THE ROLE OF THE FIRST RIB IN THE SCALENUS ANTERIOR SYNDROME

A. F. WILLIAMS, OLDHAM, ENGLAND

From the Department of Anatomy, University of Manchester

The scalenus anterior muscle was first believed by Murphy (1905) to play a part in the production of symptoms by a cervical rib and since then its importance in a proportion of these cases has been recognised. Adson and Coffey (1927) claimed that division of the muscle, without resection of the cervical rib, was sufficient to relieve symptoms. Naftziger (quoted by Ochsner, Gage and De Bakey 1935) drew attention to the scalenus anterior as the possible cause of symptoms even in the absence of a cervical rib. This condition, in which the symptoms of a cervical rib occur in the absence of the rib itself, was called the scalenus anterior syndrome by Ochsner et al. (1935). Since then the suggestion that the muscle could cause pressure on the brachial plexus and subclavian artery has been widely, though not universally, accepted; but in recent years doubt has been increasing. The exact mechanism by which it could give rise to the symptoms has always been in dispute.

Patients with scalenus anterior syndrome—used as a general term to include all those with symptoms of pressure in the cervico-brachial region but no cervical rib—can be divided into two groups: 1) those with a scalenus minimus, a ligamentous band or similar abnormality; and 2) those in whom the anatomy appears normal. The second group present the chief etiological problem and provide the basis for the present study.

ANATOMY

The anatomy of the region has been investigated in eleven adults (twenty-two dissections) and three foetuses (six dissections), in order to determine any anatomical causes for the symptoms in these cases with apparently normal radiographic appearances. The most striking feature noted was the course taken by the first thoracic nerve, and to a lesser extent the lowest trunk of the brachial plexus. The first thoracic nerve runs in the first intercostal space, ascends in front of the neck of the first rib and passes over its upper border to join and form a considerable component of the lowest brachial trunk. In its course the nerve forms a well marked loop over the rib (Figs. 1 and 2). Published drawings usually show the nerve running out almost horizontally and do not indicate the loop which is in fact present. Because of this loop the nerve is peculiarly vulnerable for downward traction on the arm pulls the nerve and lower trunk more firmly against the first rib. This is the position in which patients with the scalenus anterior syndrome have most trouble, whereas raising the arm often eases the symptoms because at the same time the nerves are drawn away from the rib.

The second feature noted was that the neurovascular bundle emerges from behind the posterior border of the scalenus anterior and runs downwards and laterally from it (Fig. 3). When the arm is drawn downwards the nerves and arteries are pulled away from the muscle, which by itself appears most unlikely to cause any pressure on them. It is true that when an abnormality such as a cervical rib or ligamentous band is present the plexus may be compressed between the abnormal structure and the scalenus muscle, division of which might well relieve the pressure. But in the absence of any such posterior abnormality it is difficult to imagine the scalenus anterior causing any pressure on the bundle.

The possible role of scalenus medius in the causation of the syndrome has also been
studied. The scalenus medius varies considerably in size, texture and proximity to scalenus anterior. But in all cases its distal fibres lie almost parallel with the medial border of the first rib. The first thoracic nerve passes over the first rib at about the anterior margin of the insertion of scalenus medius. In four out of the twenty-two adult dissections the border of the muscle was raised two or three millimetres above the edge of the rib in a sharp tendinous edge. This increased the height that the first thoracic nerve had to rise in surmounting the first rib and could facilitate the syndrome under discussion. This sharp edge is also more likely to cause injury than the usual smooth surface of rib and muscle.

![Diagram](image1.png)

**Fig. 1**

**Figs. 1 and 2**

Drawing of a dissected specimen showing the structures crossing the first rib as seen from below (Fig. 1) and from the side (Fig. 2).

The interval between the attachments of the two scalene muscles to the first rib is variable. In nearly half the subjects it was found that their bony insertions were almost continuous, and the plexus, in passing over the rib, would be separated from it by the muscles (Telford and Mottershead 1948).

In the scalenus anterior of foetuses it was found that tendinous fibres were virtually absent as observed by the naked eye. In almost all the adults the lower part of the muscle contained a large proportion of tendon, and it seems probable that tendon replaces muscle as age advances.
DISCUSSION

In cases ascribed to the scalenus anterior there are two main theories to explain its action. On the one hand it is claimed that the muscle is in a state of spasm and so elevates the first rib with consequent stretching of the neurovascular bundle and production of symptoms. But there is no evidence that division of the muscle causes any change in the position of the rib (Swank and Simeone 1944, Telford and Mottershead 1948). This hypothesis is not convincing. On the other hand there is a wider belief that the scalenus anterior merely acts passively and causes pressure on the structures running behind it. The muscle is often reported as being hypertrophied or unduly tendinous, but as already mentioned there is a wide range in its size, extent of insertion and amount of tendinous tissue even in normal individuals (Gage and Parnell 1947, Telford and Mottershead 1948). Some writers, for example, Naffziger and Grant (1938), have stated that there is a natural tendency for the neurovascular bundle to slide ventrally when the scalenus anterior is divided, but this has been denied by others (Telford and Mottershead 1948). My surgical and anatomical observations are in agreement with this view.

Any explanation of the syndrome must be consistent with the following facts. 1) The syndrome is more frequent in women than men. 2) It arises most commonly between the ages of twenty and forty. 3) The right arm is the one generally affected.

If an anatomical abnormality of the scalenus anterior were responsible a more even sex distribution would be expected. Indeed, as the change in the muscle is generally described as hypertrophy or increase of fibrous tissue it is likely that it would occur more often in males than in females. It is therefore improbable that alterations in the muscle itself are of importance.

That symptoms begin so commonly between the ages of twenty and forty years suggests that some factor precipitates the onset during these decades. The usual explanation given is that the shoulder girdle has descended and reached its final position by this time. This seems to explain the syndrome best and is in accord with the anatomical findings. As the shoulder girdle descends the tension on the neurovascular bundle—particularly the first thoracic nerve, as it crosses the first rib—is increased and may be sufficient to cause symptoms in the hand and arm. As the descent of the shoulder girdle is greater in women, and their musculature is generally weaker, they are more liable to have trouble than are men. The right arm is naturally more often affected than the left because it is the one most used by most individuals. The symptoms may begin after an illness or confinement has led to muscular atony or after unaccustomed heavy work—circumstances which may lead to an increase in the tension on the brachial plexus and particularly the structures arching over the first rib.

It seems that a cervical rib, a ligamentous band and the first rib produce their symptoms in more or less the same way, namely by tension on the neurovascular bundle. The cervical rib provides the highest obstacle and so is most liable to produce clinical signs, while the
first rib is the lowest hurdle and so is least likely to cause trouble. If the height of the first rib is increased by the scalenus medius, symptoms may occur more readily.

It is conceivable that tension on the first thoracic nerve may be transmitted to some of the sympathetic rami associated with it and to the nerve of Kuntz, and may be partly responsible for some of the vascular changes which may occur.

TREATMENT

In earlier reports of this syndrome good results were generally claimed for division of the scalenus anterior. But further experience has shown that this operation is not so universally effective as at first believed (Tanna 1947, Telford and Mottershead 1948) and this lack of success has been the most compelling reason for a search for other etiological agents.

If traction on the first thoracic nerve and the lower part of the plexus over the first rib is the most important cause treatment should be directed first to easing this tension. This may often be done by changing to a lighter occupation or by improving the musculature of the shoulder girdle by exercises. If this is unsuccessful operation must be considered in case there is an abnormality such as a fibrous band which may be removed. If none is found the usual procedure is to divide the scalenus anterior, but as already stated the results are not entirely satisfactory. The scalenus medius, if raised above the border of the first rib, may be divided, but it is unlikely that its division alone can make a great deal of difference. The logical procedure seems to be resection of part of the first rib (Stopford and Telford 1919) to allow the neurovascular bundle to take a more direct course to the arm and reduce tension.

CONCLUSIONS

It is believed that in the scalenus anterior syndrome, when no anatomical abnormality is found, symptoms are due to tension on the neurovascular bundle, and in particular the first thoracic nerve, as they cross over the first rib. The operation that seems most likely to help is resection of the first rib, and it is suggested that "first rib syndrome" would be a more apt name for the condition.

SUMMARY

1. Dissections have been made of the cervico-brachial region.
2. The possible causes of the scalenus anterior syndrome are discussed and an attempt is made to relate them to the anatomical findings.
3. It is suggested that a more suitable description is the "first rib syndrome," and that the most logical treatment is to remove part of the offending first rib.

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REFERENCES


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