above directions.

'FOURTH CHEST EXERCISE, OR HALF-DIPPING

'After following up the last two exercises as directed, for a minute or less daily for six weeks, the muscles on the front of your chest will be strong enough to try something harder.

'**Directions.**—1. Stand between two desks, which should not be over two feet apart, and seventeen inches would do better.

'2. Place one hand on each desk.

'3. Breathe a deep, full breath, and hold it in.

'4. Taking your feet off the floor, and resting your weight on your hands, lower slowly and steadily, not till your knees reach the floor, but till they are about half-way down.

'5. Rest there till you slowly count three.

'6. Then raise yourself up, simply by pushing on the desks, till your arms are straight again.

'7. Do not let the feet touch the floor at any time during the exercise, but keep them together and well out behind you.

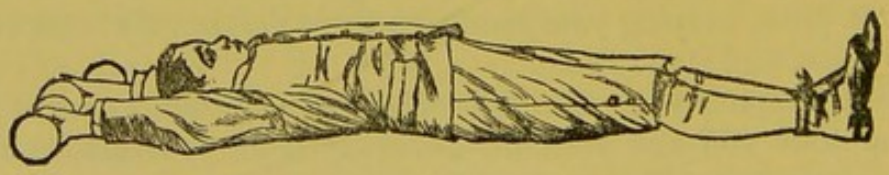
'8. Repeat this twice.

'Do two of these half-dips daily the first week, five each day the second week, and seven daily the third week. On the fourth week try something harder yet.

'THREE HOME EXERCISES FOR ENLARGING THE CHEST.—FIRST HOME CHEST EXERCISE

'**Directions.**—1. Lie flat on your back on the floor, or, better yet, on a mattress, pillow, or other substance easy to the back.

FIG. 64



'2. Take a dumb-bell in each hand, and stretch your arms up back of your head as far as you can, till the dumb-bells touch the floor, as in fig. 64.

'3. Breathe a deep, full breath, and hold it all in your chest.

'4. Now raise the dumb-bells, and bring them clear over till they are as high as you can reach, as in fig. 65, not bending the elbows once all the way.

'5. Rest a moment. Then lift them back of your head again, inhale a full breath, hold it in, and raise them as before.

'6. Repeat this three times.

'Do this, in the first week, three times each morning soon after rising, and as many times before going to bed. The second week, do it five times each morning and evening, and after that ten times each morning and evening right along.

FIG. 65

'This is great work for the chest, the putting the arms over your head in this way, and the deep breathing at the same time, *causing you to expand your chest to its utmost capacity*—a thing, by the way, which many persons do not do once in a whole day, sometimes even in a whole month.'

[The above directions for training young people to become strong, are applicable to all children in good health who have not already developed deformity. Some of them are very useful in the course of treatment of curvatures of the spine, but, as already urged in the foregoing pages, great care and discrimination must be observed before recommending any exercises when there is much general debility, or when there is any departure from what is natural in the condition of the spine.—N. S.]

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