

IN THE NAME OF GOD

ThORACIC OUTLET SYNDROME

ANATOMY , SIGN , SYMPTOM

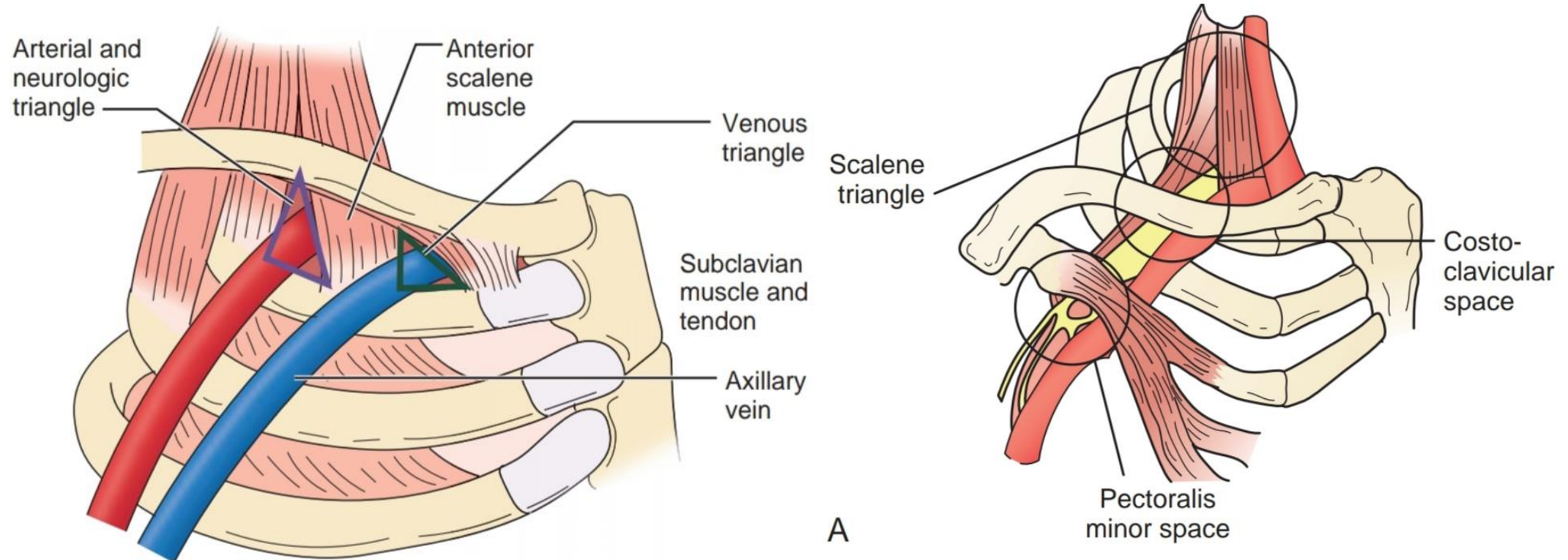
INTRODUCTION

Thoracic outlet syndrome (TOS) is a condition resulting from compression of the neurovascular structures traversing the thoracic outlet.

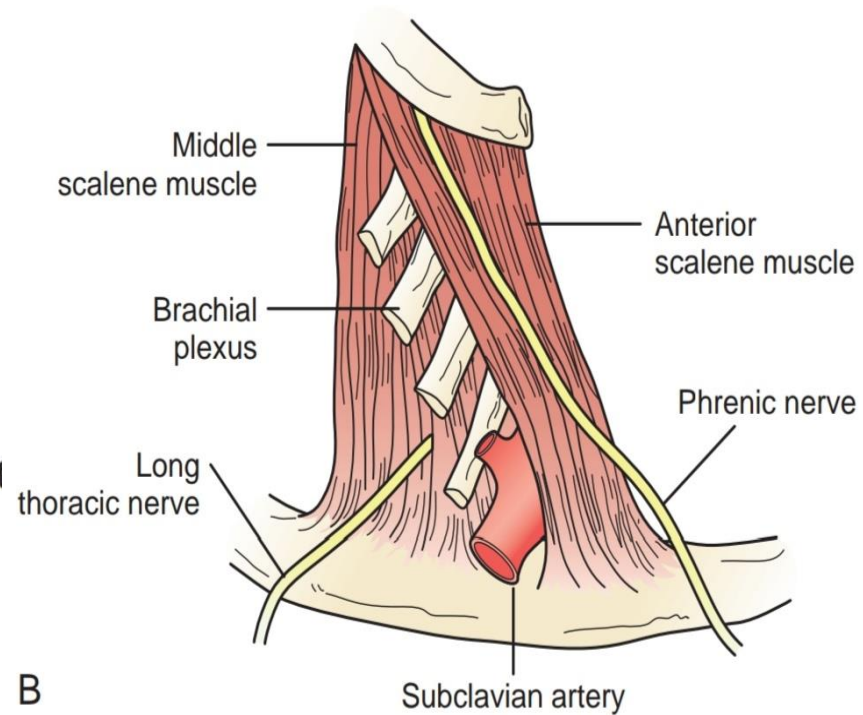
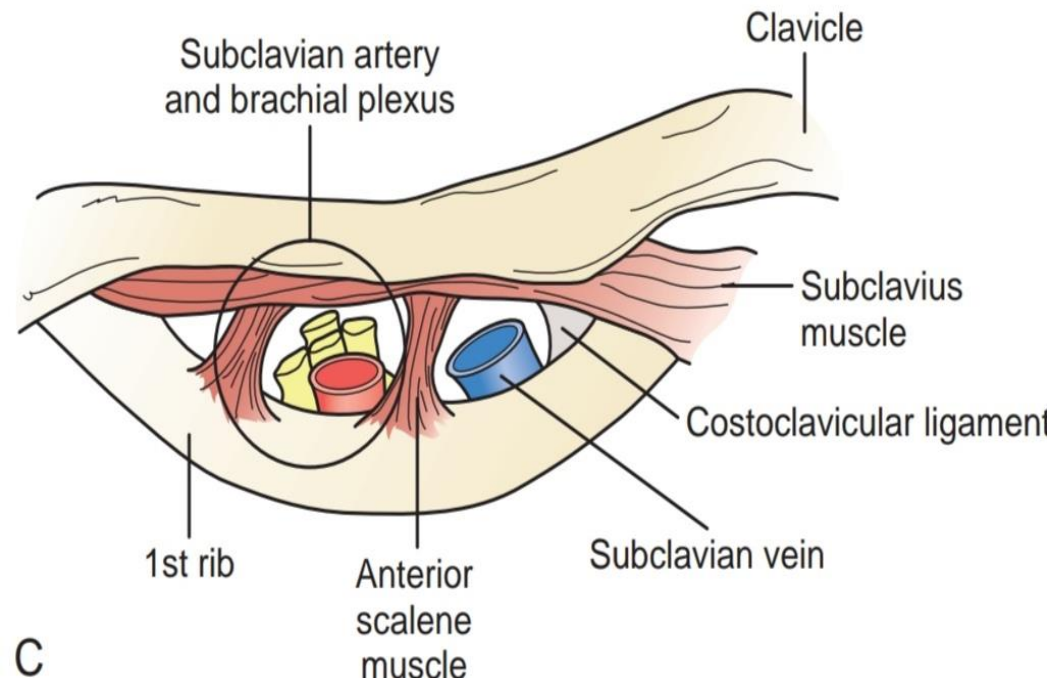
The syndrome is divided into three types based on the symptoms and signs of neurovascular compression: neurogenic TOS (nTOS) results from brachial plexus compression, venous TOS (vTOS) results from subclavian vein compression, and arterial TOS (aTOS) results from subclavian artery compression.

ANATOMY

There are three anatomic spaces that pertain to the thoracic outlet, including the **scalene triangle**, the **costoclavicular space**, and the **pectoralis minor (PM) space**. The costoclavicular space is traversed by the subclavian vein and is the most common site of subclavian vein compression.



The subclavian artery and brachial plexus traverse the thoracic outlet between the anterior and middle scalene muscles, also referred to as the scalene triangle. The scalene triangle is the most common site of brachial plexus compression. When present, cervical ribs and anomalous first ribs also compress the plexus in this location.



NERVES

Brachial Plexus; The space formed by the scalene triangle is traversed by the five nerve roots arising from cervical spine levels C5 through T1 that make up the brachial plexus. The three trunks of the brachial plexus include the upper trunk (formed by fusion of the C5 and C6 nerve roots), the middle trunk (composed of the C7 nerve root), and the lower trunk (formed by fusion of the C8 and T1 nerve roots).

Phrenic Nerve; Arising primarily from C4, the phrenic nerve usually receives branches from C3 and C5. It is single in 87% and double or triple in 13% of individuals. The phrenic nerve descends 84% of the time from the lateral to the medial side of the anterior scalene muscle. In the other 16% of individuals, the phrenic nerve remains on the lateral side.²

phrenic nerve; passes lateral to medial as it descends along the anterior surface of the scalene muscle, and then behind the subclavian vein into the mediastinum, where it innervates the diaphragm.

long thoracic; The long thoracic nerve arises primarily from C6 and usually receives contributions from C5 and C7. The C5 and C6 branches run through the muscle belly of the middle scalene muscle, where they usually join. The C7 branch arises from the posterior aspect of the nerve root and often descends below the middle scalene before joining the other two branches.

Cervical Sympathetic Chain; the cervical sympathetic chain lies over the transverse processes of the cervical vertebrae and is therefore very close to the origin of the anterior and middle scalene muscles. As a result, when cautery is used to excise the scalene muscles at their transverse process origins, the current may reach and damage the cervical sympathetic chain.

Variations and Anomalies of the Scalene Muscle

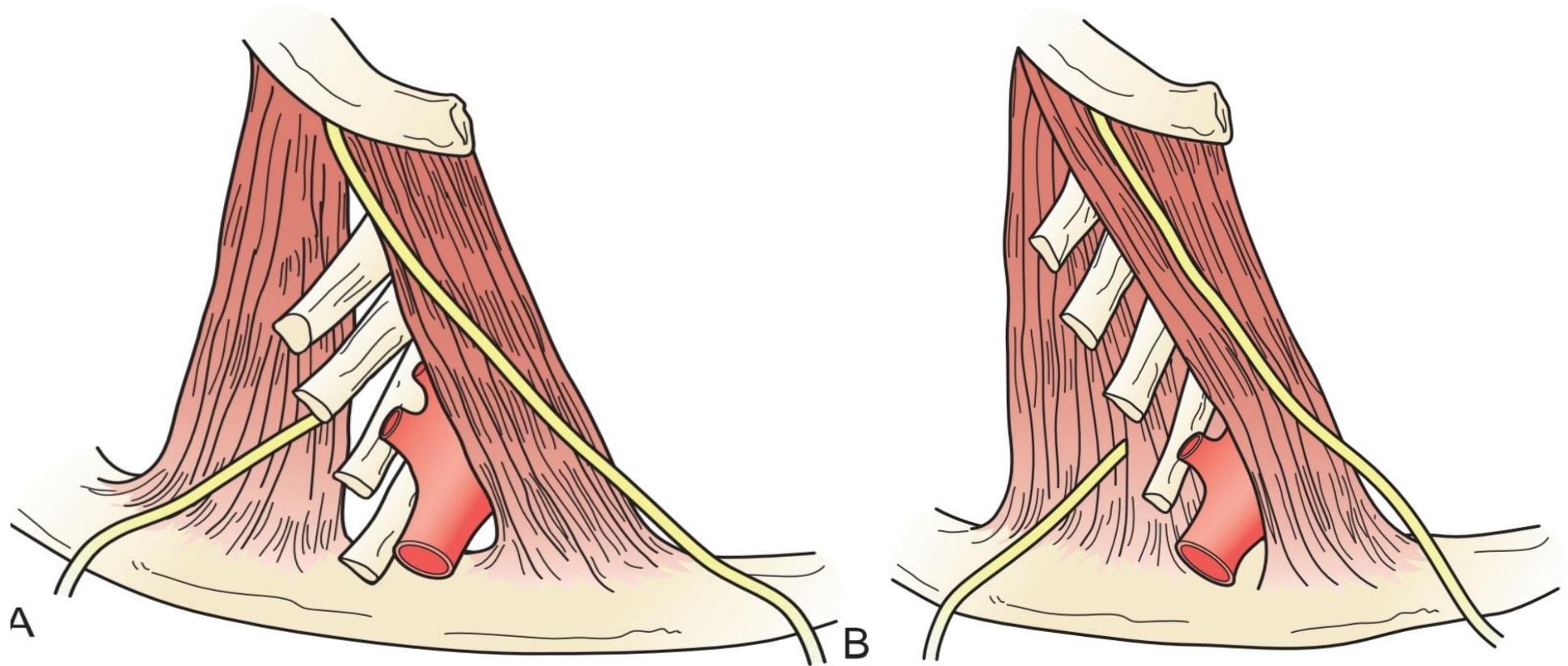
Splitting of the anterior scalene around C5 and C6; Such splitting was noted in 45% of cadavers and in only 21% of nTOS patients.

Scalene minimus muscle; This muscle arises from the transverse processes of the lower cervical vertebrae, runs in front of C8 and T1 and behind the subclavian artery, and inserts on the first rib or Sibson fascia. Its incidence is 25% to 55%.

Interdigitating muscle fibers; Such fibers commonly run between the anterior and middle scalene muscles. They were noted in 75% of nTOS patients and in only 40% of cadavers.

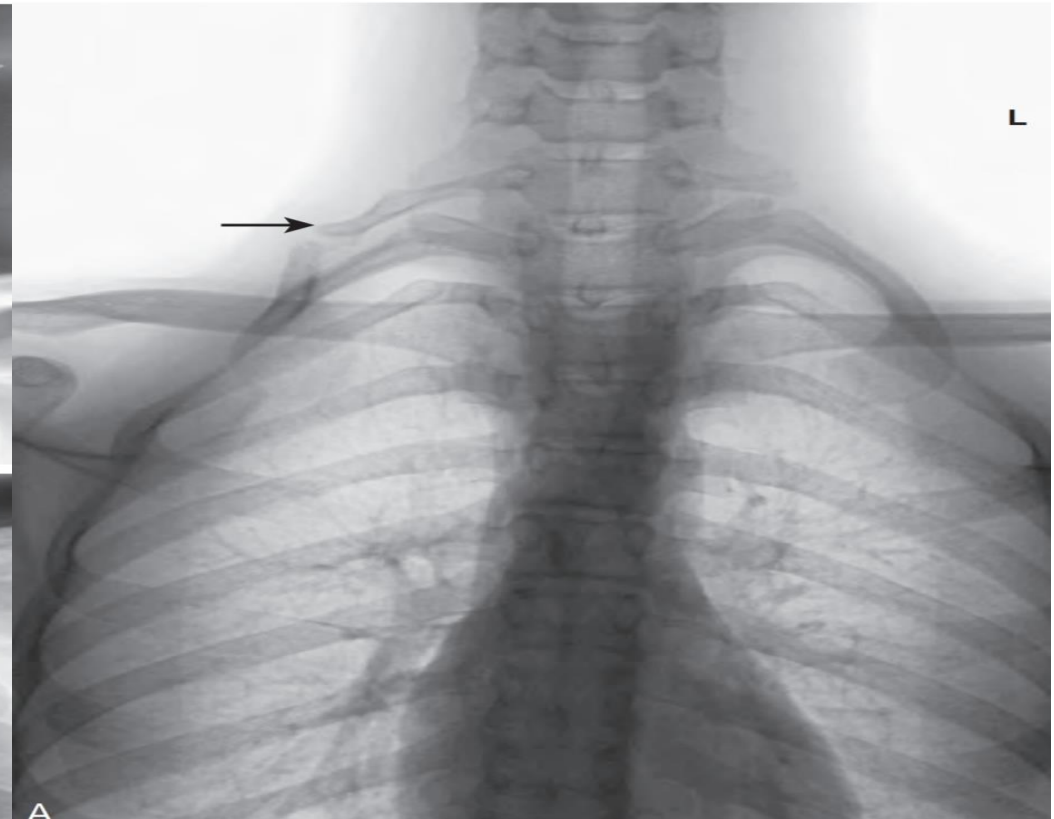
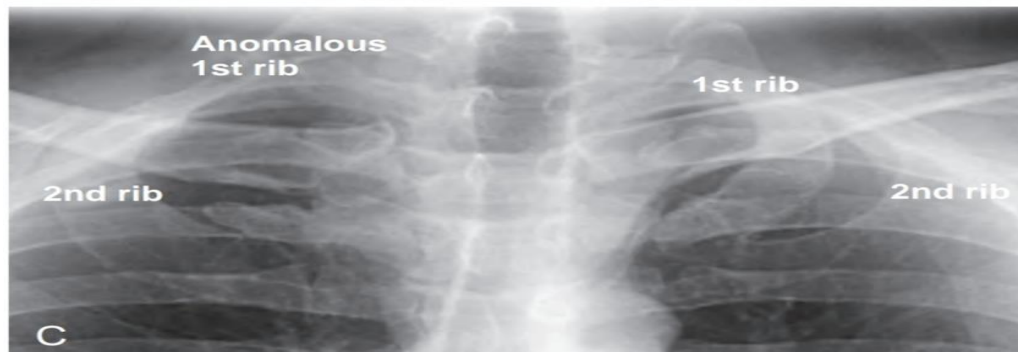
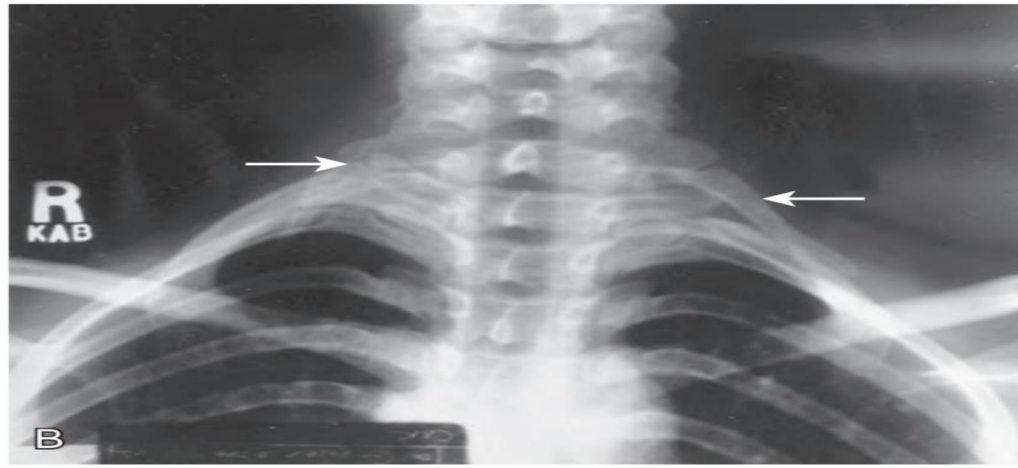
Congenital bands and ligaments; These structures are frequently observed in the normal population, with an incidence as high as 63%.

Scalene triangle width; The width of the scalene triangle varies from very narrow to quite wide, with the distance between the two scalene muscles at their insertion on the first rib ranging from 0.3 to 2.0 cm. The nerve roots emerge lower in a wide triangle compared with their pathway in a narrow triangle.



Skeletal Abnormalities

As many as 29% of patients with TOS have been reported to have skeletal anomalies, including cervical ribs, clavicular anomalies, and isolated first rib abnormalities, the majority of which are congenital. Cervical ribs and anomalous first ribs are both narrower and are positioned more cephalad than a normal first rib. The only difference between the two is that a cervical rib arises from the transverse process of C7, whereas an anomalous first rib arises from the transverse process of T1.



Pectoralis Minor

The PM can also cause compression of the structures of the thoracic outlet, leading to nTOS, vTOS, and aTOS in rare circumstances. Pectoralis minor syndrome (PMS) results when this muscle causes compressive symptoms in the subcoracoid or PM space. The PM space is actually outside the thoracic outlet area, but compression of the upper extremity neurovascular bundle can occur in this space between the PM muscle and ribs of the chest wall. The PM syndrome results from excessive trauma or exercise of the shoulder girdle caused by hyperabduction.

The PM muscle becomes tight and hypertrophied and can compress the brachial plexus, axillary vein, and rarely the axillary artery.

PMS is frequently responsible for recurrent nTOS after thoracic outlet decompression and can be responsible for up to 75% of cases of recurrent nTOS. It is this PM space that should be evaluated more carefully, particularly in patients with recurrent or persistent symptoms after initial operation for nTOS.

CLINICAL FINDINGS

Neurogenic TOS(Symptoms);

Neurogenic TOS most frequently occurs in individuals between 20 and 40 years of age, and approximately 70% of affected patients are women. Neurogenic TOS may arise in individuals engaged in a variety of occupational or recreational activities, most often those involving heavy lifting or repeated use of the arm(s) in elevated positions, or following a spectrum of injuries

To the head, neck, or upper extremity.

Pain and Paresthesia;

The primary symptoms of NTOS include pain, dysesthesias, numbness, and weakness. These symptoms usually occur throughout the affected hand or arm without any localization to a specific peripheral nerve distribution, and they often involve different areas of the entire upper extremity. Extension of symptoms from the hand to the shoulder, neck, and upper back is not infrequent, and in many patients the symptoms in the neck or upper back may be perceived as the most functionally disabling.

Headache;

Headaches are a common complaint associated with NTOS. This most likely occurs as a result of referred pain to the occiput.

Weakness and Muscle Atrophy;

Prolonged severe extrinsic compression of peripheral nerves can result in muscle weakness and atrophy, but such findings are actually rare in patients with NTOS, probably due to the intermittent nature of nerve compression in NTOS. Most commonly, hand or arm pain with use of the affected extremity may lead to the perception of weakness, causing the patient to avoid use of the arm or positions that exacerbate symptoms.

Disability;

The majority of individuals with positional complaints related to NTOS are affected to only a mild and tolerable degree, usually due to transient irritation of the brachial plexus in certain positions of the arm or during certain activities.

Vascular Symptoms;

Vascular symptoms should be specifically sought in the history of patients with suspected TOS—particularly discoloration or coldness in the hands and fingers.

Physical Examination

The range of motion of the upper extremity and lateral motion of the neck are assessed under both passive and active conditions. Pain and tenderness over the shoulder joint is evaluated as potentially related to rotator cuff pathology, and tenderness over the trapezius muscle may indicate fibromyalgia.

Elevated arm stress test (EAST or Roos test); The patient is seated with arms abducted at 90 degrees in external rotation, with elbows flexed to 90 degrees and the head in neutral position. The patient is asked to open and close the hands for 3 minutes or until pain/paresthesia sets in and the patient is unable to continue. This test has a high negative predictive value for nTOS if the patient is able to perform the maneuver for 3 minutes.

Modified upper limb tension test (Elvey test); The patient is asked to abduct both arms to 90 degrees with the elbows extended. The patient is then progressively asked to dorsiflex both wrists. The test is considered positive if symptoms are elicited on the ipsilateral side. A subsequent maneuver is carried out by having the patient laterally flex the head on each side. The test is then considered positive if symptoms are elicited on the contralateral side.

Pectoralis minor; In some patients, compression of the neurovascular bundle as it passes underneath the pectoralis minor muscle tendon is a substantial factor contributing to NTOS.

Arterial TOS

Signs and Symptoms;

The most common presentation is hand ischemia due to microembolization. However, arterial TOS can be associated with less dramatic symptoms, and many cases go unrecognized because the condition tends to occur in young patients without atherosclerotic risk factors. Early in the disease process, patients may present with mild symptoms of exertional arm pain or unilateral Raynaud syndrome. Moderate to severe exertional pain may be associated with subclavian artery thrombosis.

Clues to the diagnosis of arterial TOS include the young age of the patient and the tendency for symptoms to be unilateral, which helps differentiate the condition from systemic pathologic states.

The directed physical examination should consist of measuring blood pressure in both upper extremities and auscultating for bruits in the supraclavicular fossa. A bruit may be elicited on shoulder abduction or the overhead arm position if it is not present in the relaxed position. Specific findings on physical examination include a palpable cervical rib and a pulsatile supraclavicular mass. Evidence of microembolization to the hand, including digital ischemia and splinter hemorrhages, may also be present.

Compression Maneuvers;

ADSON TEST;

Compression maneuvers such as the Adson test, costoclavicular maneuver (exaggerated military position), and hyperabduction maneuver (shoulder abduction beyond 90 degrees) have historically been used to aid in the diagnosis of TOS, but none is accurate. Ablation or reduction of the radial pulse with these maneuvers is considered a positive test result, but the incidence of false-positives in normal, healthy volunteers ranges from 9% to 57%.

Venous TOS

clinical presentation(sign and symptoms);

The mean age at diagnosis for vTOS is 32 years, with the majority of patients affected between the second and fourth decades. Individuals who perform strenuous or sustained upper extremity activities, whether athletic or occupational, are particularly prone to the development of subclavian-axillary vein thrombosis. The dominant arm is involved in the majority of cases.

Upper extremity edema is the hallmark characteristic associated with subclavian-axillary vein thrombosis. The edema is often but not always accompanied by pain and cyanosis of the affected extremity. The edema usually involves the shoulder, arm, and hand, and is characteristically non pitting.

Dilated superficial veins over the shoulder, neck, and anterior chest wall can often be visualized as collateral veins try to accommodate the increased venous pressure (a pattern often referred to as *first rib bypass venous collaterals*). A minority of patients may demonstrate symptoms resembling neurogenic TOS, such as numbness and tingling in the distribution of the inferior trunk of the brachial plexus.

Patients may report some degree of pain. The description can include aching, stabbing, or a feeling of tightness that worsens with exertion.

The two most potentially severe complications of subclavianaxillary vein thrombosis are pulmonary embolism and upper extremity phlegmasia cerulea dolens (venous gangrene). The reported incidence of pulmonary embolism due to subclavianaxillary vein thrombosis is less than 10%. Comparedwith iliofemoral DVT, the small clot burden of upper extremity DVT may reduce the clinical impact of pulmonary embolism.

Venous gangrene is exceedingly rare and has been limited to case reports in patients with malignant disease or an underlying hypercoagulable state. No reports of venous gangrene occurring secondary to vTOS have been published.

Thank you