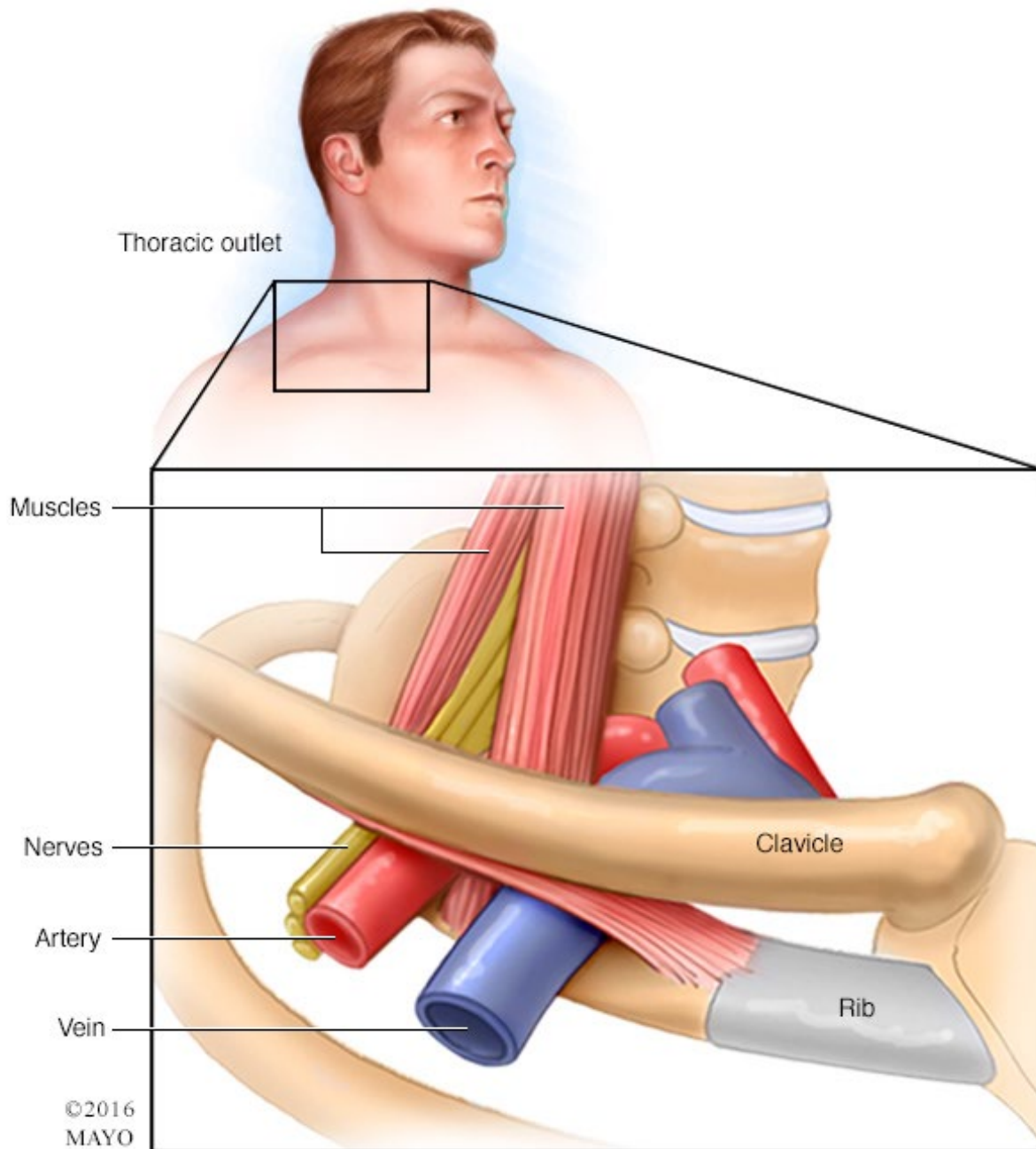


Thoracic Outlet Decompression for Neuro-arterial TOS



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Thoracic Outlet Syndrome

Thoracic Outlet Syndrome is in fact a group of several syndromes with different symptom constellations. There are two broad groups – Venous and Neuro-arterial.

The major nerves to the arm are collected in a bundle called the Brachial Plexus. The major vessels to and from the arm are the Subclavian artery and vein. The Thoracic Outlet is the junction between the chest cavity, and the arm. The Brachial plexus and the Subclavian vessels enter/exit the arm from the neck and chest through the Thoracic Outlet.

The Thoracic Outlet is a small triangular space through which the Subclavian artery and Brachial plexus pass to the arm. The boundaries of the Thoracic Outlet are formed by bones and muscles – the 1st rib, the clavicle (collar bone), and the anterior and middle scalene muscles. See Figure 1.

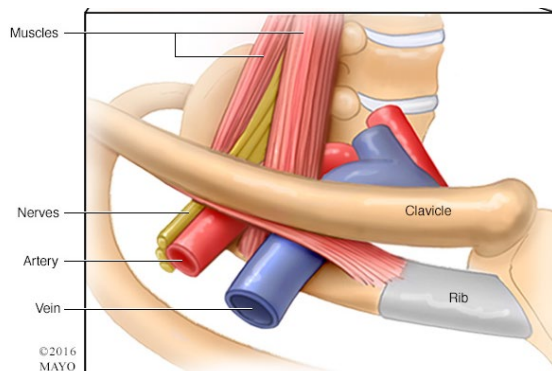


Figure 1. The Thoracic Outlet and the major neurovascular structures of the upper limb.

It is a narrow space, and some people have a narrower, tighter space. Movements of the arm further narrow it, with the potential to compress the vascular and neural structures. Some congenital and acquired factors can make the space tighter.

Some people have an extra rib called the cervical rib which runs in of the scalene muscles and can exacerbate the compression. Other rib and muscle anomalies also can exist. See Figure 2.

Symptoms and Complications

- **Asymptomatic** - most people do not suffer any symptoms even when the structures are intermittently compressed.
- **Arterial Compression** - many people compress their subclavian artery when they elevate their arm. This often has no symptoms or effect. If it is severe and

frequent enough, it can have symptoms and complications.

- **Arterial Emboli** - with more severe arterial compression, clot can form in the subclavian artery and then travel downstream and block the arteries in the arm. This can cause potentially limb threatening ischaemia.
- **Arterial Aneurysm** - repeated compression can weaken the wall of the subclavian artery and cause it to dilate. This increases the likelihood of clot formation.
- **Pain** - compression of the Brachial plexus can cause pain in the region of the shoulder, arm and hand in some positions
- **Parasthesia/Numbness** - compression of the Brachial plexus can cause altered sensation in the upper limb, particularly in the hand.
- **Weakness** - In more severe cases, Brachial plexus compression can cause weakness.
- **Muscle Wasting** - In rare cases, the compression on the Brachial Plexus can cause irreversible wasting of the small muscles of the hand in a condition called Gilliatt-Sumner Hand.



Figure 2. An Xray demonstrating a left Cervical rib.

Investigations

The diagnosis of thoracic outlet syndrome is often one of exclusion. This means that other causes of the symptoms need to be excluded. These include peripheral nerve, orthopaedic and cervical spine conditions. Multiple investigations are usually required and include:

- **Duplex ultrasound scan** of the subclavian and upper limb vessels – in various positions.
- **MRI** of the cervical spine and the major nerve roots. MRI images of the shoulder may also be requested.
- **CT Angiography** of the chest and arm arteries.
- **Nerve conduction studies and EMG**
- **Chest XRAY**



Treatment Options

- **No treatment.** If there are no symptoms and no evidence of complications then there is no indication for treatment.
- **Conservative management.** The mainstay of conservative management for neurogenic thoracic outlet syndrome is physiotherapy. The aim is to improve posture which can increase the dimensions of the thoracic outlet and reduce the compression.
- **Scalenotomy.** The thoracic outlet is roughly triangular. Two of the sides are muscular, and the 1st rib forms the base. Division of one or both of the scalene muscles helps for reduce compression.
- **Rib resection.** Removal of part of the 1st rib (and Cervical rib if present) is often combined with scalenotomy to maximize the decompression in the thoracic outlet.
- **Arterial Repair.** If there has been damage to the subclavian artery or emboli to the arteries of the arm, an embolectomy or arterial repair/replacement may be required.
- **Neurolysis.** Any scar tissue or muscle fibers constricting the brachial plexus is resected to help relieve compression.

Scalenotomy and rib resection.

The surgery aims to remove multiple sides from the thoracic outlet to relieve compression on the neuro-arterial structures.

Under general anaesthetic, a transverse incision is made above the collar bone. This is approximately 7 - 10cm long. Part of the sternocleidomastoid muscle is divided superficially. The anterior scalene muscle is identified, and the overlying phrenic nerve is protected. The anterior scalene muscle is divided close to the rib. The Brachial plexus and the Subclavian artery are identified and protected. The first rib is identified and separated from the surrounding muscles and the underlying plura and lung. The rib is then divided and its mid-portion excised. Depending on the structures being decompressed and the anatomy, the middle scalene muscle is often divided also.

Embolectomy

If recent clot needs to be removed from the arteries of the upper limb, it can be extracted using a catheter and balloon through a small opening in the artery near the shoulder. This is called embolectomy.

Arterial repair.

If the subclavian artery has been damaged by repeated compressive trauma, it may

require repair. This may be achieved using a patch or interposition graft.

Post-operative period.

Post-operatively, there will be some pain in the operative area, and it will be sore to move initially. Appropriate analgesia will be administered for this.

It is important to continue to move the shoulder in the post-operative period to prevent 'frozen shoulder' and you will be instructed how best to achieve this. Over the next weeks, your upper limb mobility will improve.

Expectations

Patients with neurogenic thoracic outlet syndrome without arterial complications or muscle wasting will usually be advised to undertake focused physiotherapy for at least 6 months. If this relieves the symptoms, then no further intervention is necessary.

If physiotherapy does not relieve the symptoms, surgical decompression with a scalenotomy and rib excision may be offered. Reported success rates for decompression are variable, but symptom improvement occurs in 70% + of cases.¹

Side effects and Complications

Unfortunately, no treatment is without risk. While not exhaustive, the more common and important risks are outlined below.

General risks include-

- **Anaesthetic risks** including pneumonia and lung issues, cardiac issues, allergy.
- **Death** – Very rare.
- **Deep Venous Thrombosis** – a clot in the deep veins of the leg.
- **Pulmonary Embolus** – a clot traveling to the lung, which can occasionally be life threatening.

The specific risks include:-

- **Scar.**
- **Wound infection.** This will usually be treated with antibiotics and may require drainage.
- **Lymphatic collection.** Watery fluid called lymph drains from the arm through multiple tiny channels. These may continue to leak and create a collection under the wound which may require drainage.
- **Failure to relieve symptoms.** Unfortunately, decompression may not relieve the symptoms.



- **Arm Vein Thrombosis** – a clot in the veins of the arm.
- **Phrenic Nerve Injury (~10%)¹**. The phrenic nerve is a relatively slender nerve, and prone to injury even when handled with care. This causes diaphragmatic paresis and impaired breathing. It may be temporary or permanent.
- **Long Thoracic Nerve Injury (~4%)¹**. This causes abnormal movement of the shoulder blade.
- **Brachial Plexus Injury (~0.6%)**. Areas of sensory disturbance are not uncommon, and often resolve with time. Injuries to major parts of the brachial plexus are uncommon and can lead to more significant weakness or sensory disturbance in the upper limb.
- **Pleural/Lung injury**. This can cause a pneumothorax which may require drainage.
- **Bleeding**. The thoracic outlet is a vascular area with multiple vessels which may be injured and bleed. They may bleed immediately, but the bleeding may be delayed and occur in the post-operative period.
- **Arterial injury**. Manipulation of the artery can cause injury and bleeding. It may also cause the artery to occlude which will require repair.
- **Frozen Shoulder**. Prolonged immobilization can cause frozen shoulder. This can severely limit the movement of the joint. It is important to maintain movement post-operatively to prevent this.

1.

1. Thoracic Outlet Syndrome. Illig et al. Springer. 2013.

