

VARIATIONS OF THE FIRST RIB, ASSOCIATED WITH CHANGES  
IN THE CONSTITUTION OF THE BRACHIAL PLEXUS.

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EARLY in 1910 I published in the *Anatomischer Anzeiger*<sup>1</sup> a brief note upon the causation of the so-called "sulcus subclaviæ" which is commonly seen upon the upper surface of the first rib. I drew attention to the fact that this groove was, in the cases which I had dissected with especial purpose, occupied by, and almost certainly caused by, the lowest cord of the brachial plexus.

Further dissections, and a consideration of the bearings of the question, confirmed me in my belief as to the correctness of this view; and later I published in this *Journal*<sup>2</sup> some additional facts, and a good deal of speculation, concerning the meaning and the influence of this nerve-pressure upon the ribs.

Since that time other circumstances have again directed my attention to this point. Firstly, Professor Aimé Mouchet published a paper<sup>3</sup> to demonstrate that, as far as his special dissections showed, the sulcus subclaviæ was occupied by the arteria subclavia, and that, at the utmost, the lower cord only occasionally impressed an additional marking (described by Poirier) upon the rib. He maintained that the orthodox description needed no revision.

Secondly, the clinical interest of the question attracted other workers, and my colleague, Mr Percy Sargent, has collected a mass of important details from cases of cervical ribs upon which he has operated.

Thirdly, more recently there has been the striking evidence provided by a well-recorded case of brachial neuritis caused by the pressure of the plexus on a normal first rib.

If the conclusions of Professor Mouchet are correct, and the old descriptions are valid, it is obvious that any speculations based on the assumption that the sulcus is a nerve groove must be worthless. It was therefore necessary to examine first ribs in relation to the nerve cords as

<sup>1</sup> *Anat. Anzeig.*, xxxvi. p. 25.

<sup>2</sup> *Journ. Anat. and Phys.*, vol. xlv. p. 377.

<sup>3</sup> *Anat. Anzeig.*, 9th June 1910, p. 591.

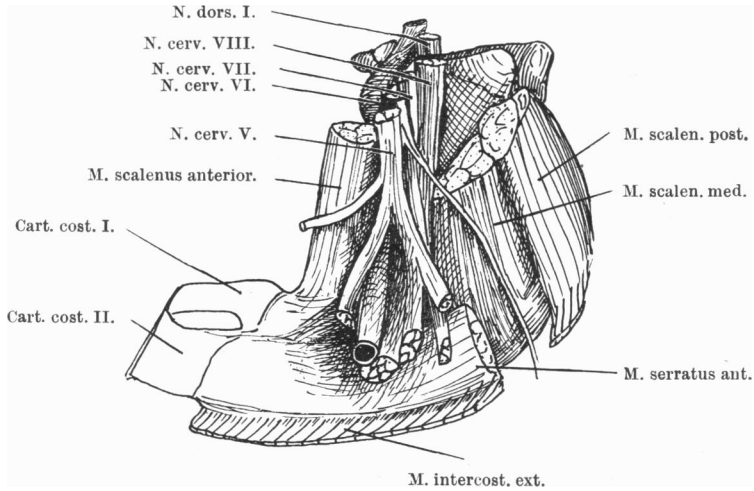
widely as possible; and the post-mortem room offered the best opportunities for this study. The method followed was to examine the dome of the thorax after the removal of the viscera, and to determine, from below, the amount of the first dorsal nerve passing under and over the rib. The upper surface of the rib was then cleared, and the position of the artery and nerves was noted, and finally the condition of the sulcus was examined. When possible, the rib and all the structures in relation to it were excised, and afterwards a dissection of the specimen was carried out and the relations of the soft tissues to the rib were noted. The ribs were then cleaned and preserved along with the notes relating to them. It became necessary to adopt some plan for making permanent records of the constitution of the lower cords of the brachial plexus in association with this collection of excised ribs, and the method employed was as follows:— Fine electrician's copper wire was taken, and the bulk of the various nerves was estimated in strands of this wire. The strands of the standard wire were then made into nerve cords, which were fixed by being dipped into melted solder. Forty first ribs of both sexes and all ages were excised, dissected, and afterwards reassociated with their reconstructed plexuses. The results derived from this study are doubtless capable of being elaborately tabulated, but it is perhaps more profitable to generalise and state that the greater the contribution of the first thoracic nerve to the plexus the deeper the sulcus upon the first rib. In the series reconstructed the degree of contribution varied from a minimum in which the first thoracic nerve gave three branches below the rib, and only a small branch over it, to the plexus, to a maximum in which the whole bulk of the first thoracic nerve joined the plexus by passing over the rib. The variations of the rib, consequent upon this, consisted of a differing degree of development of the sulcus. With a minimum contribution to the plexus the sulcus is entirely absent, and this condition is by no means rare; with a maximum contribution the sulcus is deep, and it lodges the cord behind and below the artery. An interesting condition was noted when the whole nerve passed over the rib, for not only was the sulcus deeper in such cases, but a curious downward bend was produced in the rib at this point. This bend is alluded to in my previous paper ("a typical form of first rib"), and this method of production was postulated for it; Dwight has also noted it in cases of cervical rib.

In examining the large series of bodies from which these forty selected ribs were taken, some anomalies more striking than the mere variation in depth of the "sulcus nervi brachialis" were met with. Some cases in which the groove was subdivided, as described by Poirier and Mouchet, were examined; and in these cases it was found (as Mr Sargent had

previously demonstrated to me) that the two parts of the double groove were occupied by the separate trunks of the eighth cervical and first thoracic nerves: the groove was not subdivided for the artery and the nerve trunk, but for the two constituents of the nerve trunk.

Two cases from the post-mortem room, and two from the dissecting-room, were dissected in which a well-developed scalenus minimus of Albinus was present. This little muscle lies behind the artery, separating the artery from the lowest cord of the plexus, and in all the examples met with it raised the artery some distance from the bone. In all cases the nerve lay in contact with the bone, and was necessarily responsible for the sulcus nervi brachialis developed. The musculus scalenus minimus of Albinus is not an infrequent muscle, and since its presence in most cases definitely excludes the arteria subclavia from contact with the rib, the dissection of cases in which it is found should be directed in order to ascertain what degree of grooving of the rib is present, and what structure is in contact with this groove.

Among the subjects examined for the purposes of this inquiry I have not been fortunate enough to meet with any case in which cervical ribs were developed, but I am able to record a case, which I imagine to be of some interest, in which the first thoracic ribs were rudimentary. The subject was a girl aged seven years, and the condition found upon dissection was as follows:—The first ribs were only partly developed, consisting of both bone and fibrous tissue, and having on each side a costal cartilage imperfectly separated from the costal cartilage of the second rib. The eighth ribs reached the side of the sternum in the manner of the normal seventh ribs. The twelfth ribs were long and well developed, but there was no rib attached to the first lumbar vertebra. Upon both sides the second thoracic nerve sent a contribution to the brachial plexus, a condition described in similar cases by Dukes and Owen, Hertslet and Keith, and by Lane (for these and other references see *Journ. of Anat. and Phys.*, vol. xlv. p. 393). The disposition of the parts is worth recording, and I have figured the two sides as seen from below and from above (see figs. 1, 2, 3, and 4). I do not propose to describe the specimens in detail, for their characters are sufficiently indicated in the figures, but some features are worth noting. In the first place, the general likeness of these ribs to cases of cervical ribs is very striking, and the specimen, when freed from its connections in the body, gives but little indication as to which rib in the series is rudimentary. It needs a careful study of the parts *in situ*, the consideration of the sternal attachments of the ribs, and a count of the vertebræ lying cephalic and caudal to the rib, to determine beyond all dispute if we are dealing with an example of the opposed conditions of a developed cervical rib or a rudimentary first rib.



Girl at. 7. Case of bilateral rudimentary first rib, with N. dorsalis II. joining brachial plexus.

FIG. 1.—Left side seen from above. The muscular origins remain *in situ*.

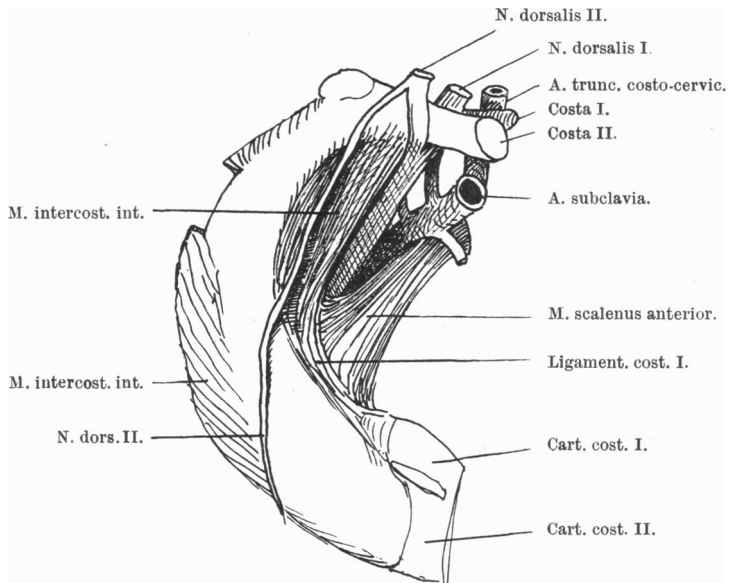


FIG. 2.—Left side seen from below.

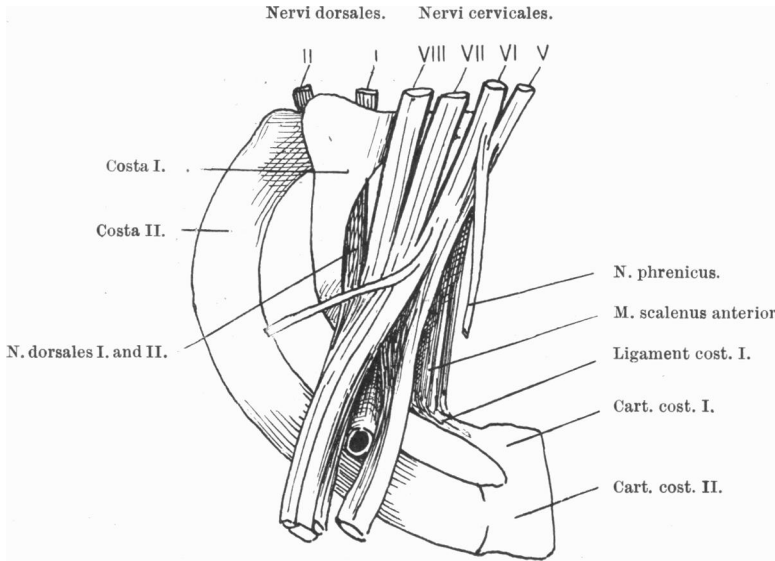


FIG. 3.—Right side seen from above. The muscles have been dissected away.

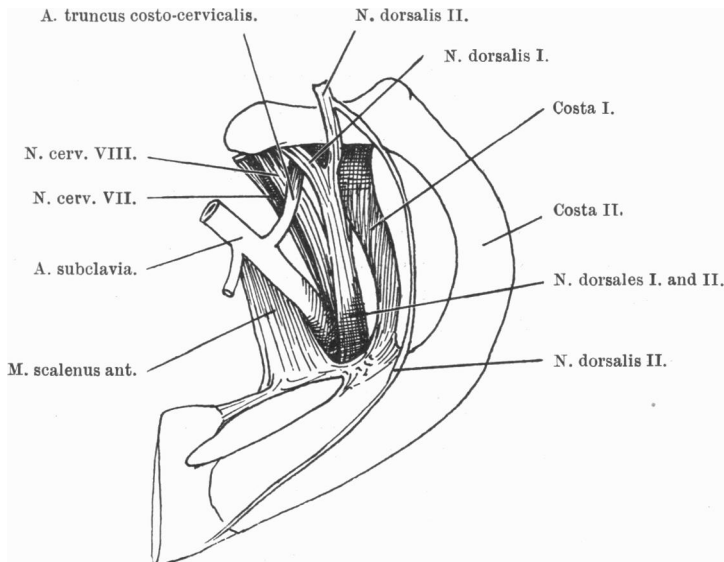


FIG. 4.—Right side seen from below.

It will be noticed that upon both sides the arteria subclavia lies above the rib, occupying its normal relation to the nerve trunks; and the specimens suggest that some of those cases described as cervical ribs, in which the artery is found lying above the rib, are in reality examples of rudimentary first rib. It has become accepted in surgical teaching that the arteria subclavia is elevated by cervical ribs, and diagnostic importance is attached to this relation. Certainly in all cases of true cervical ribs the artery is not so elevated, and it would seem to be the exception, in actual operation, to meet the artery above the cervical rib. It is therefore probable that a closer examination of many of those cases in which this condition was present would reveal the fact that seven vertebræ which bore no ribs lay anterior to the rib-bearing vertebra.

I have no history of any symptoms arising from the condition in the case figured, but the subject was below the age at which the symptoms usually appear, and it is not improbable that with advancing age the pressure of the nerve trunks would manifest itself as brachial neuritis. The late appearance of the neuritis in these cases is difficult to account for, but its explanation is probably to be sought in the shrinking of tissues which takes place in the years following the completion of growth.

One clinical sign is of great interest. It is commonly found that the patient is most troubled by the neuritis when the arms are dependent, and that temporary relief may be obtained by raising the arm from the side. It is probable that what certainly happens in the cadaver (as when the arms are placed in the conventional position for dissecting the axilla) takes place also in the living, and that the nerve may be elevated from the surface of the rib, its place being then partly taken by the artery.

That a wider interest than the pressure symptoms of a cervical rib attaches itself to this question of the relation of the nerve cords to the groove is shown by the case reported by Dr Thomas Murphy in the *Australian Medical Journal* of October 1910, of which an abstract appeared in the *Lancet* of 17th December 1910.

Briefly, in this case a woman of twenty-eight had for eight years shown varying, but usually severe, symptoms of brachial neuritis, and the condition present pointed to pressure upon the nerve trunks. The diagnosis of cervical rib seemed obvious, but a skiagram showed that no cervical rib was present. Since pressure upon the plexus at the root of the neck caused an increase of the pain, an operation in this site was wisely determined on. 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 had gone, and no return of symptoms resulted

even after severe exercise. The constitution of the plexus in this woman is not known, but it is not at all improbable that the lowest cord was made more than usually bulky by the inclusion of the whole of the first thoracic nerve, with perhaps a contribution from the second thoracic.

This clinical case is an interesting corollary to the findings of pure dissecting-room anatomy; and it is possible that it may be the forerunner of many others in which the surgeon may give relief to symptoms of brachial neuritis of obscure origin. When it becomes recognised that it is the primary disposition of the nerve trunks which causes the ribs to assume their permanent characters, not only will the common anomalies of the vertebral column be more easy of explanation, but the clinician will recognise that the factor which makes the groove upon the rib in normal cases may produce the symptoms of neuritis in cases which depart from the normal.