



Thoracic outlet syndrome: a hard problem in diagnosis and management

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Thoracic outlet syndrome presents a diagnostic and management challenge to general practitioners, physicians and surgeons alike. It is classified into three general categories depending on the specific structure believed to be impinged at the thoracic outlet (vein, artery or nerve), all of which involve pain in the upper extremity. The principles of management generally involve a stepwise escalation from conservative measures such as physiotherapy, activity and posture modulations in addition to analgesic medications before surgical decompression of the thoracic outlet is considered. Vos *et al.* (1) in their review article have described the different approaches in the most commonly used form of surgical decompression of the thoracic outlet 1st rib resection.

As Vos *et al.* (1) have identified, part of the challenge in the management of TOS is the lack of recognised diagnostic criteria (2). Clinicians must use a combination of accurate history taking, clinical examination and the use of other diagnostic tools where appropriate. Each subtype of TOS, venous, arterial and neurogenic, presents differently.

Venous TOS may be suspected clinically by the development of upper limb DVT, with a tender swelling of the upper extremity developing after occlusion of the subclavian vein. This can be diagnosed reliably with duplex ultrasound scanning. Venous TOS only represents 5% of cases of thoracic outlet syndrome (3).

Similarly arterial TOS may be suspected clinically by the development of Raynaud's phenomenon—classically described as a progressive skin colour change from white, to blue, to red in a painful limb as arterial occlusion gives way ischaemia, cyanosis and reactive hyperaemia in turn. Additionally embolisation, occlusion and aneurysmal change

may occur in the context of subclavian artery occlusion.

By far the most common category of TOS, but unfortunately also by far the greatest challenge diagnostically, is that of neurogenic TOS whereby compression of the brachial plexus is theorised to cause upper extremity pain. This form represents 90–95% of cases of TOS (3). In fact the diagnosis of NTOS is so controversial that many further split this category up into two distinct categories—true NTOS where neurophysiological deficits with nerve conduction studies and electromyography are identified, and disputed NTOS, by far the more common, where no such studies can identify a deficit, yet the patient still reports pain of the upper extremity. Classically neurophysiological deficits were not thought to be present until permanent neuronal damage had occurred, but there is now a suggestion that T1 and C8 derived fibres might show conduction deficits which can be demonstrated when testing the medial antebrachial cutaneous nerve and medial motor nerve supplying the abductor pollicis brevis (4). Pain in nTOS is usually described as affecting the neck and shoulder and radiating into the arm. It is typically accompanied by paraesthesias and in more progressed cases by muscle weakness. Unfortunately there are no accepted clinical diagnostic criteria in NTOS and as such the responsibility lies with the individual clinician's judgement.

A number of provocative tests are available to the clinician, despite their variable reliability. Wright's test involves abduction and external rotation of the shoulder with the neck laterally flexed away from the testing side, leading to a loss of pulse and reproduction of symptoms as the thoracic outlet is compressed. Adson's test involves extension of the arm with the neck extended and turned

towards the affected side, which again may lead to a loss of radial pulse and reproduction of symptoms. Roos' test can also be employed by asking the patient to repeatedly open and close their hand whilst holding it above their head, awaiting reproduction of symptoms. Unfortunately provocative testing in TOS has a high incidence of false positives. In one study 58% of random volunteers had at least one positive provocative test (5). Others have shown the specificity for Adson and Roos test to be 76% and 30% respectively. However, specificity increases to 82% when both tests are used together (6), highlighting the need for multisource information when coming to a diagnosis of TOS.

The difficulty in diagnosis is also complicated by the uncertain role of imaging for diagnosis in TOS. Whilst in venous TOS venography is standard practice in demonstrating subclavian vein compression, generally imaging is only useful identifying anatomical abnormalities that could represent a source of compression, with plain radiographs or CT, or to identify arterial complications such as embolisation or aneurysms using angiography. As we can see, neither symptomatology, clinical examination or imaging tests are useful alone, but together a picture of TOS can be painted.

Non-invasive interventions such as botulinum toxin injections into the anterior and middle scalene muscles have also been reported, but with mixed success. Indeed a randomised control trial comparing botulinum toxin injection with placebo saline injections yielded no significant difference in pain or disability ratings at 6-month follow up (7). Unfortunately this study did not stratify patients by type of thoracic outlet syndrome. Indeed there is increasing evidence that patients reporting symptoms of neurogenic thoracic outlet syndrome may have brachial plexus branching variants where the nerves may become more susceptible to impingement within the scalene muscle body. Furthermore these variants might be determined using ultrasound (8). This might re-open the door to botulinum toxin injections in select patients with said branching variants. However, until these treatments can be verified, surgery remains the mainstay of treatment once conservative measures such as physiotherapy and activity and posture modulations have been tried and failed.

The surgical management of thoracic outlet syndrome comprises usually involves decompression of the thoracic outlet via either resection of the 1st rib or a congenital cervical rib if present. In vascular TOS, reconstructive vascular surgery may also be required as an adjunct. Rib resection has been demonstrated to be superior to other

operations such as supraclavicular neuroplasty of the brachial plexus (9).

As Vos *et al.* (1) have described concisely, there are three well recognised approaches: transaxillary, supraclavicular and infraclavicular. All approaches have serious potential complications. Damage to the long thoracic nerve may cause winging of the scapulae resulting from denervation of the serratus anterior. Thoracodorsal nerve damage can cause denervation of the latissimus dorsi. Phrenic nerve damage when dividing the anterior scalene may cause ipsilateral diaphragmatic paralysis. Intercostobrachial nerve damage may lead to reduced sensation in the axilla and dorsomedial upper arm. Haemothorax and pneumothorax have been documented, and postoperative pain may be severe.

The different approaches have their own benefits. The transaxillary approach is generally considered safe, provides good cosmetic results, and avoids the need for retraction of neurovascular tissues. However, the workspace is deep and narrow making it a technical challenge. The supraclavicular approach provides good exposure of the subclavian artery, thus making it a good option for ATOS. The upper brachial plexus is also visualised well with this approach. However, it incurs an additional risk of damage to the supraclavicular nerve, where damage may cause numbness to the skin overlying the clavicle, anteromedial shoulder and proximal thorax. The infraclavicular approach may be preferential in VTOS due to good exposure of the subclavian vein.

All in all success in TOS after rib resection is high, with 90% in vascular TOS, but only 60–80% in NTOS (3). This difference perhaps exemplifies the difficulty in not only diagnosing NTOS, but identifying those that would likely benefit from surgical decompression. Perhaps with further development of diagnostic investigations, such as ultrasound, identification of specific branching variants might stratify patients into groups where certain branching variants might require different management. Further research in this area is required. Thoracic outlet syndrome remains an exciting field for the diagnosing clinician whether a surgeon, physician or general practitioner.

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Footnote

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