Morbid anatomy and pathology of lateral curvature of the spine : an expansion of a note published in The Lancet of September 24 1904 / by Geo. Steele-Perkins, M.D.

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On a future occasion I purpose dealing with the Treatment I advocate for these cases, viz.: Physical Exercises and Position.

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Morbid Anatomy.

Before dealing with the morbid anatomy of lateral curvature there are one or two points to which it would be advisable to refer as they will enable the description to be understood more easily. Owing to the fact that the bodies of the vertebræ are more moveable than the processes, the latter being imbedded in muscles and fasciæ and the facets of the dorsal vertebræ being in addition articulated to the ribs, any individual vertebra does not rotate on its central axis. As a result of this the lateral deviation of the spinous processes which are visible is much less than the deviation of the bodies which are not visible and hence one is liable to under-estimate the amount of deviation that has really occurred unless this point is borne in mind. Further, the fact that the movement of the bodies is greater than that of the spinous processes can be easily understood if it is remembered that the bodies in the thoracic and abdominal cavities are practically unsupported and, further, that in the lumbar region there is no attachment to the ribs. Again, rotation can be most marked in the dorsal region because it is able to take place to a certain extent in that portion of the spine owing to the position of the articular processes, whereas in the cervical and lumbar regions rotation is unable to occur to a similar degree because the articular processes are so directed that they prevent excessive rotation taking place. When the pressure acting on the spinal column takes place in an abnormal direction the bodies are pressed out of their natural position more than the processes, because one of the chief functions of the bodies is that of support.

It is not my intention to enter at all fully into the morbid anatomy and pathology of lateral curvature of the spine, as it has been fully dealt with by many authors. But a brief description of the changes that occur in a moderately severe case may remind the reader of the salient points, and may be excused on that ground. In a moderately bad case the deformities which are most usually met with are a lateral curvature with a curve the convexity of which is

to the right in the dorsal region and a curve the convexity of which is to the left in the lumbar region, rotation of the bodies having occurred in both regions. In this class of case it must be remembered that there is not only a deviation but a rotation of the spine as well and that in consequence the structures of the spine will be altered in their relative positions to each other as well as in their external appearance and internal structure. The different changes that occur are naturally most marked at that part of the spine where there are the greatest lateral deviation and rotation. The bodies are displaced and rotated to the greatest extent at the point of greatest convexity of the curve. Owing to the pressure on the concave side to which the bodies are subjected the density of their structure is increased and their thickness diminished on that side. Rotation alters their shape, the broader part being on the side of the convexity, the narrower on that of the concavity. There is one very important point to bear in mind when considering the position of the bodies in those cases in which rotation has taken place and that is that the bodies rotate to the *convex* side ; the importance of remembering this will become apparent when dealing with rotation exercises when considering treatment. The pedicles, on the concave side, owing to the pressure they undergo, become to a certain extent absorbed and thereby are shortened. The articular processes on the concave side, owing to pressure and absorption, as in the case of the pedicles, become shorter than those on the convex side of the curve. The transverse processes undergo certain changes similar to those occurring in the other parts but are not so much altered because the pressure on them is not so great. Any alteration that occurs is in their shape. The important change that takes place in the transverse processes in cases of rotation is the alteration in their position ; the process on the convex side of the curve is rotated backwards, thereby becoming prominent and causing the muscles over it also to become prominent, whereas the transverse process on the side of the concavity is rotated forwards and in consequence causing the muscles which lie over it also to fall forwards and hence a flattening, which is very apparent, takes place on the concave side of the curve. The laminæ on the concave side, owing to the pressure they undergo, are shortened and owing to absorption become thinner. The spinous processes do not rotate as much as the bodies for the reason that has previously been given—namely, that a vertebra does not rotate on its central axis, the axis of rotation being nearer the most posterior portion of the spinous process than the most anterior portion of the body. Consequently the deviation of the spinous process is no estimate as regards the amount of rotation the bodies have undergone, the rotation of the spinous processes being slight, whereas the rotation of the bodies may be great. It has previously been said that the bodies of the vertebræ are rotated to the side of the convexity ; it therefore stands

to reason that the spinous processes are rotated to the concavity of the curve. The intervertebral discs undergo more or less alteration according to the severity of the pressure to which they are subjected, becoming thinner on the side of the concavity. The spinal canal, owing to the altered shape of the vertebræ, undergoes a corresponding alteration in its outline. The anterior common ligament is no longer in its normal position but is found to be more on the concave side than the convex. The posterior common ligament does not undergo so much alteration in position as the anterior, partly because it is situated inside the spinal canal and partly because the amount of displacement at the posterior part of the bodies is not as great as at the anterior. The ligamenta subflava and the inter-transverse ligaments are shortened on the side of the concavity and stretched on the side of the convexity. The inter-spinous and the supra-spinous ligaments undergo slight changes corresponding with the altered position of the spinous processes. The spinal muscles in a moderate case of lateral deviation with rotation are not altered in structure but have become more or less wasted and unable to fulfil their proper functions. This wasting is to be noticed particularly on the concave side of the curves, although it is not always as much as at first sight may appear on account of the forward rotation of the transverse processes as already described permitting the muscle on that side to become more buried than its fellow on the opposite side and consequently more flattened, whilst the prominence of the muscle on the convex side is increased by the backward rotation of the transverse process on that side. The muscles on the convex side of the curve are also frequently weakened owing to the undue stretching they have undergone. The ribs on the side of the dorsal convexity corresponding to the curve are posteriorly more or less prominent according to the amount of rotation of the vertebræ that has taken place and the angles of the said ribs are correspondingly increased, the ribs being also more oblique and the inter-costal spaces opened out, whilst on the same side anteriorly the corresponding ribs are flattened. On the side of the dorsal concavity the ribs corresponding to the curve are flattened posteriorly and their angles decreased, whilst anteriorly their convexity is increased and often there is a tilting forwards of the lower edge of the seventh, eighth, ninth, and tenth costal cartilages. The thorax has its cavity encroached upon on the side of the convexity and consequently its size lessened. The mamma on the side of the convexity of the curve in the dorsal region is less prominent and flatter than its fellow, owing to the ribs being less convex anteriorly than normal, whereas the mamma on the side of the concavity is unduly prominent owing to an increased convexity of the ribs anteriorly on that side. The viscera in the class of case now under consideration are not much affected, alterations in these organs taking place

principally in the severer forms of the deformity. The pelvis undergoes no changes in the milder forms of this deformity.

Having described the morbid anatomy of a moderately bad case of lateral deviation with rotation as much as is necessary for understanding the treatment we will consider the changes that occur in slight cases. In those cases in which there is a lateral deviation without rotation no structural changes are present ; there are only weakness and want of development of the muscles. Cases in which there is lateral deviation with more or less rotation the changes present are dependent upon the amount of rotation that has taken place ; in slight cases of this description little more than muscular wasting and relaxation of muscles are noticed, whereas in more advanced cases we find an alteration in the thickness of the bodies and intervertebral discs, and the changes in the other structures previously described, only to a less degree.

In severe cases the changes present are greater than those which have been described as occurring in a moderately severe case. The bodies become very dense in structure on the side of the concavity and their cancellous tissue even becomes compact. In the worst cases osseous deposits occur in the concavity which aid in preventing the curvature becoming even more severe. The intervertebral discs undergo a process of ossification in the severer forms of the deformity. The anterior common ligament has sometimes been found to have a formation of bone taking the place of its normal structure in very advanced cases. The spinal muscles in severe and long-standing cases are often found to have undergone fatty degeneration and even fibroid changes are sometimes present. The ribs in bad cases become very convex posteriorly on the side of the convexity, the angles becoming much increased, whilst anteriorly the ribs become very flattened with corresponding flattening of the mamma ; on the side of the concavity the ribs become very flattened posteriorly, whilst anteriorly their convexity is great, causing much prominence of the corresponding mamma ; sometimes considerable tilting forwards of the lower edge of the seventh, eighth, ninth, and tenth costal cartilages occurs. In cases of great deformity osseous tissue is sometimes formed between adjoining ribs. The thorax in the cases we are now considering has its respiratory capacity much diminished. The viscera undergo alterations in their positions, the heart and œsophagus getting displaced according to the curves that are present, the liver, stomach, and intestines also getting disarranged, but the descending aorta follows the direction even of very severe curves. The pelvis is more or less altered in shape according to the severity of the case and the lumbo-sacral angle trespasses either on the left or right of the cavity according as to whether the convexity of the curve in the lumbar region be to the one side or the other.

Pathology.

Any disease, constitutional or otherwise, which produces general debility and loss of stamina, gives rise to more or less difficulty to maintain the erect position and consequently stooping—i.e., an increase in the normal antero-posterior convexity of the spine in the dorsal region—occurs which is known as kyphosis. This general want of muscular strength if associated with some determining factor causes a lateral deviation of the spine to occur, which when persistent and if more than to a limited degree, and accompanied as it is with a weakening of the spinal ligaments, must of necessity give rise to rotation of the bodies of the vertebræ. Where there is a general falling off in muscular power it is the spinal muscles that suffer more than any other part, as they have to maintain the body in the erect position. The persistently inaccurate positions to which reference was made above as determining factors may be instanced by the standing on one leg, writing in wrong attitudes, and various positions which have to be adopted when following certain occupations. The ribs posteriorly on the side of the convexity are, as has been said, prominent and anteriorly are flattened. The reason of this is that the ribs in front are attached to the sternum which being immoveable forms a fixed point, whilst behind the ribs being articulated to the bodies of the vertebræ and these bodies being rotated to the convex side it stands to reason that the distance between the attachment of the ribs to the sternum anteriorly and their articulation to the bodies of the vertebræ posteriorly is greater than normal and the angle of the rib brought backwards—that is to say, the angle is increased and that therefore the angle must of necessity become more prominent, whilst the ribs in front are correspondingly flattened. The spinal muscles, as has previously been stated, are prominent on the convex side of the curve and flattened on the side of the concavity. This is due to the transverse processes on the convex side being more prominent owing to the rotation of the bodies to that side, which of necessity causes the transverse processes to come backwards, and to the transverse processes on the concave side being less prominent owing to their being rotated forwards, added to which is the fact that the muscles on the concave side are weakened.

A curvature having taken place in one part of the spine, sooner or later a compensating curve will occur in another part. It is always an important point, as far as treatment is concerned, to decide which curve is primary and which secondary. The most common deformity met with is a curve in the dorsal region with the convexity to the right and a curve in the lumbar region with the convexity to the left. In many cases the dorsal is the primary and the lumbar the compensating or secondary curve, whilst in other cases the lumbar curve is primary and the dorsal secondary. For instance, if the determining factor be the excessive use

of the right arm then the dorsal curvature would be primary and the lumbar secondary, whereas on the other hand if the determining factor be due to the fact that one leg is shorter than the other the lumbar curve will be primary and the dorsal curve secondary. In many cases it is very difficult to determine which of two curves is primary, nevertheless no trouble should be spared in endeavouring to form a correct diagnosis on the point. The importance of it lies in the fact that in treating the case it is the secondary curve that first disappears, although at the same time a reduction in the primary curve is taking place and it is the primary curve that is straightened last. We have first, therefore, to direct our main attention to the reduction of the secondary curve and when this has been rectified we can bring our energies to bear on the straightening of what remains of the primary curve. To decide which curve is the primary one and which the secondary a careful investigation as to the cause, particularly as to what is the determining factor, is of the greatest importance, as the cause of the deformity will in a large number of cases enable us to decide at once which is the primary curve. Then, again, the primary curve is generally greater than the secondary, although sometimes the secondary curve has increased beyond that of the primary curve, in which case you will often find a third curve which is really compensatory to the second curve, and in the treatment of such a case the third curve must receive the greatest attention at first, then the second curve, and, finally, what then remains of the primary curve. A third curve may, of course, occur, and often does, without the secondary curve becoming greater than the primary curve, but nevertheless it is compensating to the secondary curve. The primary curve may be in the cervical, dorsal, or lumbar region, most usually it is in the dorsal region, but primary lumbar curves frequently occur, being caused by one leg being shorter than the other or a tilting of the pelvis to one side. It is to be noticed that a shortening of one leg does not necessarily, although it does usually, result in a lumbar curve with the convexity on the side of the shorter leg, as one would expect, but that sometimes the convexity of the lumbar curve is on the opposite side to that of the shortened leg. The pathology of this is obscure but the fact remains. A compensating curve is naturally always on the opposite side to the curve which it compensates. A dorsal curve is not always compensated by a lumbar curve but sometimes by a curve lower down in the dorsal or else in the dorso-lumbar region. Doubtless sometimes two curves may occur at the same time, but at any rate this is very unusual and generally a careful investigation will enable one to discover that one curve preceded the other, if only by a short time. The compensating secondary curve is always more easily corrected than the primary curve.

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