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CASE REPORT

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An accessory middle scalene muscle causing thoracic outlet syndrome

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The aim of our study is to present a very rare accessory middle scalene muscle, leading to thoracic outlet syndrome. In particular, a muscular bundle was discovered on a male cadaver connecting the middle portion of the middle scalene muscle with the anterior scalene muscle insertion to Lisfranc's tubercle. This triangular accessory muscle and, especially, its sharp medial border compressed the middle and lower trunk of the brachial plexus and the subclavian artery. This anomaly is of great importance because it emphasises the fact that it is not primarily the anterior scalene muscle that produces symptoms of thoracic outlet syndrome but the anterior displacement of the middle scalene muscle or its accessory muscular bands. We also present the relative international literature and the clinical significance of our finding.

Key words: accessory scalene muscle, thoracic outlet syndrome

INTRODUCTION

Thoracic outlet syndrome [10] is a well-known entity caused by compression or irritation of the brachial plexus, subclavian artery or subclavian vein at the point where these structures pass through the thoracic outlet [6, 17]. The most acceptable and prevailing concept of the cause of thoracic outlet syndrome without a bony abnormality is that certain people have an anatomical predisposition to it. Many structures have been identified as narrowing the thoracic outlet, such as the anterior scalene muscle, cervical ribs, clavicular deformity, anomalous blood vessels, congenital fibrous bands across the thoracic outlet, congenital aponeurotic fibres and the smallest scalene muscle [9, 13].

Thoracic outlet syndrome due to compromise of the brachial plexus is known as neurogenic thoracic outlet syndrome [2, 5]. Classic thoracic outlet syndrome presents with lower cervical nerve involvement (the C8 to T1 nerve roots of the lower trunk) with hypesthesia and paresthesia along the distribution of the ulnar nerve. Upper plexus thoracic outlet syndrome presenting with symptoms resulting from the involvement of the C5 to C7 nerve roots is relatively rare and can be mistaken for cervical disc disease [18, 19]. Although the original term "scalenus anticus syndrome" implied that the anterior scalene muscle was at fault, simple anterior scalenotomy was known to be associated with failure to effect a permanent cure in these patients; an immediate diminution of symptoms would occur, but these would recur in 50% of patients [11].

Since the middle scalene muscle contributes to this syndrome in an unprecedented fashion and warrants greater recognition, we present a rare case of an accessory muscle fasciculus compressing the middle and the lower brachial plexus and the subclavian artery.

CASE REPORT

In a male cadaver aged 76 years that had been used for educational and research purposes in the Department of Anatomy at the Medical School of

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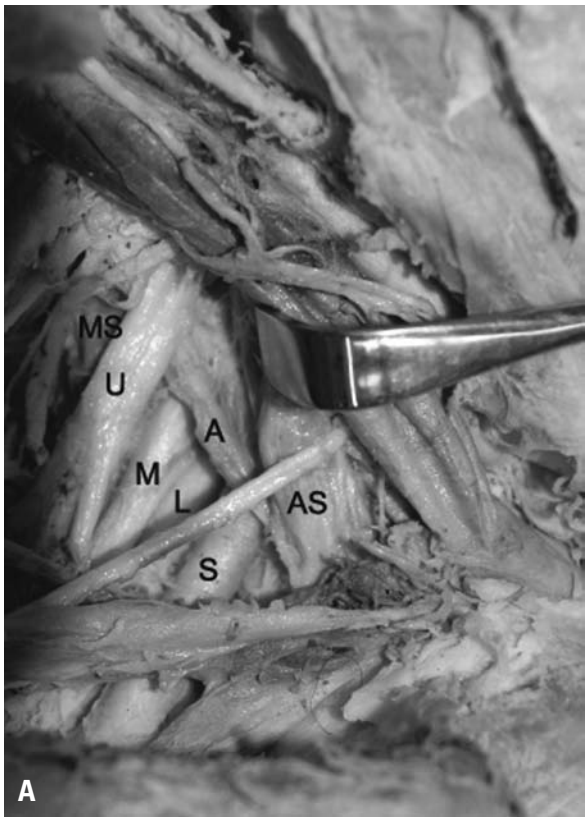
the Aristotle University of Thessaloniki we discovered, after careful preparation of the right posterior cervical triangle, an accessory muscular fasciculus connecting the anterior and middle scalene muscle. In particular, we found a triangular band arising from the middle third of the medial border of the middle scalene muscle and directed obliquely to the medial side in order to insert into Lisfranc's tubercle. Prior to its insertion the band fused with the anterior scalene muscle. We named this muscular band an "accessory middle scalene muscle" and estimated its length and width. Specifically, we found its length to be 38.34 mm and its width at the mid-point to be approximately 9.6 mm. We noticed that this muscular band and, especially, its sharp medial border, passed underneath the upper primary trunk of the brachial plexus and was directed anteriorly to the middle and lower primary trunk and the subclavian artery, anatomical structures which could be entrapped under certain circumstances by the accessory middle scalene muscle (Fig. 1).

DISCUSSION

Thoracic outlet syndrome is a well-known entity, which includes a variety of neurovascular symptoms in the upper limbs. Despite the fact that the syndrome was first recognised by Hunald in 1743, it was only in 1956 [10] and in 1958 that it was considered a unified entity under the term "thoracic outlet syndrome". The symptoms of this syndrome, which influences the neck, the shoulder and the upper limb, are caused by pressure or irritation of the brachial plexus, the subclavian artery and the subclavian vein, as these structures pass through the thoracic outlet and the costoclavicular space.

The interscalene triangle is defined anteriorly by the anterior scalene muscle, posteriorly by the middle scalene muscle and at its floor by the first rib. The scalenus anterior is situated deep (posteromedially) to the sternocleidomastoid. From the third to the sixth cervical anterior tubercles musculotendinous fascicles converge, blend and then descend almost vertically to a flat narrow tendon attached to the scalene tubercle on the inner border of the first rib and a ridge anterior to the subclavian arterial groove. The scalenus medius, the largest and longest of the scaleni, runs from the transverse process of the axis (and sometimes the atlas) and lower five cervical posterior tubercles to the upper surface of the first rib between its tubercle and the groove for the subclavian artery.



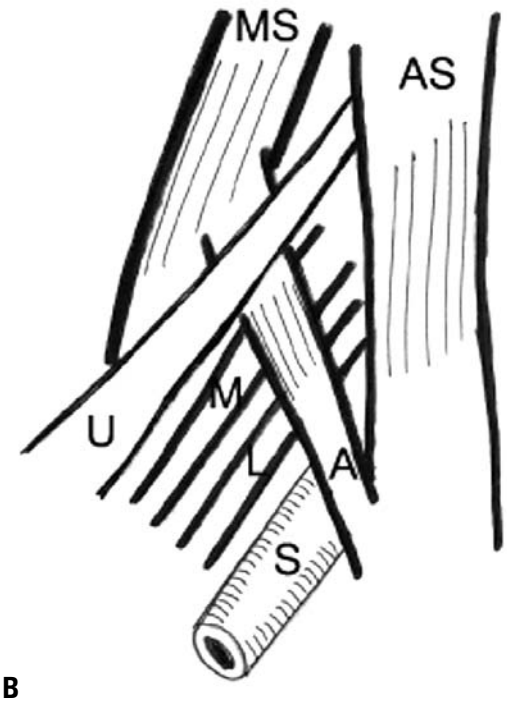


Figure 1. A. The accessory middle scalene muscle (A) appears to connect the anterior scalene muscle (AS) insertion and the middle scalene muscle (MS). The compressed middle (M) and lower trunk (L) of the brachial plexus and the subclavian artery (S) within the interscalene triangle (U — upper trunk of brachial plexus) may be distinguished. **B.** Schematic representation of the Figure A.

The brachial plexus and the subclavian artery emerge from the interscalene triangle. The seventh cervical nerve is found at a lower anterior site. The lower primary trunk, which is formed from the anastomosis of the fibres of the A8 and C1 nerves, passes through the interscalene triangle and is positioned adjacent and posterior to the subclavian artery. It is therefore likely that both the subclavian artery and the nervous trunk at this point may be compressed from a narrowing of the base of the interscalene triangle. This narrowing may be caused by calcification of the adhesions of the scalene muscles or by osseous abnormalities of the first rib. However, certain movements of the scalene muscles may cause pressure of the nervous trunk. The nervous trunk may be entrapped on the hard verge of the first rib, when the rib is pushed with force downwards during a severe convulsion of the middle scalene muscle.

In certain cases the lower nervous trunk is also pulled violently upon the middle portion of the first rib, when the arm is abducted above 90°, causing aesthetic abnormalities and kinetic weakness in the course of the A8 and C1 spinal nerves.

Everything that causes elevation of the superior part of the thoracic cage, such as the partially or completely shaped supernumerary rib or fibrous bands that connect to the scalene muscle, can cause pressure on the lower nervous trunk from below.

The base of the interscalene triangle averages 1.1 cm in width, with a minimum of 0.1 mm to a maximum of 2.2 cm, as measured by Daseler and Anson [1] in 100 autopsy studies. Kirgis and Reed [12] found the triangle width to be even smaller at operation in 43 men (7.7 to 7.8 mm in men; 6.5 to 6.8 mm in women). Thus the neurovascular structures have little room; any occupation of space by anomalous structures would set the stage for symptoms of entrapment. Furthermore, Daseler and Anson [1] found the contents of the triangle to be of interest in 60% of their extremities. The lower trunk of the plexus, consisting of the combined eighth cervical and the first thoracic roots, was situated at the base of the interscalene triangle posterior to the subclavian artery. Thus not only is there a narrow outlet but there is also a large nervous trunk occupying a vulnerable position for potential entrapment.

Considerable attention has been given to the anteriorly positioned anterior scalene muscle, which has obviously been very accessible to surgeons over the years. Kirgis and Reed [3] first raised objections to the anterior scalene concept, presenting evidence in 1947 that the anatomical relation and state of contraction of the middle scalene muscle may be the major factor in the production of the syndrome. Telford and Mottershead [14, 15] emphasised the distinction between the two scalene muscles. In examining 105 cases of thoracic outlet syndrome, 35 of which were without bony abnormalities, 8 patients (23%) showed a forward or anterior insertion of the middle scalene muscle, resulting in the lower trunk of the plexus and artery being in direct contact with the muscle's sharp edge.

Further evidence of the importance of the middle scalene muscle was published by Kirgis and Reed [4] in 1948 and was based on 56 cadaver dissections. In practically all the dissections the lower trunk of the brachial plexus was found to rest on the inferior portion of the anterior lateral margin of the middle scalene muscle, regardless of the relation between the attachments to the first rib of the two scalene muscles. Kirgis and Reed [4] concluded that it was impossible for the main body of the anterior scalene muscle, which arises from the anterior surfaces of the cervical transverse processes to compress directly the components of the brachial plexus.

Thomas et al. [16] found the middle scalene muscle inserted anterior and posterior to the anterior scalene muscle in 14 arms in 13 patients. It was a very broad insertion that rode along the entire inner and middle borders of the first rib. Its medial border was either the muscle or a firm fibrous raphe that was contiguous with and not separate from the middle scalene muscle; it was in close approximation to the lower trunks of the brachial plexus. Similar to this sharp anterior medial edge of the middle scalene muscle was the so-called middle scalene band. This originates from the seventh cervical vertebra behind the middle scalene muscle and passes very close to the anterior border, seeking attachment to the scalene tubercle. In several patients Thomas et al. [16] found it difficult to either place this band in an isolated category or include it in the group representing the anterior insertion of the middle scalene muscle, since the muscle's sharp edge could suggest a tight band. If combined, 58% of the arms (17 out of 29) showed a significant contribution of the middle scalene muscle and its anterior edge to the crowding of the interscalene triangle, thus producing thoracic outlet syndrome. The authors found the smallest scalene muscle in one patient and solitary "outlet bands" in 6 (21%) [16].

It is of historic interest that in 1910 Murphy [7] described a patient with an entrapment syndrome

in the absence of any bony anomaly in whom the plexus was intimately associated with the inferior portion of the anterior lateral border of the middle scalene muscle. Our case supports the previously mentioned theory of middle scalene muscle nerve compression, since the accessory muscular bundle of the middle scalene muscle was inserted into the area of Lisfranc's tubercle just posterior to the anterior scalene muscle insertion.

According to Roos [12], there are five types of scalene muscle anomaly affecting the upper plexus: type 1 is a direct attachment of the anterior scalene muscle on the perineurium of the major nerves, type 2 is a pencil-sized muscle bundle connecting the anterior and median scalene muscles, type 3 is an abnormal development of the upper part of the anterior scalene muscle posterior to the C5 and C6 nerves and displacing the upper two nerves anteriorly, type 4 is a single mass of scalene muscle with the individual nerves penetrating the muscle body, and type 5 consists of strong fibrous bands or ligaments crossing the cervical nerves vertically behind the anterior scalene muscle. The case described by us of an accessory middle scalene muscle is of value because of its rarity and its clinical significance. Very few cases of such an accessory middle scalene muscle have so far been described in the international literature. The triangular and not the pencil-sized muscle could be included in the Type 2 scalene muscle anomaly, according to Roos. Natsis et al. [8] reported the presence of a similar case in a study of 93 cadavers, using the term "double scalene muscle".

Persistent contraction of these muscular anomalies on the cervical nerves of the plexus causes nerve compression, leading to pain and muscle weakness. The muscular band described by us also compresses the subclavian artery leading to vascular thoracic outlet syndrome. Complete resection of these scalene muscle anomalies is essential to relieve the upper plexus symptoms [12].

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