Thoracic Outlet Syndrome

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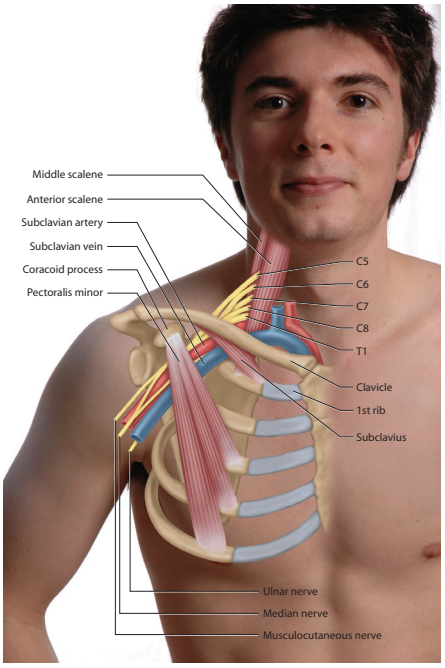
THORACIC OUTLET SYNDROME

The upper thoracic region is where neurovascular structures exit into or 'outlet' into the upper extremity. These structures are the brachial nerve plexus, the subclavian artery and the subclavian vein. Thoracic outlet syndrome (TOS) is the name given to the group of pathologic conditions in which compression of these neurovascular structures occurs (Figure 1).



▲ **Figure 1:** The three entrapment sites of thoracic outlet syndrome (TOS) are between the anterior and middle scalenes, between the first rib and clavicle, and between the pectoralis minor and rib cage.

There are three major types of TOS, named after the region where the compression occurs:

1. anterior scalene syndrome, which occurs between the anterior and middle scalenes
2. costoclavicular syndrome, which occurs between the first rib and the clavicle
3. pectoralis minor syndrome, which occurs between pectoralis minor and the rib cage.

These conditions are grouped together as TOS because they are all neurovascular compression conditions that can cause the same signs and symptoms into the upper extremity. Further, the same pathologic mechanisms often underlie more than one type of TOS so it is common for a client to present with two or all three forms of TOS.

Anterior scalene syndrome

The brachial nerve plexus and the subclavian artery run between the anterior and middle scalenes. If the scalenes become tight, compression of these structures can occur. Scalenes are commonly tight due to whiplash injuries in which the head and neck are forcefully thrown posteriorly or contralaterally, straining or overstretching them, and triggering a muscle spindle reflex that causes them to spasm. Scalenes can also tighten due to adaptive shortening in response to chronic postural influences, such as typically occurs with a hypolordotic neck. Additionally, they can tighten due to their overuse as assistant muscles of inspiration, presenting in clients who have laboured breathing from chronic respiratory diseases such as asthma, emphysema or chronic bronchitis.

Costoclavicular syndrome

The brachial nerve plexus, subclavian artery and subclavian vein run within the costoclavicular space between the first rib and the clavicle. If this space decreases, these neurovascular structures can become impinged. The costoclavicular space will narrow if the clavicle and first rib approximate each other. This can occur in three ways:

1. The clavicle depresses toward/against the first rib. This can be observed in the common postural condition of rounding and slumping of the shoulders. A tight subclavius can also cause this to occur.
2. The first rib elevates toward/against the clavicle. This often occurs in clients who have laboured breathing. Tight anterior and middle scalenes and subclavius can also cause this to occur.
3. The clavicle depresses and the first rib elevates.

Pectoralis minor syndrome

The brachial nerve plexus, subclavian artery and subclavian vein run between the pectoralis minor and the rib cage. If the pectoralis minor becomes tight, these structures can be impinged. Pectoralis minor syndrome is the most common form of TOS because the pectoralis minor is so often tight. The common postural distortion pattern of rounded shoulders (protracted scapula/clavicle) causes shortening of the pectoralis minor. Then, due to adaptive shortening, the pectoralis minor increases its tone to tighten at this shortened length. However, tightening of the pectoralis minor due to it being overstretched is also fairly common. This occurs if the arm is abducted and then suddenly and forcefully stretched posteriorly behind the body. Also, like the scalenes, the pectoralis minor is often recruited as an accessory muscle of inspiration and may tighten in clients with laboured breathing.

Cervical rib TOS

There is a fourth type of TOS that is often referred to as "true TOS". This condition is caused by the presence of a small, genetically anomalous cervical rib that is attached by fibrous tissue to the transverse process of the seventh cervical vertebra.

The presence of this rib can cause compression of the brachial nerve plexus and/or the subclavian artery.

SIGNS AND SYMPTOMS

If we understand that the pathomechanics of TOS is compression of neurovascular structures, the signs and symptoms can be extrapolated. Compression of the sensory portion of a nerve can cause tingling, numbness, decreased sensation (hypoesthesia), increased sensation (hyperesthesia) or pain. Compression of the motor portion of a nerve can cause weakness or twitching of the associated musculature.

The brachial plexus is composed of five major nerves: the median, radial, ulnar, musculocutaneous, and axillary nerves. Figure 2 shows their sensory innervation distribution in the hand.

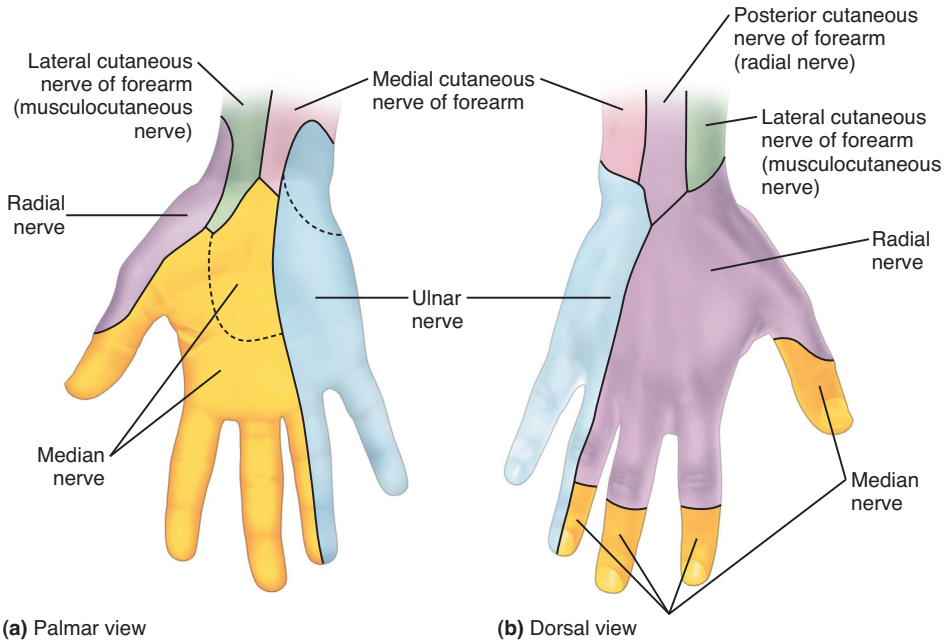
Because all three forms of TOS can cause compression of the brachial nerve plexus, all of the aforementioned sensory and motor signs and symptoms can occur. These signs and symptoms could occur anywhere within the upper extremity because the brachial plexus innervates the entire upper extremity (the word brachial refers to the arm).

If the subclavian artery is compressed, the strength of the pulse in the upper extremity will decrease (but the speed of the pulse will not be affected). Most commonly, the radial pulse on the radial side of the distal forearm is the pulse that is assessed to determine whether there is compression. If the subclavian vein is compressed, venous drainage would be compromised, causing swelling in the upper extremity.

Signs and symptoms of neurologic compression with TOS are more common than signs and symptoms of subclavian artery or vein compression. Specifically, tingling and numbness in the hand are the most commonly found symptoms of TOS. However, understanding the mechanics of subclavian artery compression is important when assessing TOS.

ASSESSMENT

Knowing how to assess TOS is also an extension of our understanding of the underlying pathomechanics of the condition. Even though the effects of neural compression are the most common presenting complaints of TOS, it is the effect of arterial compression that is primarily used to assess this condition.



▲ **Figure 2:** Sensory innervation distribution of the hand.

A different assessment test is used for each of the three forms of TOS. Common to all of them is that the client is moved into a position that increases the neurovascular entrapment of that condition while the strength of the radial pulse is assessed. If the strength of the radial pulse diminishes (showing that the subclavian artery is compressed), then it can be reasoned that any neurologic signs and symptoms that the client is experiencing are coming from the same entrapment site. In this manner, the specific form of TOS can be assessed.

Adson's test (for anterior scalene syndrome)

The assessment test used for anterior scalene syndrome is called Adson's test. It is performed by feeling for the strength of the radial pulse while asking the client to rotate the head and neck to the same (ipsilateral) side, and then extend and laterally flex the head and neck to the opposite (contralateral) side (Figure 3). This position maximally stretches and pulls taut the anterior and middle scalenes on the side being assessed[1]. This may entrap the neurovascular structures as they pass between the two muscles.

The test is positive if the strength of the radial pulse diminishes. It is also positive if the client experiences an increase of neurologic symptoms into the upper extremity on that side.

▲ **Figure 3:** Adson's test for anterior scalene syndrome.

[1] Adson's test stretches/elongates the anterior and middle scalenes because the client is asked to perform the actions that are opposite to the actions of these muscles. The anterior and middle scalene flex and do same-side (ipsilateral) lateral flexion; the anterior scalene also does opposite-side (contralateral) rotation.

Adson's test will also likely show as positive if the client has TOS caused by a cervical rib.

Eden's test (for costoclavicular syndrome)

The assessment test used for costoclavicular syndrome is called Eden's test. It is performed by feeling for the strength of the radial pulse while asking the client to stick the chest out and pull the shoulder girdles back, as if standing in a military position of attention (not surprisingly, Eden's test is also known as the military brace test) (Figure 4).

▲ **Figure 4:** Eden's test for costoclavicular syndrome.

This position maximally approximates the clavicle and first rib, decreasing the costoclavicular space and possibly entrapping the neurovascular structures as they pass through this space.

Eden's test is positive if the strength of the radial pulse diminishes. It is also positive if the client experiences an increase of neurologic symptoms into the upper extremity on that side.

Wright's test (for pectoralis minor syndrome)

The assessment test used for pectoralis minor syndrome is called Wright's test. It is performed by feeling for the strength of the radial pulse while asking

Wright's test is positive if the strength of the radial pulse diminishes. It is also positive if the client experiences an increase of neurologic symptoms into the upper extremity on that side.

▲ **Figure 5:** Wright's test for pectoralis minor syndrome.

There is also an alternative version of Wright's test. It is performed by asking the client to abduct the arm at the glenohumeral joint and flex the forearm at the elbow joint. The forearm can be rested on the head (Figure 6). This tethers the neurovascular structures around the pectoralis minor. If the pectoralis minor is tight, compression will likely occur. The same criteria are used to determine a positive result.

Addendum to Adson's, Eden's and Wright's tests

To intensify the tests described above, ask the client to take in and hold a deep breath. This will increase the possible compression in each condition, specifically:

- it causes the anterior and middle scalenes to contract in an effort to lift their respective attachment sites

▲ **Figure 6:** Alternative position for Wright's test for pectoralis minor syndrome.

- it causes the pectoralis minor to contract in an effort to lift its rib cage attachment, thereby intensifying Wright's test for pectoralis minor syndrome.

The advantage of adding this component is that it makes each test more sensitive, allowing a milder case of TOS to be detected. However, the disadvantage is that taking in and holding a breath can cloud the discernment of exactly which form of TOS is present (or which forms are present) because any one form of TOS can now possibly show positive to all three tests.

Brachial plexus tension test

If any of the three forms of TOS are found to be present, it is possible to determine which brachial plexus nerve is being impinged. This can be accomplished in two ways.

One approach is to note what region of the client's upper extremity