1. **Definition**
Clinical syndrome caused by compression of the neurovascular bundle as it passes through the thoracic outlet, a narrow space bordered by the scalenous muscles, clavicle and upper border of the 1st rib.

The subclavian artery and brachial plexus trunks traverse the interscalene space bordered by the anterior scalenus muscle anteriorly, the 1st rib inferiorly and the middle scalenus muscle posteriorly. The subclavian vein passes through the costoclavicular space bordered by the clavicle, subclavian muscle, costoclavicular ligament and 1st rib.

2. **Pathology**
- Compression of the neurovascular bundle is caused by any change in the normal anatomy or abnormal structures that limit the area of the thoracic outlet, e.g.
  - Cervical rib, fibrotic bands, abnormal ligaments, anatomic abnormalities of the scalenus muscles, callus of the 1st rib or clavicle or any positional changes that change the normal relationship of the 1st rib to the structures that pass over it
- Often a history of preceding neck trauma

3. **Clinical presentation**
- The patient may present with neurological, arterial or venous symptoms or any combination of these
- Symptoms are typically related to posture and are often elicited by elevation and abduction of the upper limb

4. **Neurogenic TOS**
- Responsible for ± 90% of cases
- Females are more often affected than males (4:1) and usually present between the third and fifth decades
- Often a history of previous trauma e.g. flexion-extension (whiplash) injury of the neck with injury to the scalenus muscles, repeated minor trauma with specific movements e.g. workers that have to lift heavy objects or work with their hands elevated above the head
- Underlying miofascial or skeletal abnormalities predispose to injury and brachial plexus irritation

**Contributing factors:**
- Bad posture, descent of the shoulder girdle due to loss of muscle tone, obesity, pendulous breasts, etc.
4.1. Symptoms:

- Pain is the most important symptom. Distribution relates to the brachial plexus trunks that are involved. The lower trunks of the brachial plexus ($C_8/T_1$) are more often involved than the upper trunks ($C_5/C_6$).
- Paresthesia is a common symptom and typically involves the fingers, hand and forearm in an ulnar nerve distribution.
- Headache: a common occurrence unilateral on the involved side.
- Hand symptoms: weakness, tiredness, clumsiness and seldom paresis.
- Symptoms are initially intermittent but later become constant.
- Are typically elicited by elevation of the arm.

4.2. Physical examination:

- Evaluate the patient's posture and look for obvious deformities.
- Complete evaluation of motor and sensory function including intrinsic hand muscles. Most patients with neurogenic TOS have normal motor and sensory function. Muscle atrophy occurs as a late sign indicative of a longstanding problem.
- Specific clinical tests that provoke or exaggerate upper limb symptoms are helpful in making a diagnosis.

1. One of the most characteristic findings in neurogenic TOS is brachial plexus tenderness elicited by supraclavicular palpation.
   - Reproduction of neck, shoulder and arm pain or paresthesia by local pressure over the anterior scalenus muscle is pathognomonic for brachial plexus irritation.
2. Adson’s test:
   - This test is performed by having the patient extend the neck, turn the head toward the side being examined and taking a deep breath.
3. Wright’s test:
   - (Allen’s test)
   - This test is performed by having the patient turn his head away from the side being examined and taking a deep breath while the examiner passively abducts and externally rotates the arm.
4. Costo-clavicular compression manoeuvre:
   - The shoulders are drawn back and downward in an exaggerated military position so as to reduce the volume of the costo-clavicular space.
   - Effective in patients who complain of symptoms while wearing a back-pack or a heavy jacket.
5. EAST test: (elevated arm stress test): (Roos)
   - 90° Abduction of the shoulders with 90° flexion of the elbow and external rotation.
   - In this position the patient rapidly opens his hand and fingers.

These clinical tests are not very specific, with false positive findings in up to 20% of normal asymptomatic patients.
4.3. **Differential diagnosis of TOS**

- **Cervical spine abnormalities:**
  - Disc herniation
  - Cervical spondylitis
  - Spinal tumors

- **Neurological abnormalities:**
  - Peripheral and brachial plexus neuritis, multiple sclerosis, migraine

- **Peripheral nerve entrapment:**
  - Carpal Tunnel syndrome (nervus medianus) cubital tunnel (nervus ulnaris)

- **Musculo-skeletal abnormalities:**
  - Gleno-humeral or acromio-clavicular degenerative joint conditions
  - Rotator cuff injury, biceps tendonitis, shoulder bursitis, myositis

- **Other conditions:**
  - Raynaud’s syndrome
  - Reflex sympathetic dystrophy
  - Pancoast tumor of the lung

4.4. **Special investigations:**

- **X-rays of the cervical spine:**
  - Spondylitis
  - Osteophytes
  - Intervertebral disc space narrowing

- **Chest X-rays:**
  - Bony abnormalities, e.g. cervical ribs, prominant C7 transverse process, fractures of the clavicle or 1st ribs with exostoses or callus
  - Tumor in the apex of the lung (Pancoast tumor)

- CT and MRI are important in patients with musculo-skeletal abnormalities

- Electrophysiological tests including nerve conduction studies, somatosensory evoked potentials and electromyography may indicate a neurogenic TOS, but is not diagnostic

4.5. **Treatment:**

Is mostly treated non-surgically.

1. **General measures:**
   - Improve posture
   - Avoid activities with the arms above the head and all other activities that provoke symptoms. This may require adjustment of work conditions.
   - Weight loss

2. **Physiotherapy:**
   - Correct soft tissue abnormalities
   - Strengthen posterior cervical and shoulder girdle muscles
   - Stretch anterior neck muscles
   - Ultrasound
1. Symptomatic treatment:
   - Thermal treatment e.g. ice/heat
   - Ultrasound treatment
   - Transcutaneous electric nerve stimulation (TENS)
   - Non-steroid anti-inflammatory drugs
   - Injection of trigger areas

2. Surgery:
   - Only indicated in neurogenic TOS after intensive physiotherapy (at least 6 months) and in cases of progressive neurological dysfunction and severe pain
   - Surgery involves:
     - Scalenectomy ± cervical rib excision
     - Scalenectomy ± 1st rib resection
     - Scalenectomy with cervical and 1st rib resection

5. Venous thoracic outlet syndrome

5.1. Causes:
   - Compression of the subclavian vein in the costo-clavicular space (deformity of the clavicle or hypertrophic subclavian muscle)
   - Often a history of repeated upper limb activity
     - Occupation, sport, body building
   - Repeated compression trauma of the vein causes thrombosis of the subclavian and/or axillary vein (exertional thrombosis or Paget von Schroetter syndrome)

5.2. Presenting symptoms:
   - Venous congestion, swelling, cyanosis
   - Pain, discomfort, tiredness of the arm
   - Venous collaterals in the delto-pectoral area

5.3. Special investigations for venous TOS
   - Venous Duplex Doppler study
   - Venography

5.4. Treatment of subclavian / axillary vein thrombosis:
   - Standard treatment is anticoagulation (Heparin followed by oral anticoagulation for 3-6 months)
   - In young active individuals thrombolytic therapy is of value. Catheter directed intra-thrombus administration of thrombolytic
   - Decompression of the thoracic outlet:
     - 1st Rib resection through a supraclavicular or trans axillary approach
   - Endovascular intervention in the case of residual strictures of the vein:
     - Following thrombolysis, PTA or stenting is performed
6. Arterial thoracic outlet syndrome

6.1. Causes:
- Less common than neurogenic or venous TOS
- Usually associated with a bony abnormality:
  - Cervical rib
  - Compression between the clavicle and 1st rib
Chronic arterial trauma
- Ulceration with platelet thrombi, distal embolisation or thrombosis of the subclavian artery
- Focal stenosis → post stenotic dilatation, aneurysm formation, distal emboli or thrombosis
- Continuous embolisation may lead to occlusion of the distal circulation and eventually an unsalvageable situation

6.2. Presenting symptoms:
- Acute ischaemia
- Chronic ischaemia
  - Activity induced fatigue (claudication)
  - Distal emboli (painful blue finger)
  - Ulceration or gangrene of the fingertips
  - Unilateral Raynaud’s

6.3. Clinical evaluation:
- Determine blood pressure in both arms.
- Palpable cervical rib
- Palpable subclavian artery in supraclavicular space
- Bruit or thrill over the subclavian artery elicited by abduction of the arm.

6.4. Diagnosis:
- X-rays of the thoracic outlet:
  - Arterial thoracic outlet syndrome is almost always associated with a cervical rib or anomalous 1st rib
- Arterial Duplex Doppler study:
  - Flow and structural changes in the subclavian artery
  - Flow changes provoked with the arm in abduction
- Arteriography:
  - The arm should be abducted during the investigation to produce compression on the subclavian artery

6.5. Treatment:
1. Resection of the cervical rib
2. It may be necessary to remove an anomalous 1st rib
3. Repair of the subclavian artery