Anatomy of the Thoracic Outlet and the Thoracic Outlet Syndrome

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The superior thoracic aperture, or thoracic outlet, is an upper chest area located below the clavicles and between the neck and the shoulders. Many important anatomical structures pass from the neck into the thorax and chest cavity from the thoracic outlet. Thoracic outlet syndrome is caused by the compression of the structures at the thoracic outlet, especially those passing through the inter-scalene triangle.

Boundaries of the Thoracic Outlet

The thoracic outlet is the passageway from the lower neck to the axilla. It is made of the
following:

- First thoracic vertebra T1 posteriorly
- First pair of ribs laterally
- Clavicle, sternoclavicular joint and manubrium of the sternum anteriorly

Structures that Pass Through the Thoracic Outlet

- Trachea
- Esophagus
- Thoracic duct
- Apexes of the lungs
- Nerves
  - Phrenic nerve
  - Vagus nerve
  - Recurrent laryngeal nerves
  - Sympathetic trunks
- Vessels

**Inter-scalene Triangle**

This is an important triangle in the neck anatomy in association with the thoracic outlet. The base of the triangle is formed by the first rib and the other two equal sides are made by the anterior and middle scalene muscles. Many important structures pass through the triangle. These include

1. Part of the brachial plexus – inferior trunk of the plexus
2. Subclavian artery

**Thoracic Outlet Syndrome (TOS)**
Thoracic outlet syndrome is caused by the compression of the neurovascular structures at the thoracic outlet, especially those passing through the inter-scalene triangle. Signs and symptoms in the patient are produced according to the structures involved, i.e. neurogenic, arterial and venous symptoms. The syndrome is classified on the basis of the structures involved.

Epidemiology of thoracic outlet syndrome

Neurological involvement most commonly occurs with a neurogenic clinical picture. Roughly 95% of the patients of thoracic outlet syndrome present with neurological signs and symptoms. 2-3% patients of TOS have venous symptoms at presentation. Arterial symptoms are the least common.

The neurogenic thoracic outlet syndrome is common in females of 20—50 years age, whereas, venous TOS is common in males, with a male to female ratio of 2 : 1.

Etiology of thoracic outlet syndrome

As mentioned above, the symptoms of thoracic outlet syndrome are produced by the compression of the neurovascular structures in the scalene triangle at the costoclavicular space.

Common causes of thoracic outlet syndrome include:

1. Trauma after a car accident
2. Repetitive injuries from sports-related activities
3. Anatomical defects. These include a cervical rib, a prolonged transverse process and muscular abnormalities (e.g., in the scalenus anterior muscle, a sickle-shaped scalenus medius) or fibrous connective tissue anomalies
4. Pregnancy
5. A condition called Forward head posture (FHP) seen in people who read on the computer for long periods of time, such as students, teachers, typists
6. Abnormal pressure on the shoulders due to heavy backpack or bag
Pathophysiology of thoracic outlet syndrome

Neurogenic thoracic outlet syndrome usually occurs after trauma to the head and neck. Swelling or disturbance of anatomy at the scalene triangle leads to the irritation of the cords of the brachial plexus producing neurologic symptoms. Brachial plexus supplies the muscles of the upper limbs and chest.

Arterial thoracic outlet syndrome may occur as a result of a cervical rib or an excessively long transverse process of C7 resulting in arterial compression with the movement of the arm. Involvement of the artery due to outlet obstruction can progress to an arterial stenosis with post-stenotic dilatation or aneurysm formation as well as thromboembolism. The second part of the subclavian artery is commonly involved.

Venous obstruction or involvement can occur with compression along the rib or clavicle. The subclavius and costoclavicular ligaments are commonly involved.

Signs and symptoms of thoracic outlet syndrome

In neurogenic TOS, following signs and symptoms are seen:

1. Wasting of the base of the thumb (Gilliatt-Sumner hand),
2. Painless atrophy of the muscles of the hands with carpal tunnel syndrome,
3. Numbness or tingling in the arm or fingers,
4. Pain in neck, shoulder or hand,
5. Weakening grip and difficulty in daily activities,
6. Associated signs of arterial insufficiency (anterior scalene syndrome).

In venous and arterial TOS, symptoms and signs include:

1. Discoloration of the hands during activities or even at rest (bluish color),
2. Arm pain due to claudication and edema due to disturbance of venous flow,
3. Blood clot in veins or arteries in the upper area of the arm due to atherosclerosis,
4. Pallor in one or more of fingers or entire hand,
5. Cold fingers, hands or arms,
6. Fatigue or tiredness after minor or with activity,
7. Numbness or tingling in fingers or hands,
8. Weakness of arm or neck,
9. Throbbing lump near the collarbone.

Due to disturbance of vascular flow in the vessels after compression, change in color of the hands and fingers with early fatigue after minor activities is common.

Complications of thoracic outlet syndrome
1. Frozen shoulder
2. Carpal tunnel syndrome
3. Paget-Schroetter syndrome
4. Cerebrovascular arterial insufficiency
5. Loss of vision as a circumstance of vertebral artery compression

Diagnosis of thoracic outlet syndrome

**Anterior scalene syndrome** produced due to the compression of the plexus and the subclavian artery is diagnosed by **Adson's sign** whereas the **costoclavicular syndrome** is caused by the narrowing and compression of structures between the clavicle and the first rib. It is diagnosed with the **costoclavicular maneuver**.

Adson’s sign is the loss of the radial pulse when the head is rotated toward the ipsilateral side with neck extension and deep inspiration. If it is negative, TOS still can’t be ruled out because many people with outlet obstruction may still present with a positive Adson’s sign.

Treatment of thoracic outlet syndrome

**Management of thoracic outlet syndrome includes:**

- Stretching
- Acupuncture
- Chiropractic adjustments
- Osteopathy
- Occupational therapy
- Physical therapy

**Intramuscular steroid injection** settles the inflammation and pain in the muscle.

**Surgical management** has more chances of success in thoracic outlet syndrome. First rib resection or cervical rib removal can be done if structures are compressed against the
rib. Scalene muscle is removed in patients in whom neurovascular structures are compressed along the scalene muscle.

References


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