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DISCUSSION ON CERVICAL RIBS.

The Anatomy of Cervical Ribs.

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Introduction.

That the rib series of man is subject to a certain amount of numerical variation is, of course, an old observation in anatomy; that abnormal ribs may develop, or normal ribs fail to develop, at either end of the thoracic region was well known to the old masters of anatomy.

Many authors mention specific instances, and it is interesting to note that increase rather than reduction in the number of ribs was considered to be the most frequent anomaly. Helkiah Crooke, in his "Mikrocosmographia" of 1651, says: "They are commonly both in men and in women on each side twelve, oftener more than fewer. For Nature would rather there should be an abundance than want. And in a publick anatomy when a malefactor was cut up, Bauhine found thirteen on each side; the first on the left side was perfect, but the first on the right side was imperfect. Fallopius also twice found one too many, Columbus once eleven at Padua" (p. 744). It is not difficult to see why Crooke laid stress upon the fact that the number of ribs is the same in both men and women, for such a finding was not readily acceptable to all men of his time.

Such an anomaly of development was naturally likely to attract attention as a mere anatomical curiosity, and as such it has accumulated its literature—which may be termed the literature of the first period.

But very early some more advanced workers saw in this variation a certain similarity to the condition found in some lower animals. Edward Tyson, in his "Anatomy of a Pygmie" of 1699, says: "It (the anthropoid) had thirteen ribs of a side, six and twenty in all. In man there is but twenty-four, though sometimes there has been observed thirteen to a side."

The time was not near advanced enough for such ideas to be carried further, but such an observation may almost be said to usher in the second period of the literature of rib anomalies. This period properly begins when Darwin's views came to be appreciated by human anatomists, for then these numerical variations were eagerly seized upon as a subject to which study was directed in order to discover some order in the irregularity of development which might throw light upon the processes of evolution. From this inquiry a great mass of literature has arisen. Rosenberg (1876) believed that in these variations a progressive development was manifested, and that the general shortening of the thoracic region, which is at work throughout the mammalian series, was evidenced as a distinct and ordered evolutionary process from ape to man. Confirmation of his views was freely provided by other biologists who extended these studies, but Holl, of Innsbruck (1882), disputed the theory, and Paterson (1893), and Bardeen (1905) brought forward many facts which definitely contradicted it. Dwight, of Harvard, after a prolonged study of abnormal human vertebral columns, saw no progressive change in any direction, and recognized no evolutionary tendency in the process, but decided that all these anomalies "are merely variations round a mean, which for want of a better word we must call accidental" (1911).

The idea underlying most present-day theories appears to be that these variations are compensatory efforts to restore to normal proportions a vertebral column in which some initial error of segmentation has occurred. Around such discussions the bulk of the anatomical literature of cervical ribs has been built up. Cervical ribs, in fact, like so many other parts of the human body, passed through a period during which their sole interest to the anatomist was purely morphological. This period was fertile in the production of literature, yet furnished but little material towards the application of the study of human anatomy to the practical needs of medicine and surgery.

These abnormal structures were, however, rescued from this condition of mere morphological signposts by the clinician; for cases were met with in practice which showed a definite train of symptoms associated with the presence of an abnormal rib in the cervical region. Anatomists again turned to the study of rib anomalies, and such studies may be considered as constituting a third period in the literature of cervical ribs.

The anatomical literature of this period remains scattered as isolated papers in various publications; so far it has not influenced text-book teaching, and it is not available to the clinician in any consecutive form. It is the purpose of this paper to review the present state of anatomical knowledge regarding the causation of abnormal rib development, and to collect such material as has accumulated which throws light on the anatomical condition and the clinical manifestations of the anomaly.

Comparative Anatomy and Development of Rib Anomalies.

Of the many segments which enter into the composition of the human vertebral column only a certain number are destined to bear ribs. Normally twelve such segments in the thoracic region carry ribs, but abnormally in man as many as fourteen or as few as ten vertebræ may be rib-bearing or thoracic vertebræ. These rib-bearing vertebræ are preceded by and followed by ribless regions of the vertebral column; but it must always be remembered that, even in the ribless regions, the vertebræ possesses very definite rudiments of the ribs which develop fully only in the thoracic region.

Now such a condition is not common to all vertebrate types, for amongst the snakes every member of the vertebral series may carry a well-developed rib. Such animals have no cervical or lumbar region or—popularly—possess neither neck nor waist. All stages in the production of ribless cervical and lumbar regions are seen in the gradual change of structure which takes place in the transition between snakes and lizards, and the clue to these changes is to be found in the study of the developing perfection of the limbs.

It may be stated as a general rule that the functional development of the limbs is accompanied by a reduction of the rib series, and that a ribless neck and a ribless waist are the outcomes of the development of a functional arm and leg. To discover the reason for this association it is only necessary to turn to the developing embryo.

In the early human embryo the epiblastic bases of the spinal nerves run as girdles around the body. They are, in fact, the expression of the primitive segmentation of the body, for segmentation "finds its expression in the arrangements of the primitive segments and the nerves supplying these, and not in the skeleton, which is a later development" (J. Arthur Thomson). But between each spinal nerve band there run alternate mesoblastic bands which constitute the basis of the future ribs; a rib may be regarded as an intersegmental mass of mesoblast, and a spinal nerve as the representative of the primitive segmentation. Such a simple condition of segment and intersegment is seen in the human embryo, and as such it persists in the adult snake. The ribs, however, when they are laid down are placed upon a more

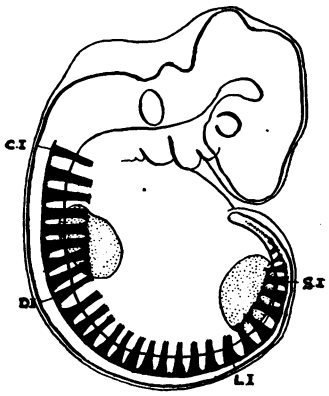

FIG. 1.

Diagram, after a reconstruction of an embryo of 6·9 mm., by Streeter, to show the nerve-roots running almost parallel to the limb buds.

superficial plane than the nerves, so that the nerves become partially sheltered by the encircling ribs, and they emerge from this shelter in order to reach the muscles and the skin which they supply. This simple girdle arrangement may persist so long as each individual nerve possesses only the function of supplying a segment which is itself a girdle of the animal body. But in the embryo of a limbed animal it is readily seen that when the limb buds appear they are formed as the derivatives of several body segments, and at first occupy an area coterminous with these body segments. Into these limb buds the nerves from several body segments are consequently continued. At an early stage, when the limb bud is coterminous with

the body segments from which it arises, the parallel arrangement of the nerves, even to their distal terminations in the limb buds, will be maintained. But it is very soon manifest that this orderly arrangement becomes upset. The limb bud ceases to keep pace with the body segments as the latter become of increasing breadth. The bud grows out at right angles to the body axis and so becomes an attenuated derivative of several body segments, which body segments have long outstripped the area of the original base from which the limb budded. This change necessitates an alteration in the arrangements of the segmental nerves which run to the limb bud; for now, instead of running parallel to each other from the body to the limb, they become gathered together in a leash in the root of the limb and are widely

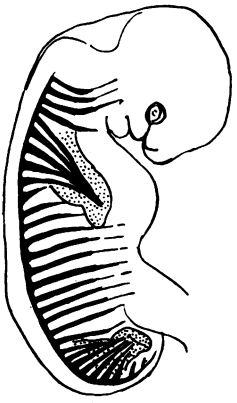

FIG. 2.

Diagram of a somewhat older embryo to show the nerve-roots entering limb buds in an oblique manner: formation of a plexus.

separated at their origins from the spinal cord. In other words, the segments and intersegments have grown apart in the body but are still closely approximated in the limb, and nerves, representative of several widely separated segments in the body, are therefore focused upon one point in the limb. This constitutes the formation of a limb plexus.

It is the formation of the brachial plexus which produces the ribless neck and the formation of the lumbo-sacral plexus which produces the ribless waist. The manner in which the ribless areas are brought about may be followed readily in the developing embryo. When first the body segments which are represented in the limbs begin to grow apart, and so outstrip their prolongations into the limbs, they are composed of

epiblastic nerve and mesoblastic rib basis. The epiblastic nerve passes from within outwards through each mesoblastic segment and intersegment, for lying at first beneath the shelter of the rib basis it has to emerge into the outgrowing limb. If the primitive condition were retained each limb base would be as extensive as that area of the body from which its segments are derived, and each limb nerve would emerge between two ribs to run into this enormously broadened limb base. Such a conception makes the actual process more easy to realize, for it is not difficult to picture a relative shrinkage of the limb bud, a gathering together of the limb nerves in the narrowed limb, and a consequent interruption by epiblastic nerves of all the intervening

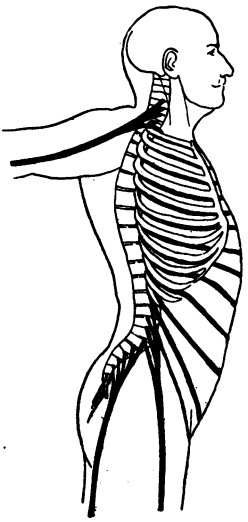

FIG. 3.

Diagram to show the directions of the spinal nerves and their gathering into plexuses in an adult.

mesoblastic intersegmental bands. This is what actually happens in the developing embryo, for the rib bases begin to develop in the ribless areas and continue to grow until the concentration of the emerging nerves on the limb root cuts short their distal extension. The ribs may therefore be said to be shorn from the neck region (and from the loins) by the straining of the nerves across the mesoblastic basis in which they would be laid down. So far as the bony element is at liberty to develop between the emerging nerves it does so, and rib rudiments are of course present as the anterior tubercles of the transverse processes in the normal cervical vertebræ.

Note.—There is one class of animals in which limbs and limb plexuses are developed without the sacrifice of any ribs; for the bony fish, though possessing functional pelvic and pectoral fins, have no waist and no neck. I take it to be a support to the present argument that in bony fish the ribs are not upon the same morphological plane as are those of the other vertebrate classes. In bony fish the ribs, instead of springing from the neural arches—and so being superficial to the nerves—are developed from the vertebral centre—and are deep to the nerves. With such an arrangement a plexus of limb nerves may be produced without transgression of the underlying ribs.

The whole of this question has been more fully discussed in a previous paper, "On the Relation of the Limb Plexuses to the Ribs and Vertebral Column" (*Journal of Anatomy and Physiology*, July, 1910, xliv, p. 377).

The Anatomical Relation of the Costal Element and the Plexus.

It would therefore seem to be apparent that there is an antagonism between the formation of a nerve plexus for the supply of the limb and the development of ribs in that region from which the nerves are derived. This antagonism is manifested in the bony elements by the many pressure marks stamped by the nerves upon the developing bone. The reality of the influence of nerve-pressure has not been by any means sufficiently appreciated, because the nerves of the adult appear to be such trivial things to have any determining influence upon the disposition of bone; but it is in the early stages of the embryo, when the nerves are of preponderant size, and the mesoblastic osseous basis is yielding and trivial, that the process is in its active stages.

One remarkable instance of nerve-pressure that has for long been overlooked is to be found in the so-called *sulcus subclaviæ* which marks the upper surface of the normal first rib. This groove is formed by, and lodges the lowest cord of the normal brachial plexus, and the reason for its being mistaken for an arterial impression is, I imagine, that when the arm is extended at right angles to the body (as it is during the progress of an ordinary dissection) the nerve-cord is somewhat raised from the surface of the bone, but the subclavian artery is not. It was during the dissection of a body in which the arms were pressed close to the sides that I first noted the relation of the nerve-cord to the groove; and abundant confirmation of the fact has since been

forthcoming from several sources (for first note on nerve-cord pressure on the normal first rib, and formation of the groove, see *Anat. Anzeig.*, 1910, xxxvi, i, p. 25).

The recognition of this groove as a sign of nerve-pressure is of fundamental importance in any inquiry as to the conditions of cervical ribs or any discussion of the symptoms which they produce. Although this groove was so long mistaken as an arterial impression, a similar but deeper groove which marks the upper surface of a developed seventh cervical rib has been recognized as a nerve groove by many

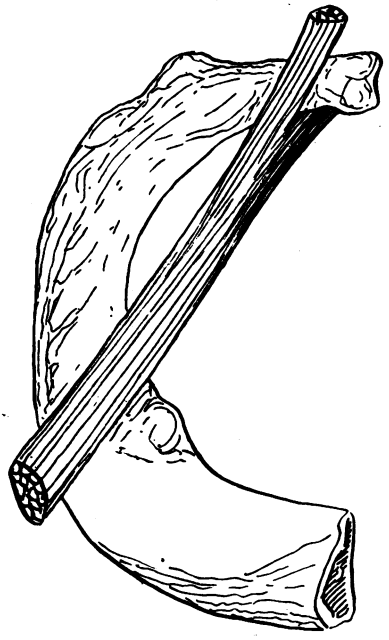

FIG. 4.

The normal first rib and its relation to the lowest cord of the brachial plexus.

observers (among them Turner, Lane, Dwight, and Phillips). This groove upon a cervical rib is of great interest, for it tells much of the story of the antagonism between the developing limb nerve and the developing rib. The groove starts upon the inner margin of the rudimentary rib, and runs across its upper surface very obliquely from behind forwards and outwards: the anterior and outer limit of the groove coincides, as a rule, with the distal termination of the rudimentary rib. Beyond the tip of the bony cervical rib upon which

the nerve groove ends a ligamentous structure generally connects the rudimentary rib either to the first rib or to the sternum.

If, now, the normal costal element of the seventh cervical vertebra be examined, it will be seen that it is abbreviated in exactly the same manner by the passage of the nerve-cord. Moreover, the elements above this show increasing evidence of the downward straining of the nerves that join the brachial plexus, and a proportionately diminishing costal element. These nerve markings on the cervical vertebræ have been discussed in a separate paper (see *Journal of Anatomy and Physiology*, 1911, xlvi, p. 41).

The markings on the lumbar vertebræ show equally well the influence of the nerve elements (see *Journal of Anatomy and Physiology*, 1912, xlvii, p. 118), but do not concern the present inquiry; nevertheless,

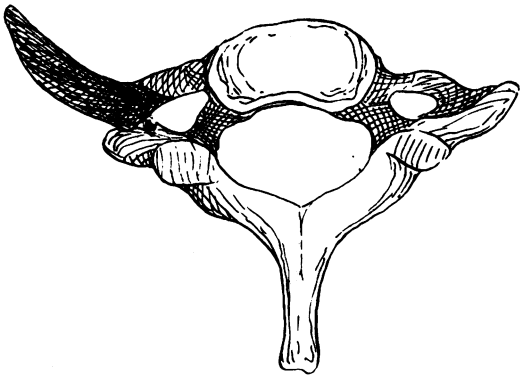

FIG. 5.

A left cervical rib showing nerve groove impressed on its upper surface by the brachial plexus.

they add weight to the supposition that the distinctive features of the elements of the vertebral column are impressed upon them early in development by the influence of the nerves and their manner of distribution as plexuses for the supply of the limbs. Such a supposition leads further than the current explanations of vertebral anomalies already mentioned, and it is capable of many helpful extensions, for it presumes that anomalies in the arrangement of the limb plexuses are primary, and not secondary to anomalies in the disposition of the ribs and vertebral elements.

For direct support for such a supposition it is only necessary to turn to the body and examine the condition of the first rib in relation

to the constitution of the brachial plexus. It is well known that the brachial plexus is subject to many variations about a mean which is taken as normal. The plexus may be shifted somewhat nearer to the head, or somewhat nearer to the hind end of the body. Such a shifting may not manifest itself by the absorption of nerves that are normally outside the range of the plexus, but may limit itself to a greater or less contribution from the nerve-trunks which mark its cephalic and caudal extremities. In a typical plexus a portion of the first thoracic nerve ascends within the thorax to pass out over the first rib with the brachial plexus. The amount of contribution made by the first thoracic nerve to the brachial plexus is subject to wide variations; it may furnish a slender twig, a large cord, or practically the whole of its bulk to the plexus in cases that we are accustomed to regard as within the limits of the normal.

It is also well known that the *sulcus nervi brachialis* (so-called *sulcus subclaviæ*) upon the upper surface of the first rib is also subject to much variation, and I have determined, by an examination of a series of bodies in the post-mortem room, that the depth of this groove increases as the contribution from the first thoracic nerve increases. In cases which hardly come within the limits of the abnormal this interaction of the strained caudal end of the plexus and the first rib may proceed to such a degree that the rib becomes bent downwards at the site of crossing of the lowest cord. Such a bending is often evidenced in cases of cervical rib, and has been noted by Dwight. With a large caudal contribution to the brachial plexus, therefore, the tension between the lowest cord and the first rib increases (for further details *see* "Variations of the First Rib associated with Changes in the Constitution of the Brachial Plexus" (*Journal of Anatomy and Physiology*, 1911, xlv, p. 249). Now, for the purpose of this paper it becomes all important to determine if such a pressure between a normal first rib and the lower cord of the brachial plexus can produce such symptoms as are usually ascribed to the presence of a cervical rib. It is certainly a fact that this may happen.

In the *Australian Medical Journal* of October, 1910,[1] Dr. Thomas Murphy described a case, of which an abstract was published in the *Lancet* of December 17, 1910. Briefly, in this case, a woman, aged 28, had for eight years shown varying, but usually severe, symptoms of brachial neuritis; and the condition present pointed to pressure on the nerve-trunks. The diagnosis of cervical rib seemed obvious, but a

[1] *Austral. Med. Journ.*, Melbourne, 1910, xv, p. 582.

skiagram showed that no cervical rib was present. Since pressure upon the plexus at the root of the neck caused an increase in the pain, an operation in this site was wisely determined upon. The portion of the normal first rib upon which the lowest cord lay was excised, and the plexus was allowed to sink to a lower level. Five hours after the operation the relief of the symptoms was noticed, and by the end of a week all pain was gone, nor was there any return of symptoms even after severe exercise.

The case is not an isolated one, for other instances in which the symptoms of cervical rib have been manifested in the proved absence of a cervical rib have been met with. It is, of course, a mere matter of conjecture as to why in these cases a normal first rib should produce symptoms; but there is much support for the supposition that even

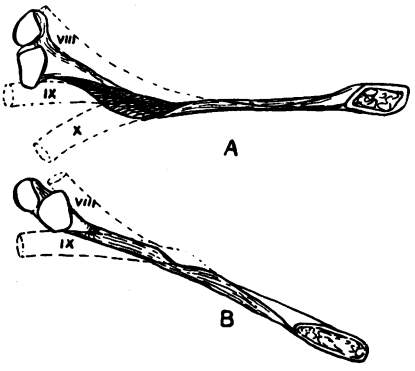

FIG. 6.

A, first thoracic rib, seen from within, to show the bending of the axis of the rib at the site of the *sulcus nervi brachialis*, contrasted with the corresponding margin of the typical form, **B**.

though the rib was normal the brachial plexus was probably of the post-fixed type.

When a brachial plexus becomes more profoundly altered from the normal so as to include caudal nerve-roots, which are normally outside the limits of the plexus, the interference with the development of the rib may naturally be expected to reach its maximum.

At times the second thoracic nerve becomes added in whole or in part to the plexus; and then profound anatomical changes may be produced, for the antagonism between nerve and rib element may lead to a curtailment of the first rib, which then presents characters surprisingly like those seen in a case of developed cervical rib. Such a

case I have met with in a bilateral condition in a female child, aged 7. The condition present was as follows: The first ribs were only partially developed, their posterior bony part was short, and terminated at the point where the lower cord of the brachial plexus passed outwards to the arm. Beyond this point they were continued as ligamentous bands, into which the fibres of the anterior scalene muscle were inserted, and which were attached to rudimentary costal cartilages which were imperfectly separated from those of the second rib. The eighth ribs reached the sides of the sternum in the manner of the normal seventh ribs. The twelfth ribs were long and unusually well developed, but no

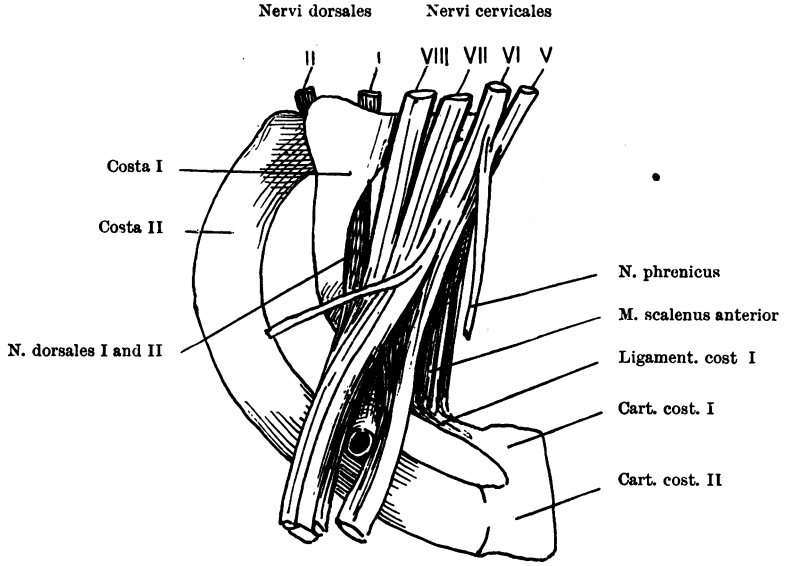

FIG. 7.

Case of rudimentary first thoracic rib. Right side seen from above. The muscles have been dissected away.

rib was attached to the first lumbar vertebra. Upon both sides the arteria subclavia passed over the rudimentary first rib with the brachial plexus in the normal manner. Dukes and Owen, Keith and Hertslet, and Lane have recorded similar cases of rudimentary first ribs in which the second thoracic nerve made considerable contributions to the brachial plexus. In the case described the whole of the second thoracic nerve did not join the plexus, but it gave a very considerable contribution to it. These cases are to be regarded as instances of a caudal migration of the limb plexus, accompanied by a partial reduction of the normal first rib,

and evidently take their origin early in embryonic life by the developing limb bud arising from one segment nearer the hind end than is normal.

These rudimentary first ribs have been repeatedly met with and described as dissecting room curiosities (in addition to those mentioned; *see* cases by Bradley, Gruber, Halbertsma, Helm, Honauld, Hunter, Knox, Leboucq, Le Double, Low, Macphail, Müller, Struthers, Turner, Zaaijer, and others), but it seems almost certain that some forms of them would be capable of producing symptoms such as are produced by

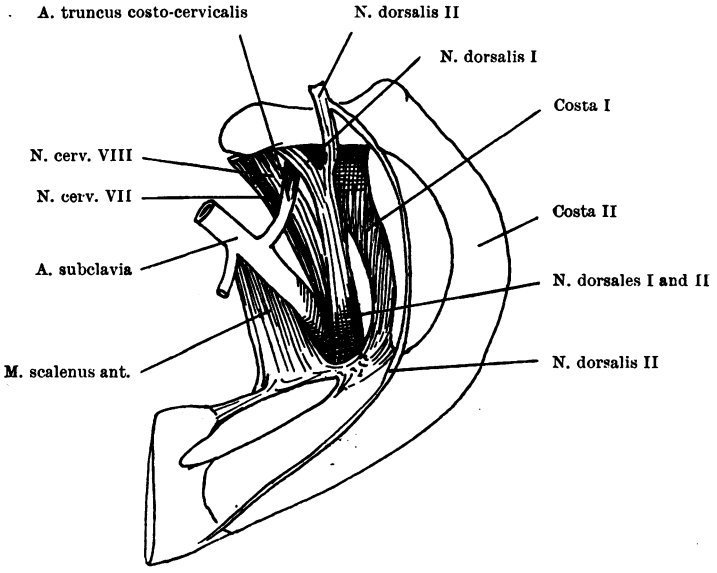

FIG. 8.

Case of rudimentary first thoracic rib. Right side seen from below.

cervical ribs. Indeed, I believe that these cases would by any ordinary methods of examination be taken for, and recorded as, instances of cervical rib. Clinically these aborted first ribs have received no recognition; yet there are many of them recorded in anatomical literature, and it is extremely probable that under the general heading of "cervical ribs" many such cases are included in clinical records. Nothing short of a count of the vertebræ lying cephalad of the disputed rudimentary rib can be considered as an adequate criterion for properly diagnosing these cases. Such cases show the interaction that may be produced between the costal element of the first thoracic segment and the lowest cord of the brachial plexus.

When the costal element of the seventh cervical segment is developed the lowest cord of the plexus passes over it, and the resulting pressure is naturally increased. We may infer that there is in these cases a tendency for the plexus to be prefixed, and we have Eisler's assertion that when a cervical rib is well developed the plexus either receives no contribution, or only a very small one, from the first thoracic nerve; also some cases that have been met with in the dissecting room demonstrate this condition (cases recorded by Black, Hertslet and Keith, &c.). All people who have cervical ribs do not exhibit symptoms of pressure upon the nerve-cords, and it is well known that some of the cases which present no symptoms possess particularly well developed cervical ribs; indeed, it has been laid down as a rule by Lewis Jones that, "where a bony prominence can be felt with ease, the brachial plexus is usually free from pressure" (*see* Theodore Thompson, *Brain*, 1908, xxvi, part cxxii, p. 286). In these cases it is to be presumed that the prefixation is considerable (involving probably a whole nerve-root), and the plexus and the bony elements have readjusted themselves at a more cephalic level than is normal. On the other hand, other cases make it quite clear that although there is a tendency to prefixation of the plexus, such prefixation is not sufficient in degree to counteract the strain produced by the presence of a costal element developed at an abnormally high level. Just as varying grades of imperfection of development of the first thoracic rib are the outcomes of varying degrees of post-fixation of the plexus, so the varying grades of perfection in the development of a cervical rib are the outcomes of varying degrees of prefixation of the plexus. And just as the post-fixation may readjust itself with the rib elements at a lower level, so may the prefixation readjust itself at a higher level. It is in the intermediate grades, in which the development of the costal process is in excess of the plexus alteration, that the strain is produced and symptoms are developed.

The Anatomical Relation of the Costal Element and the Artery.

Some years ago the surgical teaching concerning cervical ribs was practically limited to the doctrine that the rudimentary rib, by raising the subclavian artery to a higher level in the neck, and so making its pulsations more apparent, might lead to the incorrect diagnosis of subclavian aneurysm. This straining upwards of the artery has also

been held responsible for the production of the vascular disturbances frequently displayed in the forearm and hands in these cases.

Mr. T. Wingate Todd (*Journal of Anatomy and Physiology*, 1911, xlv, p. 304) declared that the "arterial symptoms are caused by the action, directly by the scalenes and indirectly by the diaphragm, on an artery with a further and more tortuous course to pursue than is normal." Others have spoken of the artery being compressed beneath the rudimentary rib. In all cases of rudimentary first thoracic rib it is certain that the artery passes over the rib or its fibrous continuation. It seems also definite that in some cases of undoubted cervical rib the artery is also elevated above the rib; nevertheless, the surgeon meets with cases in which the artery lies below a rudimentary rib that is certainly not derived from the sixth cervical vertebra. More information is needed on this point, and when a clear distinction is made in diagnosis between rudimentary first thoracic and rudimentary seventh cervical ribs, this information will rapidly accumulate; but in the present state of knowledge some uncertainty must exist as to the normal relation of the artery to seventh cervical ribs.

Whatever the relation of the subclavian artery to the abnormal rib, it seems certain that the vascular symptoms in the arm are not produced in all cases by compression of the artery, either by it being stretched over the rib or pressed beneath it. Indeed, in a subsequent paper published by Mr. Todd it is asserted that "any explanation of the vascular phenomena may be found inadequate if it depends only on direct mechanical pressure of the subclavian artery" (*Lancet*, August 10, 1912). In a still more recent paper (*Journal of Anatomy and Physiology*, January, 1913, xlvii, part ii, p. 250), Mr. Todd appears to have reversed his former theory entirely, for he says: "First the artery is cirsoid and cannot be stretched; secondly, the contracting scalenes cannot compress it."

Just as the pressure on the lowest cord of the brachial plexus produces the muscular and sensory changes, so it may in some cases also produce the vascular symptoms. It is the compression of the vasomotor fibres in the lower cord of the plexus which causes these symptoms, and this fact Mr. Todd has clearly demonstrated. The sympathetic contribution to the plexus is mostly supplied to the first thoracic nerve by a communication with the second nerve within the thorax. Such an interchange of fibres has been noticed by many anatomists, and Mr. Todd has recently demonstrated its sympathetic nature and its clinical importance in producing vascular symptoms. Spinal fibres and

sympathetic fibres are, in fact, both subject to the pressure effects caused by the antagonism between rib development and plexus formation.

The last phase in the study of this subject has been the examination of the histological condition of the vessels involved, and here Mr. Todd has shown that, at any rate in one case, they were trophic in nature and consisted of a definite change in the nature of the vessel walls. Bechterew, Cehanovič, and Lapinski, have studied the histological changes of the vessel walls produced by interference with the sympathetic nerve supply, and the appearances that they describe are similar to those displayed in this case of vascular disturbance caused by the presence of a cervical rib. Quoting from Todd's most recent paper, the changes are displayed in both artery and vein as follows: "*Artery*—(*a*) Adventitia, no marked change. (*b*) Media, increased in amount; cells apparently healthy. (*c*) Intima, reduplication in places of elastic lamina; normal appearance lost in places owing to proliferation of the lining endothelium. (*d*) Lumen partially obliterated owing to development of connective tissue, which blocks the channel, and which, judging from the pigmentation present, has resulted from the organization of blood-clot. *Vein*—Hypertrophy of muscular coat as in artery."

We may therefore sum up the anatomical condition by saying that pressure on the lowest cord of the plexus may produce all the symptoms, motor, sensory, trophic, and vascular, displayed in cases of cervical rib; or in cases in which there is any disharmony in rib and plexus development.

Anatomical Relation of the Shoulder-girdle to the Ribs.

Symptoms of brachial neuritis from pressure of a costal element, and its accompanying manifestations, appear in adolescents, in people who show loss of muscular tone, in patients who display in one form or another the symptoms of visceroptosis, and in women recently delivered. In all its manifestations brachial neuritis from rib pressure is more common in women than in men. Children with cervical ribs show no symptoms, and the reason for the late onset of any neuritis has given rise to considerable discussion. It has become stereotyped in clinical literature to regard the late development of symptoms as due to the late ossification of the rib rudiment. There was never any anatomical justification for this view; there is no evidence that a cervical rib does ossify late; and when a normal first rib is the offender this theory must naturally fail. Again, such a theory affords no sort of explana-

tion of the appearance of symptoms in cases in which the outstanding feature is a general loss of muscular tone.

It is, however, the latter class of cases which gives the real clue to the causation of symptoms, for these people display in an exaggerated form that dropping back of the shoulder-girdle and fore-limb which is a normal change in adolescents. It is a matter of lay observation that the shoulders drop back as growth proceeds; it is also a matter of common knowledge that in women they usually drop back farther than in men. In a child the clavicles rise markedly from their sternal ends towards their outer extremities; in adult men they more nearly approach the horizontal; and in adult women they not uncommonly slope downwards from their sternal ends. Such an observation is as old as anatomical literature. In cases in which muscular laxity is well marked this downward sloping of the outer end becomes more pronounced. It is true that in all these cases there is an accompanying fall of the whole thoracic cage, and a consequent lowering of the sternal end of the first rib and also of the sternal end of the clavicle; but the fall of the shoulder outweighs this, so that despite the fall of the sternal end the acromial end drops relatively to it.

The normal age changes in the position of the shoulder-girdle have been measured and tabulated by Todd (*Anat. Anzeig.*, 1912, xli, p. 385), and his figures confirm these general statements. It is, of course, obvious that the greater the drop of the arm relative to the highest rib, the greater will be the tension between the lowest cord of the plexus and that rib. It is also obvious that when a drop of the shoulder-girdle has produced sufficient tension to cause the development of symptoms, such symptoms would probably be relieved by a deliberate elevation of the shoulder-girdle. As a matter of fact, most sufferers from brachial neuritis which is due to rib pressure have evolved this much for themselves.

It would seem to be not unlikely that in normal people the anatomical relation of the normal lowest cord and the normal first rib may produce some slight pressure symptoms; but this only to the extent that an "arm-" chair is welcome after a day's work. Indeed, the whole secret of the "arm-" chair might well be that by the support it affords to the elbows and the consequent raising of the shoulder-girdle that it produces, it relieves the plexus from pressure which has been acting during the hours in which the arm was dependent. A patient with cervical ribs gains relief by sitting in an armchair, and it has been noticed repeatedly that they are most comfortable when they sit so that

the shoulders are hunched up almost to the ears. When such patients sleep they select a position which will raise the shoulder of the affected arm as far as possible from the top of the chest wall, and I have been very much struck, in the limited experience which as an anatomist I have of the clinical aspect of these cases, with the diagnostic value of this position of rest. When lying on the side it is easier to insure that the underlying shoulder shall remain elevated, and patients often lie in bed with this shoulder so far raised that the head lies rather on the shoulder than on the pillow. One woman rested in so strange a pose that it was her habit to say she slept "like a bird—with her head tucked under her wing." So far is this carried in some cases that Mr. Percy Sargent has told me of a woman who was in the habit of slinging one axilla to the head of the bed to prevent the falling of the shoulder-girdle during sleep. Such an extreme method would, of course, at once attract attention; but I think that suspicion should be aroused by the fact that in brachial neuritis caused by rib pressure, the patient lies on the painful side, whereas in most other painful conditions of the arm they lie upon the sound side.

The Anatomical Interpretation of Skiagram of Costal Anomalies.

The introduction of radiography has assisted in a marked manner in solving the problems connected with abnormal rib development; but its utility has not yet been generally employed to its utmost. To the expert radiographer there is no difficulty in the interpretation of the shadows cast by rudimentary ribs, and the diagnosis of a rudimentary rib on the negative is sufficient for clinical purposes. But we know, anatomically, that by no means all of these rudimentary ribs are seventh cervical ribs, though clinically they are all commonly classed as such. What remains for the radiographer to do in this inquiry is to determine, beyond any dispute, which member of the vertebral series gives origin to the rudimentary rib. Probably many interesting facts will come to light when this is done as an ordinary detail of routine examination.

Unfortunately, radiographers have relied on a very false criterion for determining vertebral levels in this region. It has been laid down as an axiom that the slope of the transverse process is diagnostic, for it is said that "those of the seventh cervical are short and usually set at right angles with the vertebral column, or have a downward tendency, while the first dorsal processes are larger and have an upward tendency."

(S. Gilbert Scott, "The Diagnosis of Cervical Ribs from a Radiograph," *London Hospital Gazette*, 1911, xviii., p. 92.) No reliance is to be placed upon this slope of the transverse processes even in the normal skeleton, and in cases in which abnormal rib development is present it is a most misleading feature. Many of the published skiagraphs which illustrate classical cases of cervical ribs are, judged by this criterion, cases of rudimentary first dorsal ribs. Such, in fact, they may be, and I believe it is extremely likely that with proper radiographic examination many cases of first rib pressure will be detected; but the slope of the transverse processes cannot determine which rib is rudimentary. (Further details are given in a paper on the "Radiographic Diagnosis of Rudimentary Ribs," *London Hospital Gazette*, 1912, xviii, p. 166.)

It is only by counting the number of vertebræ which lie cephalic to the disputed member that the real nature of a costal element may be determined with certainty. Such a method is now employed in some hospitals, and its universal adoption would add to the present sum of knowledge of rudimentary ribs.

Surgical Treatment.

By WILLIAM THORBURN, F.R.C.S.

MR. THORBURN said he did not propose to detain the meeting by going into the symptoms of cervical rib, because sometime ago he did that elsewhere,[1] and had nothing to add. He would say a few words about the surgical treatment of the condition, considering the indications for operation, the method of operation, and the results.

With regard to the indications for operation, he suggested that there were three great possible groups of cases in which the surgeon might be called upon to operate: (1) Those in which the rib might be removed on account of deformity; (2) those in which it might be done for the relief of vascular symptoms; (3) those in which the operation might be done for nerve symptoms. The first group could be set on one side, as it was waste of time to discuss it. With regard to those causing vascular symptoms, he had not been called upon to operate for these alone. He had only met with cases in which there were combined vascular and

[1] *Med.-Chir. Trans.*, 1905, lxxxviii, pp. 109-125, and "Dreschfeld Memorial Volume" (University of Manchester Publications, No. xxxv), 1908, pp. 85-111.