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Thoracic Outlet Compression Syndrome

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Summary

This is a retrospective study of 45 patients with Thoracic Outlet Compression Syndrome who were treated surgically in the department of Thoracic & Cardiovascular Surgery at the "Medical City Teaching Centre – Specialized Surgeries Hospital" , from January 1st, 1997 to December 31st ,2006.

They are studied according to their age , sex , causative factors , clinical features , side of affection and compliance , diagnostic measures , theraputic planing , surgical approaches , and surgical outcomes.

We compare our results with four different studies ; one from the same centre in Iraq done in 1993 , and the other three studies taken from centres in the United States of America , Turkey, and India & done in 1998 , 2003 , & 2004 respectively.

Our study agreed with the other studies that TOCS is more common in female than male , more common in the 3rd & 4th decades of life , more on the right than the left side , mostly caused by cervical rib , and more with neurological manifestations.

There are four different approaches for the surgical treatment of TOCS ; posterior approach , anterior approach , transaxillary approach , and double route approach. In our study 98% of the surgical treatment was performed through the posterior approach , we compare the advantages and disadvantages of this approach with the other approaches in the four different studies mentioned. The Thoracic Outlet Compression Syndrome (TOCS) is a group of common conditions caused by compression of the nerves & vessels supplying the upper limb. Symptoms vary from mild to limb threatening , it might be missed or ignored by many physicians as they mimic common conditions such as tension headache or fatigue syndromes. Clinical diagnosis, appropriate investigations and surgery, especially if reserved for carefully selected patients, yield satisfying and sometimes dramatic results [1] .

1-1: Historical Aspects:-

According to J.B Murphy [2] the anatomical history of the cervical rib began with the observation of Galen and Vesalius and was followed later by the studies of Hunauld in 1742. In 1818 , Sir

Astely Cooper [3] identified the connection between cervical ribs and symptoms in women with arm ischemia .In 1861, Coote at St. Bartholomew's hospital in London removed an exostosis of the transverse process of C7 vertebra to treat a weak, painful ischemic hand. In 1865, Paget first described axillary vein thrombosis. In 1919, Stopford and Telford had reported 10 cases with TOCS symptoms that were treated with 1st rib resection and scalenotomy. In 1909, Keen reviewed 42 cases of cervical rib excision from the literature. In 1916, Halstead described a collection of 716 cases of the cervical rib with at least 27 subclavian aneurysms. In 1927, Adson and Coffey suggested the division of the scalenus anticus muscle to relieve symptoms of patient with TOCS symptoms. In 1935, Oschner and Colleagues and in 1938 Naffziger and Grant reported 6 & 18 patients, respectively, with scalene anticus syndrome. In 1940, Aynesworth described 20 patients with "cervicobrachial syndrome". In 1943, Falconer and Weddell reported 4 cases with a classic description of "costoclavicular compression ". In 1945, Wright described the hyperabduction syndrome with compression in the costoclavicular area by the tendon of the pectoralis minor [62]. In 1947, Adson described the "Adson test". In 1956, Peet and Colleagues described the term " Thoracic Outlet syndrome " to include all the compression syndromes in this anatomic region .In 1958, Rob and Standeven [4] modified the name to "Thoracic Outlet Compression Syndrome" which currently considered the most descriptive name. In 1962, Clagett introduced resection of the 1st rib as the optimal operation rather than scalenotomy for scalenus anticus syndrome. In the same year, Falconer and Li [5] noted good relief of symptoms in 12 of 13 cases using a supravlavicular 1st rib resection approach. In 1966, Roos [6] described the transaxillary approach of 1st rib resection in 12 cases. In 1989, Sanders and Pearce [7] published a comparison of transaxillary 1st rib resection & scalenotomy with that of supraclavicular approach.In 1998, Urschel and Razzuk [8] presented at the American Surgical Association their total experience of 3914 patients who underwent primary neurovascular decompression with a transaxillary approach; 1221 patients required a secondary procedure through a posterior approach for recurrent symptoms .

1-2: Anatomic Features:-

Several anatomic regions have been identified as sites for the compression of the subclavian vein, subclavian artery, and brachial plexus [3]. The brachial plexus is composed of nerve roots C5 through T1 . The sternocostovertebral space is the most proximal portion of the thoracocervical tunnel through which the neurovascular structures of the upper extremity must pass. This region is bounded by the sternum,the spine and the 1st rib. This space contains the lung's apex , pleura, sympathetic trunk , jugular vein , lymphatics , subclavian vein and artery , and nerve roots. Compressive problems in this region are hypothesized to be caused usually by lesions such as tumours of the thyroid , thymus, or lung [9]. There are 3 anatomic areas in which compression of the neurovascular structures may occur: the scalene triangle,the costoclavicular space &the subcoracoid space(Fig 2).

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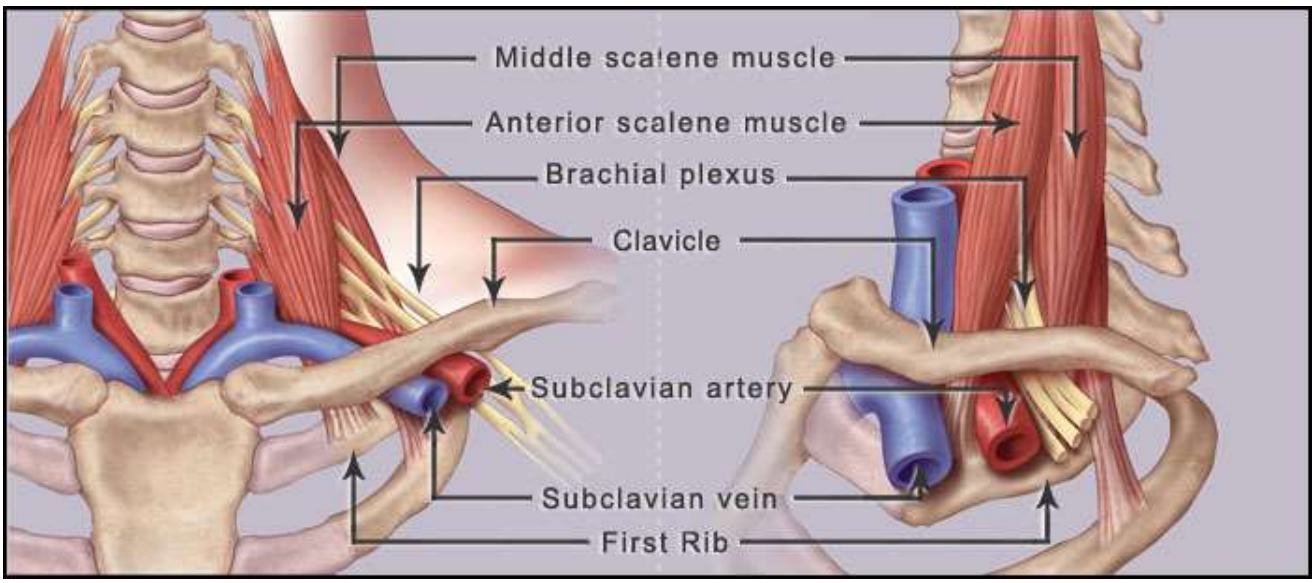
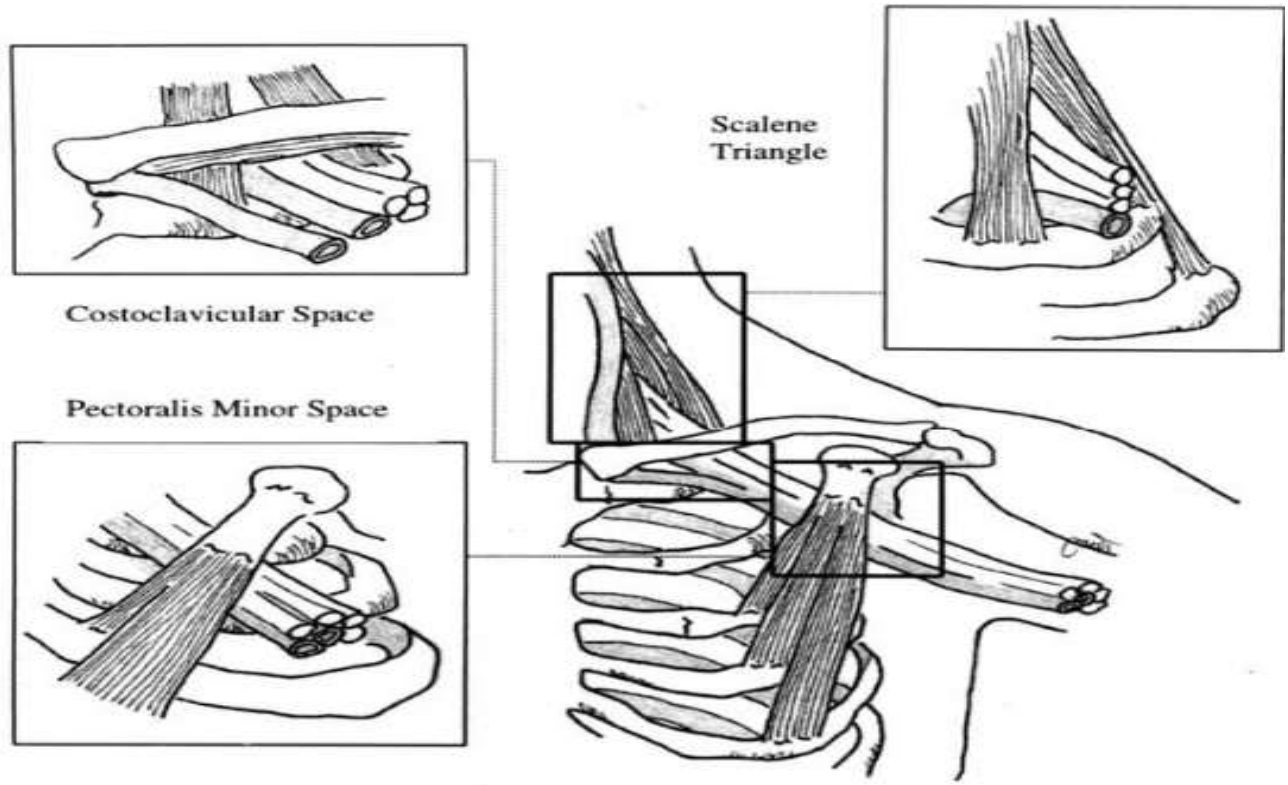


Figure(1) :The anatomy of the Thoracic outlet- anterior & lateral views (from www.tosmri.com)



Figure(2) : Three anatomic regions are hypothesized to contribute to compression in TOS: the scalene triangle , the costoclavicular space , and the space beneath the pectoralis minor muscle. (From Thoracic Outlet Syndrome. Curr.Probl.Surg.2002;39:1075)

The scalene triangle is the region bordered by the anterior scalene muscle, the middle scalene muscle & the 1st rib. The brachial plexus and the subclavian artery pass over the 1st rib between the scalene muscles, and the subclavian vein also passes over the 1st rib but external to the scalene

triangle. The costoclavicular space is bordered by the clavicle & the 1st rib, with the costoclavicular ligament anterior & the edge of the middle scalene muscle posterior. This space contains the brachial plexus , the subclavian artery & vein , & the subclavius muscle. The subcoracoid space is beneath the pectoralis muscle, the coracoid process and the ribs posteriorly. The brachial plexus courses through this space &can be tethered further with arm elevation, abduction, or abnormal depression of the coracoid [3].

Cervical ribs have been described as structures that compress the neurovascular structures in this region by occupying space in this narrow region [9]. Roos [10] described 9 types of congenital bands &ligaments in the thoracic outlet area, which may compress the neurovascular structures. Most of the ligaments extends from the transverse process of C7 or from the tip of the cervical rib and attach to the 1st rib. These ligamentous bands lie either within the body of the middle scalene muscle or on the anterior surface of the muscle & the brachial plexus may then be compressed against the taut ligament. The most commonly identified sites of compression in patient with TOCS are the scalene triangle and the subcoracoid space, although it is clinically difficult to determine the exact location of compression [3].

1-3: Incidence :-

The normal frequency of cervical anomalies [11] in the population is 0.12-1%. Cervical ribs have been reported to be present in about 0.5% of the general population[64]. However, Boles et al. [11] reported 15 members of a single family (the 2 parents and their 13 children) affected with a TOCS secondary to a cervical rib and/or an apophysomegaly of the C7 vertebra. Sallstrom and Thulesius [12] reported that the prevalence of TOCS was almost twice as common in women as in men (ratio 1.76:1).

1-4: Etiology :-

1. Bony Abnormalities:-

(a)First rib abnormalities [13] (b)Cervical ribs (c)Clavicular abnormalities and bifid clavicle (d)Long transverse process of C7 vertebra (e)Bony tumours.

2. Soft tissue Abnormalities:-

(a)Adventitious fibrous bands (b)Muscular hypertrophy and abnormalities like scalenus anticus, medius ,omohyoid and subclavius muscles (c)Anomalous course of transverse cervical artery [14]. (d)Exaggerated ligaments and membranes (e)Post-fixed brachial plexus (f)Tight pectoralis minor tendon.

3. Traumatic causes:-

(a)Fractured clavicle and/or 1st rib with callous formation (b)Anterior dislocation of the head of humerus (c)Crush injuries to the upper thorax, with resulting fibrosis (d)Sudden unaccustomed muscular efforts involving the shoulder girdle.

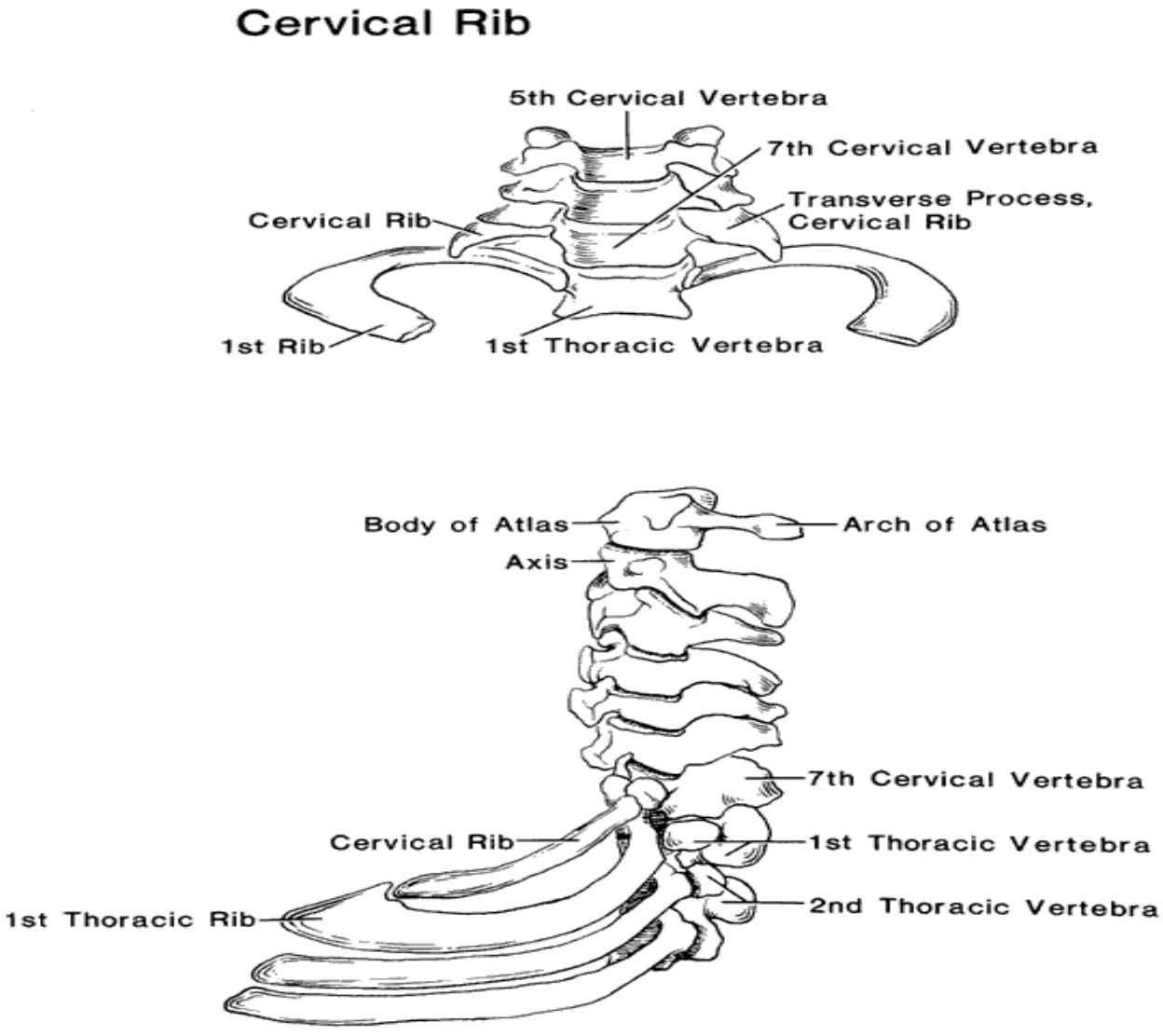
4. Other rare causes:-

(a)Supraclavicular LN enlargement and tumors like Hodgkin's disease [15] (b)Spasm of pectoralis minor muscle caused by costocondritis(Tietze's syndrome) [16] (c)Klippel-Feil syndrome (d)Cleidocranial dystosis

(e)TOCS caused by a latissmus dorsi flap for breast reconstruction [17].

Among all the above etiological factors , cervical ribs & fibrous adventitious bands are the most commonly encountered factors .

Cervical Ribs : cervical ribs usually originate from the costal processes of C7 vertebrae as bilateral but often asymptomatic osseous structures. They may terminate with free ends in the soft tissues or join the 1st rib or the sternum distally (Fig 3). The majority of cervical ribs are asymptomatic , 50 - 75% , but when symptomatic the type of the cervical rib will determine the symptom produced [18] .

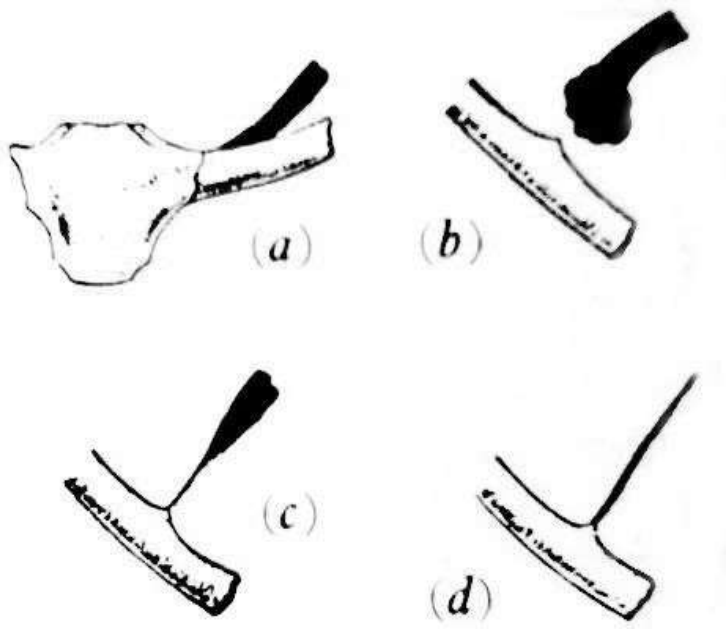


Figure(3): The anatomy of the cervical rib (From msn -Images)

Types of Cervical ribs [55] include :-

- Type 1: complete rib, articulating with the first rib or the manubrium.
- Type 2: incomplete rib, with the free end expanding to form a bulbous tip.
- Type 3: incomplete rib, ending in a tapering point, which is connected by fibrous band to the scalene tubercle of the first rib.

● Type 4: a short bar of bone, only a few millimetres beyond the transverse process of C7 vertebra.



Figure(4) : Types of cervical rib (From Bailey & Love's Short Practice of Surgery – 20 th Edition , Page 650 : a. complete rib often containing a false joint in its length , articulates anteriorly with the manubrium or the first rib b. the free end of rib expands into a large bony mass c. rib ending in tapering point which is connected by fibrous band to the scalene tubercle of the first rib d. fibrous band closely applied to the scalenus medius)

● Type 1 cervical rib usually does not produce symptoms.
● Type 2 cervical rib most likely produces arterial symptoms.
● Type 3 & 4 cervical ribs most likely produce neurological symptoms.

Fibrous bands described by Roos. [19]

:-

Type 1	A band from the anterior tip of an incomplete cervical rib to the middle of the first thoracic rib inserts into the upper rib surface posterior to the scalene tubercle.
Type 2	A band arising from an elongated C7 transverse process attaches to the first rib just behind the scalene tubercle in the same place as a Type 1 band.
Type 3	A band both originating from and inserting into the first rib arises posteriorly, near the neck of the rib, and inserts more anteriorly, just behind the scalene tubercle.
Type 4	A band originating along with the middle scalene muscle from a transverse process run along the anterior edge of the middle scalene muscle and inserting with it into the first rib. The lower nerves of the plexus may lie against it.
Type 5	The scalene minimus muscle is the fifth type of band. It arises with the lower fibers of the anterior scalene muscle and runs parallel to it but passes deep into it, behind the subclavian artery but in front of the plexus, to insert into the first rib. Normally, the entire anterior scalene muscle passes anterior to the artery. Any fibers that pass anterior to the plexus but posterior to the artery belong to the scalene minimus muscle.
Type 6	When the scalene minimus muscle inserts onto Sibson's fascia over the cupola of the pleura and lung instead of into the first rib, it is labelled separately to distinguish its point of insertion.
Type 7	A fibrous cord running along the anterior surface of the anterior scalene muscle down to the first rib attaches to the costochondral junction or sternum. In this position, the band lies immediately behind the subclavian vein and can be the cause of partial venous obstruction.
Type 8	A band arising from the middle scalene muscle runs under the subclavian artery and vein to attach to the costochondral junction.
Type 9	A web of muscle and fascia filling the inside posterior curve of the first rib forms the ninth type of band.
Type 10	Some of the anterior scalene muscle fibers form a band that connects to the perineurium of the brachial bundle.
Type 11	A band formed by fibers existing between the anterior and middle scalene muscles passes between nerve roots.
Type 12	The upper part of an anomalous anterior scalene muscle passes behind the C5 and C6 roots.
Type 13	Fused scalene muscles form a band, and the brachial nerve roots pass through the muscle like arrows.
Type 14	Fibrous bands passing vertically in front of the nerve roots behind the anterior scalene muscle form the 14th type of band.

1-5: Pathophysiology :-

Neuromuscular TOCS : A significant component of the symptoms attributed to TOCS is due to brachial plexus nerve compression [20] . Neural compression, particularly of the lower trunk can be affected against 1st rib by most of the mentioned etiological factors. Upper trunk compression at the interscalene angle can sometimes manifests as pain, numbness, and tingling sensations around the shoulder [18] . Involvement of the sympathetic system can results in Raynaud's and Horner's Phenomenon type of manifestation.[21-24]

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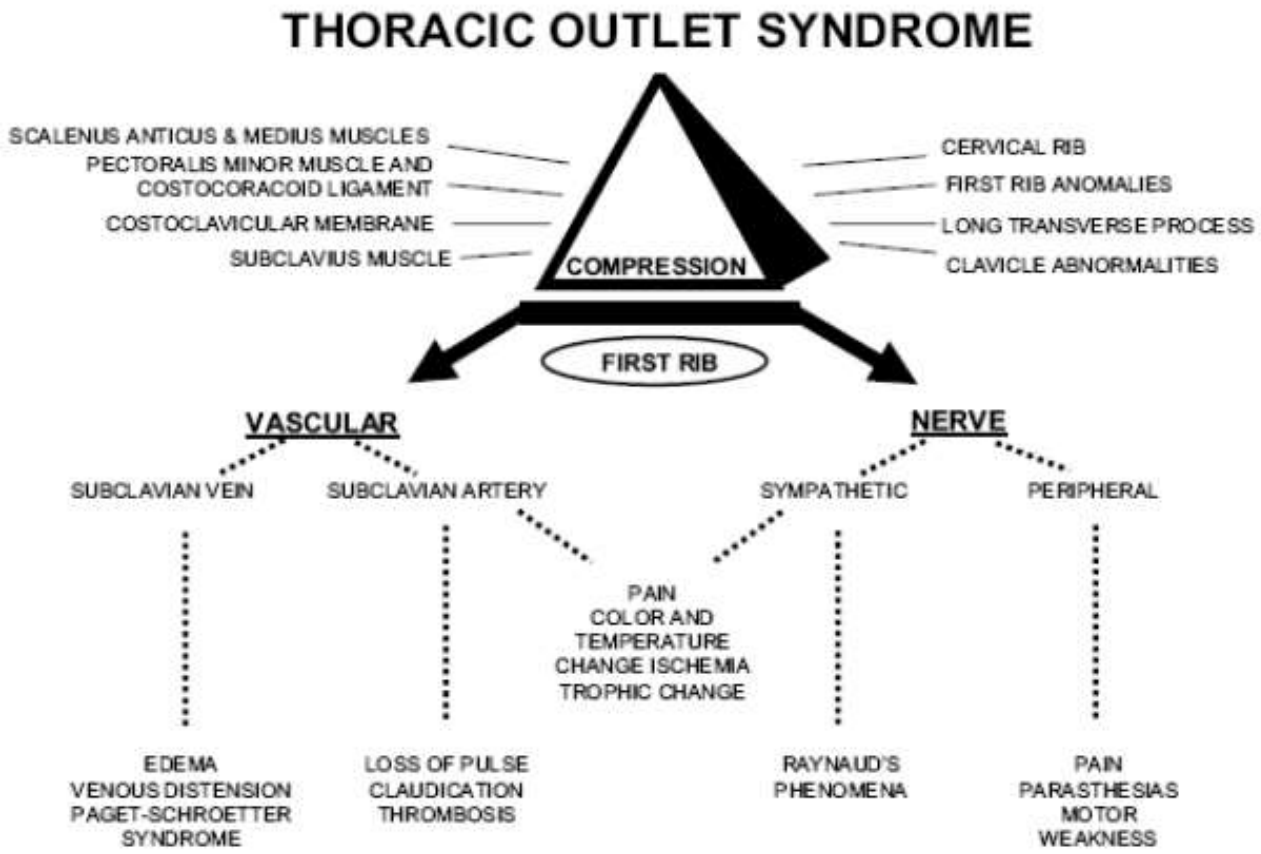
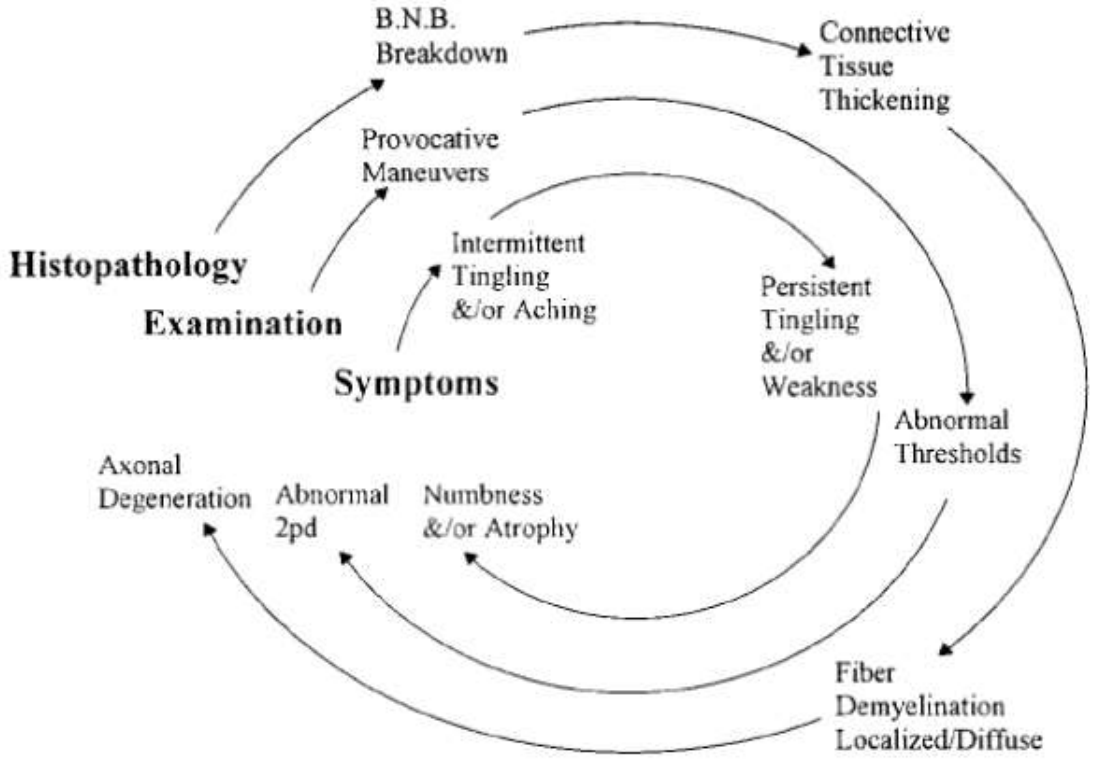


Figure(5) DIAGRAM (1) : The relation of muscles , ligaments, and bone abnormalities in the thoracic outlet that may compress neurovascular structures against the 1st rib.
(from Urschael HC Jr, Razzuk MA. Ann. Surg. 1998:228:609)

Patient symptoms and clinical findings relate directly to the histopathologic changes that occur in chronic nerve compression (Fig 5).
The patient may complain initially of aching in the muscles that are innervated by the compressed nerves; later muscle weakness and finally muscle atrophy will be noted. With compression of the sensory nerves, patients will begin to complain of intermittent parasthesias , then persistent parasthesia , and finally numbness [25] .



Figure(6 **)** The continuum of histopathologic changes that are noted in chronic nerve compression will parallel patient symptoms and clinical findings. BNB, blood nerve barrier; 2pd, two-point discrimination. (Modified from Mackinnon SE. Upper extremity nerve injuries , primary repair and reconstruction. In: Cohen M , editor. Mastery of plastic surgery. Boston: Little, Brown; 1994. p. 1598-624)

Vascular TOCS : Which include :-

(a) Compression of the subclavian artery : initiating events may include repeatitive arterial injury, anomalous ribs and ligamentous bands,or previous fractures of the clavicle or 1st rib .Subclavian artery compression can reduce blood flow to the upper extremity leading to signs and symptoms of arterial insufficiency (as pain, muscle fatigue , pallor, coldness and trophic changes) which are usually aggravated upon postural elevation of the upper extremity [23] . Continued compression of the subclavian artery may lead to stenosis, ulceration, or aneurysm formation [26] , or even thrombosis. Repeated embolization from thrombi in these aneurysm with distal ischemic manifestations can also be encountered.

(b) Compression of the subclavian vein : Thrombosis of the subclavian vein is often referred to as Paget-Schroetter syndrome(extensive edema of the upper extremity ,cyanosis and venous distension) which is hypothesized to be caused by strenuous activity or unusal positioning of the arm which causes compression of the subclavian vein [26,27] .There may also be additional structures in the thoracic outlet, such as a cervical rib or anomalous ligamentous band that compress the subclavian vein [27,28] .

1-6: Clinical Features :-

(1) Neurological manifestations : Patient complaints typically include discomfort in the suprascapular, subscapular, and cervical regions with radiation of pain into the upper extremity. Parasthesia and numbness along the medial border of the forearm & hand are most common; although with long standing symptoms ,complaints of tingling & numbness may include the entire hand. Isolated compression of the lower trunk of the brachial plexus will produce sensory alteration in the ulnar nerve distribution of the hand; compression of the upper trunk of the brachial plexus will produce sensory complaints in the thumb, index, &long fingers. Patients reports of weakness of the arm and hand and vague complaint of upper extremity fatigue are common. Headaches are reported frequently, whereas facial pain and/or numbness and anterior chest wall pain with complaints of " pseudoangina" are infrequent symptoms. Symptoms usually are exacerbated with upper extremity activities, especially with the use of the arm in an abducted or an overhead position. In some patients colour alteration of the hand occur which range from pale & white to dusty & blue. The onset of symptoms is often insidious in nature with no specific reported trauma or the patient may associate the onset of symptoms with a" Whiplash" type of cervical injury or other unusual traumatic event [3].

(2) Vascular manifestations : Symptoms of vascular compression are uncommon [9]. Compression at the subclavian artery will results in symptoms of coldness & Raynaud's phenomenon, with blanching of the digits followed by cyanosis and persistent rubor . Arterial thrombosis or occlusion may occur with persistent cyanosis or pallor of the digits. Symptoms of venous abnormalities are uncommon and would be symptoms of venous obstruction termed "Paget-Schroetter Syndrome" . Patients will experience edema and venous congestion of the upper extremity.

1-7: Staging :-

Staging of the patients' symptoms led to more objective surgical results. This method is easy and universally applicable. Staging is based completely on clinical evaluation and the patient's history [64] :

- Stage O : asymptomatic
- Stage I : appearance of symptoms or reduction in or loss of radial artery pulsations with provocative tests .
- Stage II : symptoms in daily life (e.g. pain when carrying a dish or dropping light objects).
- Stage III : deprivational symptoms that hinder the performance of daily work or acute or sever symptoms (e.g. sever pain when brushing teeth).

1-8: Diagnosis :- can be achieved by :

(1) Physical Evaluation :by provocative tests described for the diagnosis of TOCS depending on monitoring the radial pulse [9]. Four specific maneuvers have been described (Fig 6) [29] :-

Adson's maneuver ; the patient's arm is down by the side, and the head is turned towards the affected side. The patient is instructed to inspire deeply. The radial pulse is monitored. Adson's maneuver is considered positive with obliteration of the radial pulse. This test is modified often with rotation of the patient's head to the unaffected side.

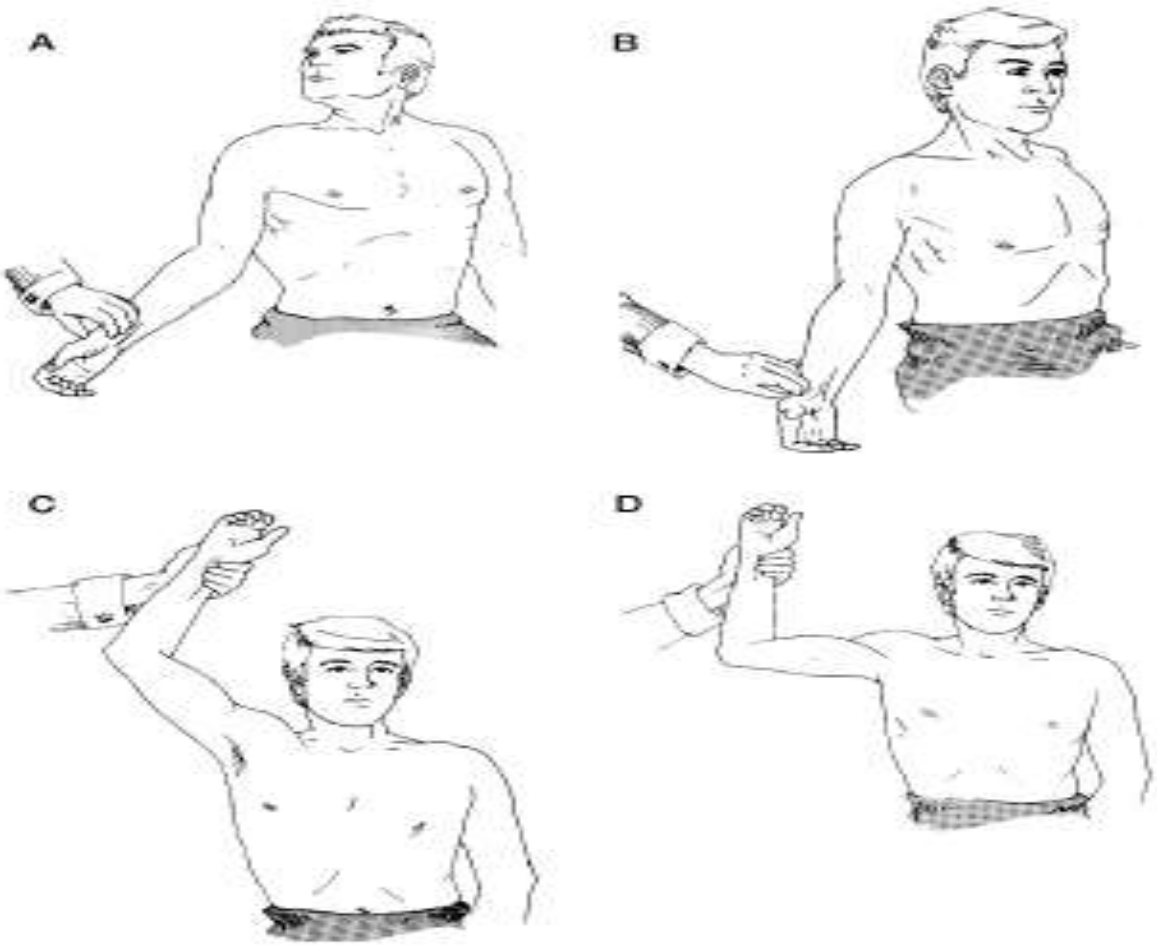
Halstead maneuver ; instruct the patient to assume a military posture, with the shoulders backward and in a downward direction to narrow (theoretically) the costoclavicular space.The radial pulse is monitored, & the test is positive with obliteration of the radial pulse.

Wright's maneuver ; hyperabduction test with the shoulder hyperabducted to 180 degrees and the elbow flexed. The radial pulse is monitored & the test is positive with obliteration of the radial pulse.

Roos's test ; arm elevation for 3 minutes, with 90 degrees of shoulder abduction & external rotation, and elbow flexed at 90 degrees; the patient is asked to open and closed the hand rapidly. The Roos's test is considered positive with reproduction of the patient's symptoms.

No single clinical test has been accepted as "diagnostic" of TOCS. Many of the tests to detect vascular insufficiency report high false positive &false negative rates in the diagnosis of TOCS[9]. Because most patients with TOCS have complaints that relate to brachial plexus nerve compression and not to the compression of the subclavian artery , the tests that monitor the radial artery will be inaccurate in many patients with suspected TOCS.

Reproduction of upper extremity symptoms has been accepted as a more accurate indicator of TOCS with provocative testing [9].



Figure(7) : Many of the original tests include (A) the Adson's test, (B) the Halstead maneuver, and (C) the Wright's maneuver that assess vascular integrity by the monitoring of the radial pulse. The Roos' test (D) was modified to include opening and closing the hand for 3 min ; the reproduction of patient symptoms was considered positive. (From Luoma A, Nelems B. Thoracic outlet syndrome, thoracic surgery perspective. Neurosurg. Clin. N. Am. 1991;2:187-226)

(2) Radiographic Evaluation :

Plain chest radiography ; the standard PA view CXR can demonstrate any bony abnormalities that could be the cause of the compression.(Fig 7)

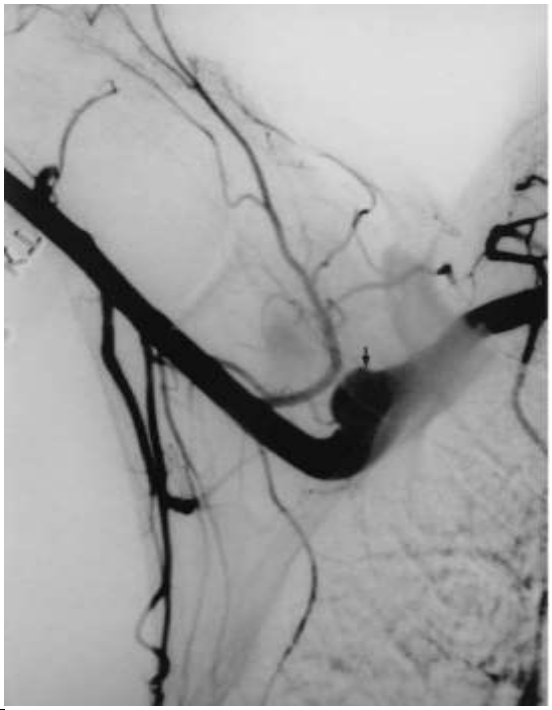
Figure(8) : Plain CXR demonstrate Cervical rib (arrow) in neutral position reveals Kyphosis.

FIG 8 : Cervical spine x-ray lateral view

Cervical spine radiography ; in a PA, lateral ,and oblique projections is helpful in the differential diagnosis of neurologic compression. (Fig 8)However hyperextension PA view of the neck can identify abnormalities of the C7 vertebra or small cervical ribs that can not be seen in standard PA view [30] .

CT-scan__; most helpful in patients with limited findings on the plain and contrast radiographs. It can demonstrate cervical ribs & fibrous bands [30] . In (Fig 9) CT scan demonstrate abnormal long left transeverse process of C7 vertebra causing pressure on the brachial plexus(arrow).

Figure(9): CT scan Abnormal long Lt. transverse process of C7 vertebra causing pressure on brachial plexus.



Figure(10) : vascular TOS. This aneurysm was documented with an arteriogram .

Figure(11) : Compression of subclavian artery at the 1st rib by arteriogram .

Arteriography ; selective subclavian arteriography is of great help to visualize arterial compression particularly when there is no bony abnormalities on plain CXR films [31,32,33] .(Fig 10,11)

Indications for arteriography include: 1. large cervical rib 2.recurrent embolization 3. pulsatile mass 4. bruit in resting position 5.reduce arm pressure or radial pulse 6. ischemia of hand 7. some 1st rib anomalies.

Phlebography ; recommended in patients with suspected subclavian vein compression or thrombosis. [30. 33. 34. 35] (Fig 12,13)

Indications for venography include : 1. edema of the hand and arm 2. elevated venous pressure 3. hand cyanosis or plethora.

Figure(12) : Venogram of typical subclavian vein thrombosis

Figure(13) : Venogram of non-thrombotic obstruction at subclavian-innominate venous junction. Axillary v. normal.

(3) Doppler Study : Doppler & Plethysmography studies can identify interruption of blood flow to the involved extremity. A near complete cut-off of flow during the stress maneuver with reproduction of the primary symptoms should be noted [63] .

(4) MRI Study : in recent years , MRI has been proposed as a suitable method for imaging the brachial plexus [36] . The minimum distance between the 1st rib & the clavicle is measured in a sagital plane and by which we can distinguish between normal & pathological anatomy (Fig 14).

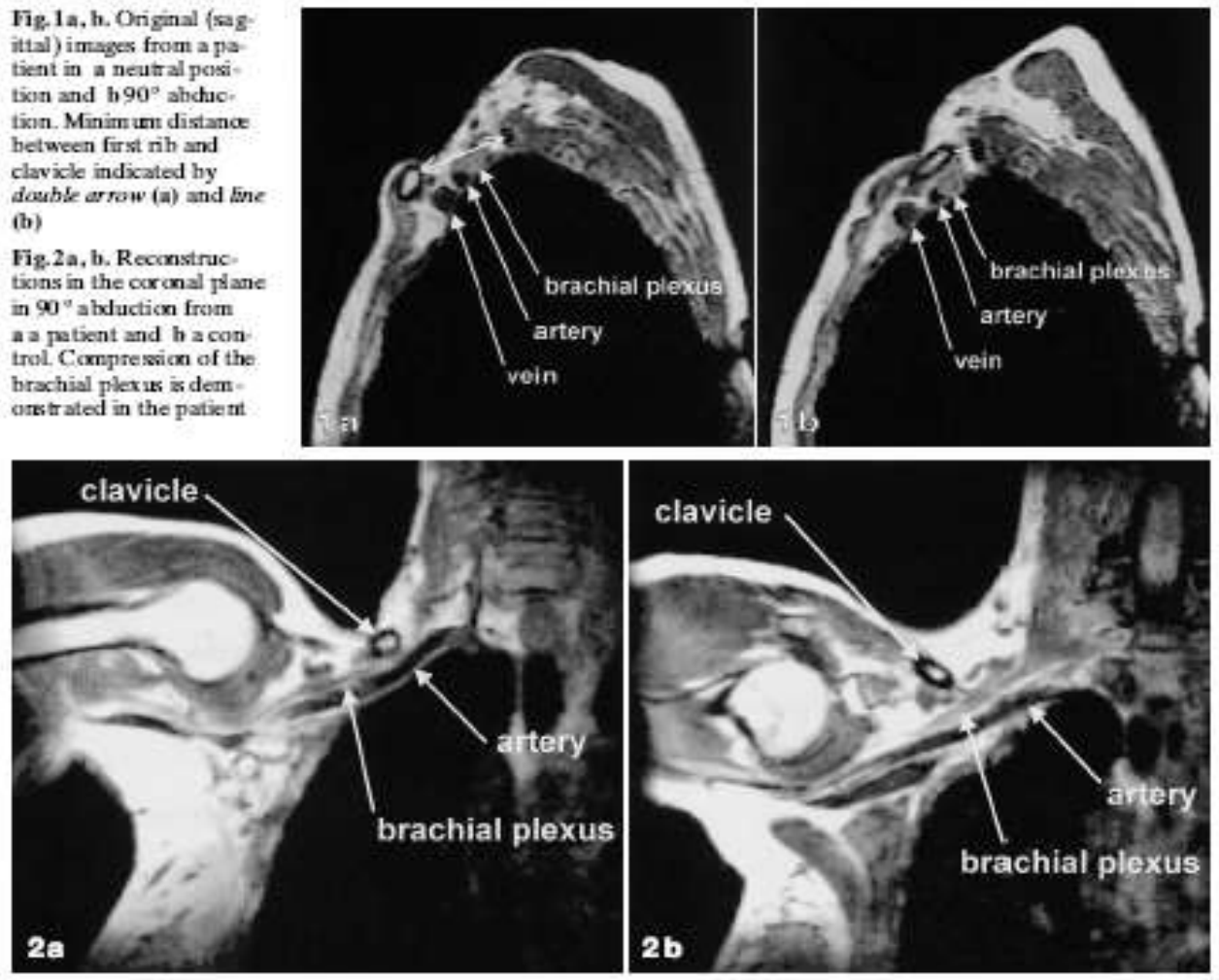


Fig. 1a, b. Original (sagittal) images from a patient in a neutral position and b 90° abduction. Minimum distance between first rib and clavicle indicated by *double arrow* (a) and *line* (b)

Fig. 2a, b. Reconstructions in the coronal plane in 90° abduction from a a patient and b a control. Compression of the brachial plexus is demonstrated in the patient

Figure(14) : MRI (from functional imaging of TOCS, Eur.Radiol.2000; 10 : 597-600)

(5) Electrodiagnostic Study : the electromyographic (EMG) study and nerve conduction velocity study, are of particular value in the diagnosis of TOCS [37] . In patients with TOCS, electrodiagnostic testing is useful particularly in the identification of associated sites of distal compression at the carpal tunnel or cubital tunnel level. The usefulness of electrodiagnostic studies in the diagnosis of TOCS has not been accepted universally and remains controversial [3] . To confirm the diagnosis of TOCS , somatosensory evoked potentials (SSEPs) has been reported as a more sensitive measures [38,39] . SSEPs would assess brachial plexus nerve compression more accurately .

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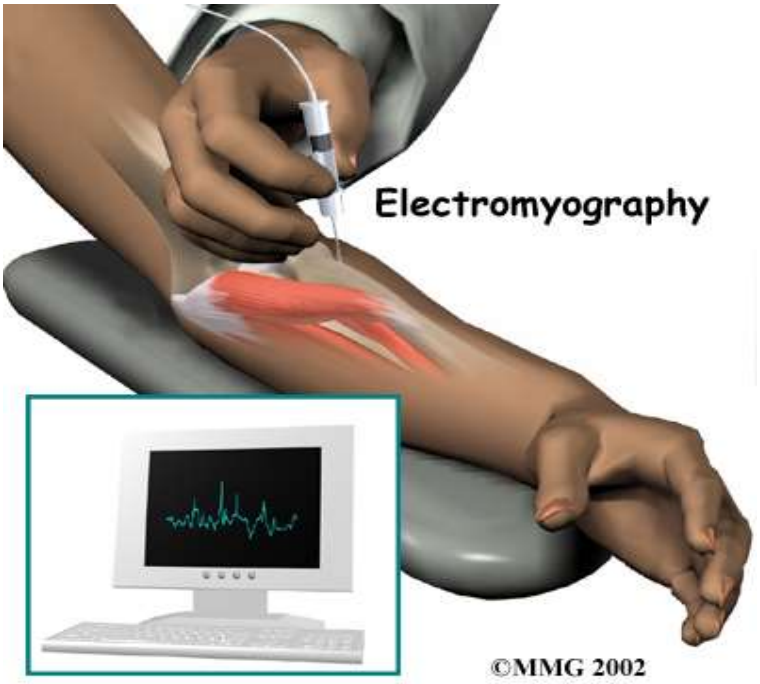


Figure 15 : EMG study

In EMG the patient is placed on the examination table with the arm fully extended at the elbow & in about 20 degrees of shoulder abduction(Fig 15).

The nerve conduction velocity is expressed in (meters/seconds) & is calculated by the following equation :-

Velocity= distance between two adjacent points / difference in latencies of these points

Where : Distance □ (millimeters) Latencies □ (milliseconds)

Diminution of the velocity in a given segment or increase delay at the wrist is indicative of either compression, injury, neuropathy, or neurologic disorder. The severity is graded according to diminution of velocity across the outlet [40,41] :-

- Slight compression □ Velocity 66-69 m/sec
- Mild compression □ Velocity 60-65 m/sec
- Moderate compression □ Velocity 55-59 m/sec
- Sever compression □ Velocity < 54 m/sec

1-9: Differential Diagnosis [62] :-

(a) Neurological: include ;

1. Cervical spine ; degenerative disease, ruptured intervertebral disc , osteoarthritis , spinal cord tumors , traumatic arthritis.
2. brachial plexus ; superior sulcus tumor , trauma-postural palsy.
3. peripheral nerves ; entrapment neuropathy (carpal tunnel syndrome , ulner n.-elbow , radial n. , suprascapular n.) , medical neuropathies , trauma , tumor.

(b) Musculofascial: include ;

myofascitis , tendonitis(supraspinitis) , bursitis , capsulitis .

(c) Vascular: include ;

1. Arterial ; atherosclerosis (aneurysm occlusive) , thromboangiitis obliterans , embolism , functional (Raynauds disease , reflex vasomotor dystrophy , causalgia , vasculitis , collagen disease , panniculitis)
2. Venous ; thrombophlebitis , mediastinal venous obstruction (benign , malignant).
(d) Other diseases: include ;
angina pectoris , esophageal , pulmonary .

1-10: Treatment :-
since the role of the 1st rib in causing compression has been established beyond any doubt, resection of the 1st thoracic rib become the standard procedure to relieve this syndrome [42,43] . However the treatment of TOCS include :

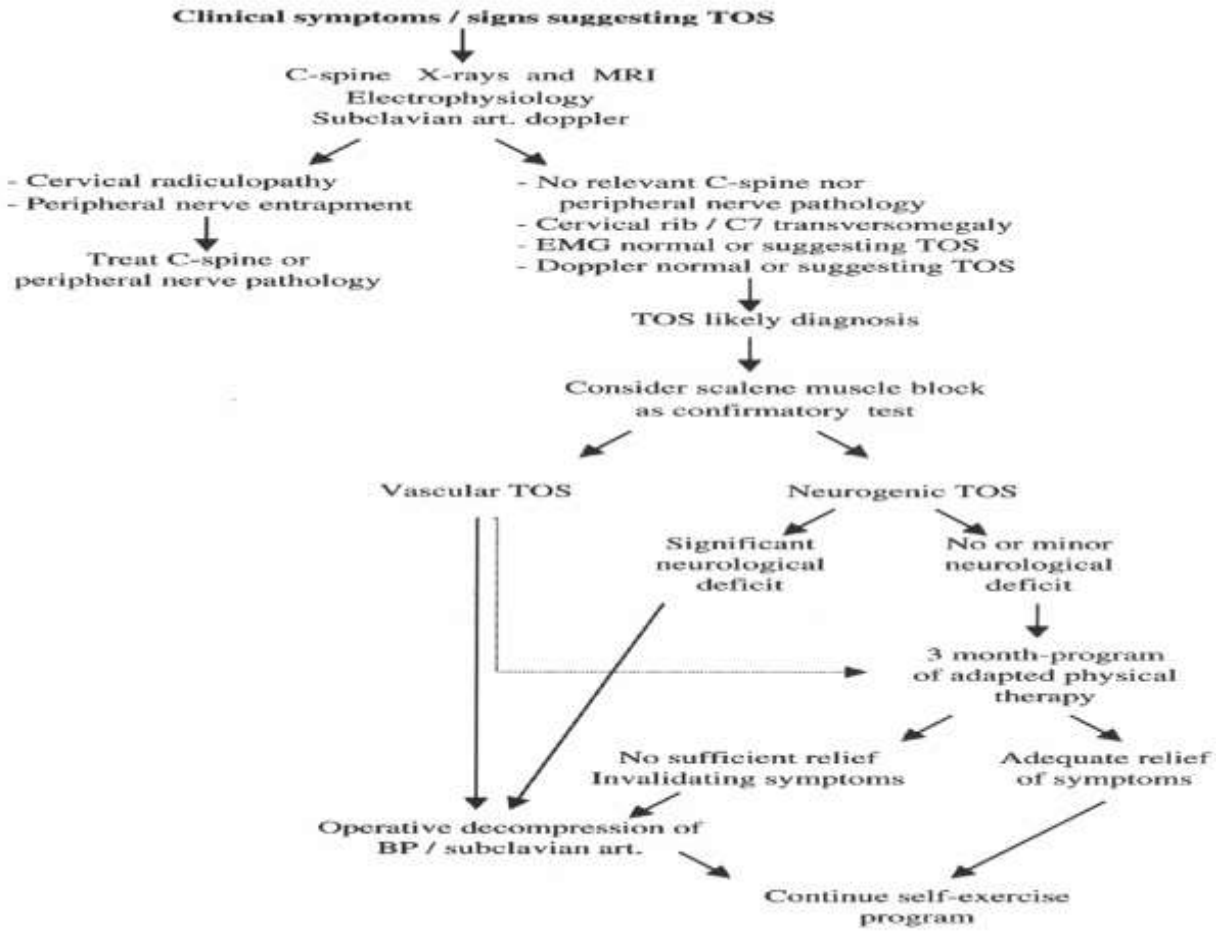


Diagram 2 : Management of TOCS. (from www.medschool.lsuhsc.edu)

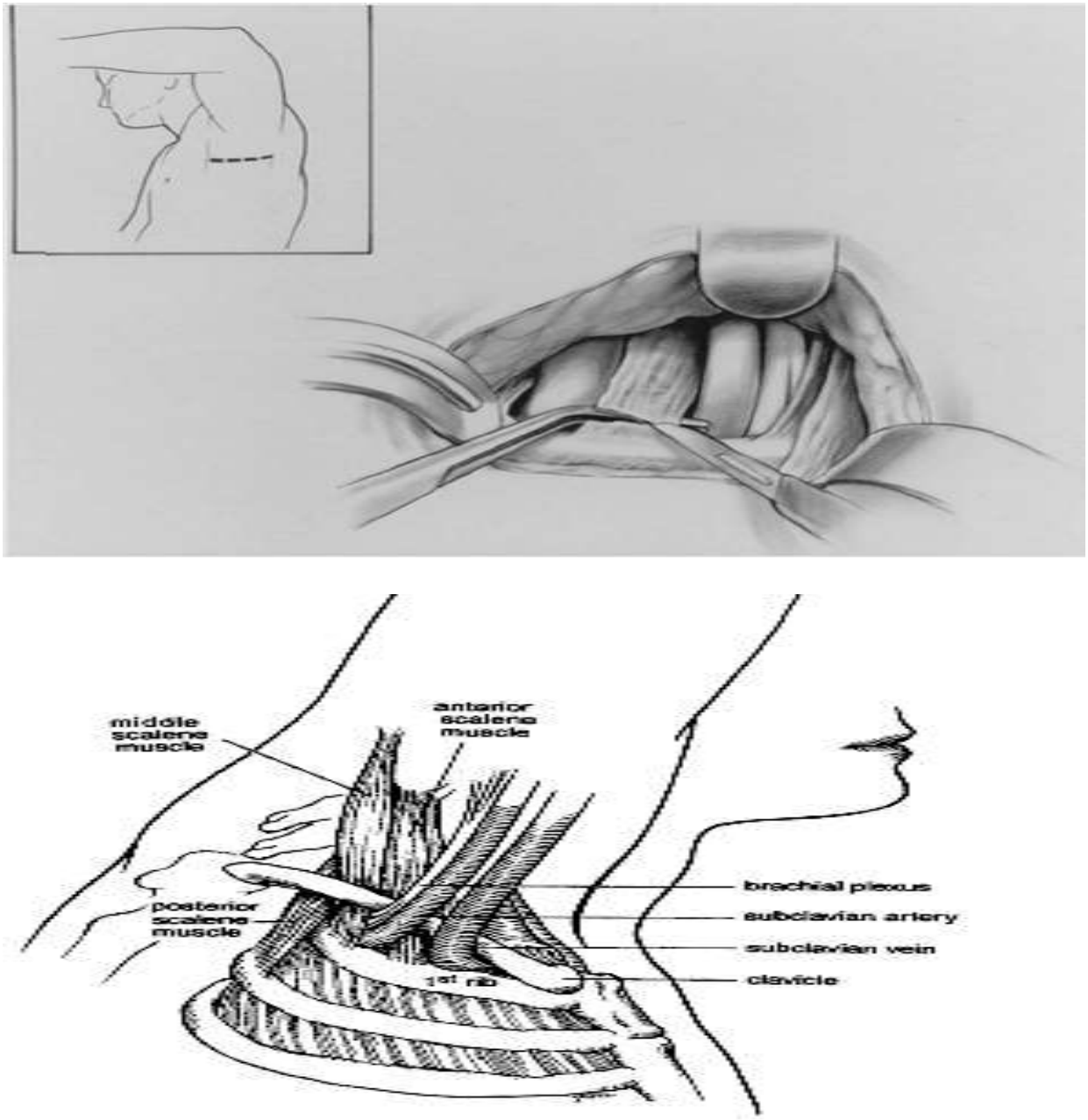
Conservative Treatment: the reported success [9,44-53] with conservative treatment of TOCS ranges from 50-90% . The goals of conservative treatment of patients with TOCS are directed towards decreasing the compression on the brachial plexus, restoring neural mobility, and correcting muscle imbalance in the cervicoscapular region (table 1).

TABLE 1. Overview of patient treatment
Evaluation
Nerve entrapment sitesPostureRange of motion and movement patterns: cervical, scapula, shoulder, armExclude or identify other pathologic conditions: cervical disc disease, nerve root impingement, shoulder tendinitisEducationPathophysiologic process of single and multiple level nerve compression Positions of most risk and least risk for nerve compression
Posture and position correction Integration of corrected postures in activities of daily living at work, home, and sleep Impact of obesity, breast hypertrophy, and general physical condition
Treatment Postural and positional correction
Neutral wrist splint at night, elbow pad, soft neck support for night use, lumbarsupport in sitting
Physiotherapy Pain control and range of motion
Stretching exercises for upper trapezius, levator scapulae, scalenes,
sternocleidomastoid, pectorals and chin retraction exercises (begin in supine with pillow support)
Strengthening exercises for middle/lower trapezius, serratus anterior, lower rhomboids
(begin in gravity-assisted positions) Aerobic conditioning program
Diaphragmatic and lateral costal breathing exercises
Progressive walking program and other aerobic conditioning exercises
Patient education and encouragement with compliance to home exercise program and
behavior modification
From Novak CB, Collins ED, Macikinnon SE. Outcome following Conservative Management of TOCS. J Hand Surg 1995 ; 20A : 542-548.

All patients, except those with complications or sever intolerable pain, should be given a benefit of conservative therapy for a period of 1-3 months to re-evaluate the results of such therapy [49].

Surgical Treatment: When patients have failed to respond to conservative management of their TOCS , Surgery may confer benefit to a significant number [54] . Surgical approaches include:

(1) Transaxillary Approach : introduced by Roos [55] in 1966 .The incision is transaxillary below the hair line , and traverse between the pectoralis major muscle anteriorly and latissimus dorsi muscle posteriorly . The incision is carried directly to the chest wall without angling up toward the 1st rib. When the chest wall was encountered, the dissection was carried superiorly to the 1st rib, identifying the intercostal brachial and thorasicus longus nerve . It was preserved by retracting anteriorly or posteriorly . The medial scalene muscle and the itercostal muscle of the 2nd rib were then eased off the rib with elevators. Scalene muscles, fibrous ligaments, and costaclavicular ligaments were resected. The 1st rib with periosteally was resected near the costal cartilage anteriorly and the transverse process posteriorly or disarticulation, keeping the T1 root out of the operative field . Then if there is cervical rib ,it is completely be resected .The pleura inspected carefully to detect any tear [56].



FI **Figure(16)** G 16 : Transaxillary Approach. (from Urschael HC. Jr. Chest Surg. Clin. North Am. 1999;9:771-780)

Advantages ; 1. cosmetically appealing, in females 2. doesn't involve muscle cutting 3. minimal blood loss 4. little risk of entering pleura 5. short operative timing 6. safe regarding neurovascular injury [60].

Disadvantages ; 1. difficult to resect (type 3&4) cervical ribs , posterior fibrous bands, costoclavicular ligament & posterior aspect of the 1st rib 2. difficult to deal with subclavian artery aneurysm [60].

(2) Supraclavicular Approach : (or Anterior Approach) in 1962, Falconer and Li noted good relief of TOCS symptoms through this approach [3]. Under GA , a supraclavicular incision is made one fingerbreadth above the clavicle extending 5-7 cm. The platysma is divided and

subplatysmal flaps are created. The omohyoid is divided and the scalene fat pad is dissected and retracted laterally. The phrenic nerve is carefully mobilized and retracted medially. The anterior scalene is divided 1 cm above its insertion onto the 1st rib. The subclavian a. is mobilized and encircled with vessel loops. The brachial plexus is dissected from surrounding tissues medially and laterally and the middle scalene laterally and the 1st rib medially are identified. The middle scalene is divided lateral to the plexus with care to avoid injury to the long thoracic nerve. The medial and lateral edges of the 1st rib are palpated and the intercostals muscle attachments are divided bluntly and sharply. The rib is then divided posteriorly distal to the transverse process. The intercostals muscle attachments are divided from the inferolateral aspect of the rib and the rib is transected anteriorly under the clavicle. Cervical ribs are easily resected through this same incision, and are identified just superior to the posterior aspect of the 1st thoracic rib [57] .

Advantages ; 1. arterial reconstruction can be carried out easily 2. cervical ribs can easily be resected. 3. useful in TOCS due to clavicular fracture [57] .

Disadvantages ; 1. subclavian vein reconstruction may require clavicular resection 2. risk of brachial plexus injury 3. extensive 1st rib resection needs supraclavicular and transaxillary approaches. [57] 4. pleura may be opened and requiring tube thoracostomy [3] .

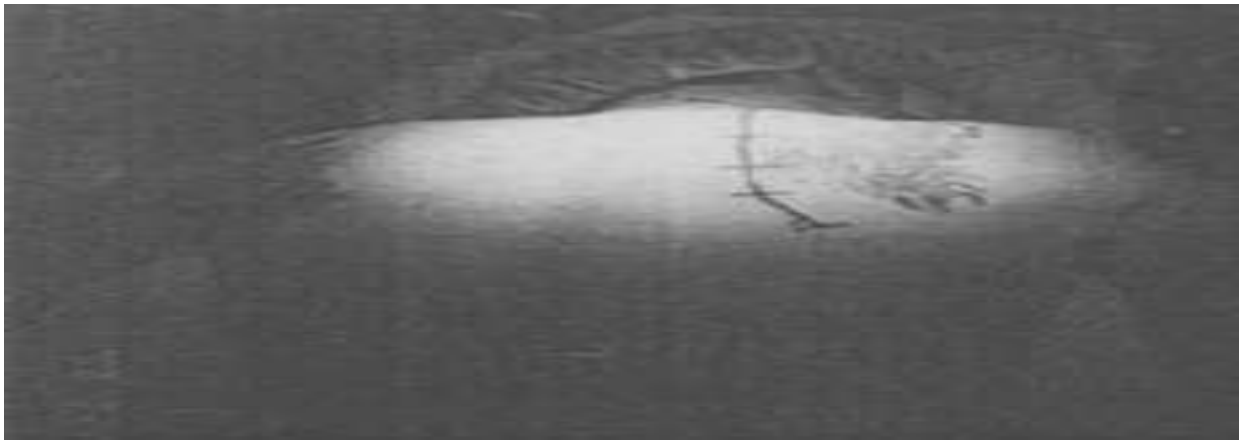
Figure(17) : Supraclavicular Approach. (from Neurosurgical Operative Atlas 1993 ; 3 : 185-191)

(3) Parascapular Approach : (or Posterior Approach) was introduced by Glagett in 1962, and it is used by a lot of surgeons and is reserved by some surgeons for complicated cases, recurrence of symptoms or regeneration of the 1st rib [58] . A curvilinear incision is made, approximately halfway between the spinous processes and the medial border of the scapula (Fig 18). After dividing skin, subcutaneous tissue and trapezius, the deep muscles(rhomboid major, rhomboid minor, and levator scapulae) are divided respectively from inferior to superior. Dissection is carried out beneath these muscles medially as far as the spinous processes and laterally in the avascular plane between scapula/serratus anterior and the thoracic wall.

The superior portion of the posterior chest wall is exposed by lateral retraction of the scapula. The 1st rib is palpated and scalenus posterior and the underlying scalenus medius are divided at their attachments to this rib. The 1st rib is then resected extraperiosteally (to prevent regeneration of the rib). By reflecting the scalenus muscles superiorly, the brachial plexus will now be visualized at the level of the trunks [59] .

Advantages ; 1. easier exposure to the lower elements of the plexus 2. more proximal exposure of the nerve roots 3. less risk of vascular injury 4. no risk to the phrenic nerve 5. safe approach 6. good exposure in TOCS with vascular complications [59] .

Disadvantages; division or transection of the large muscles of the back.



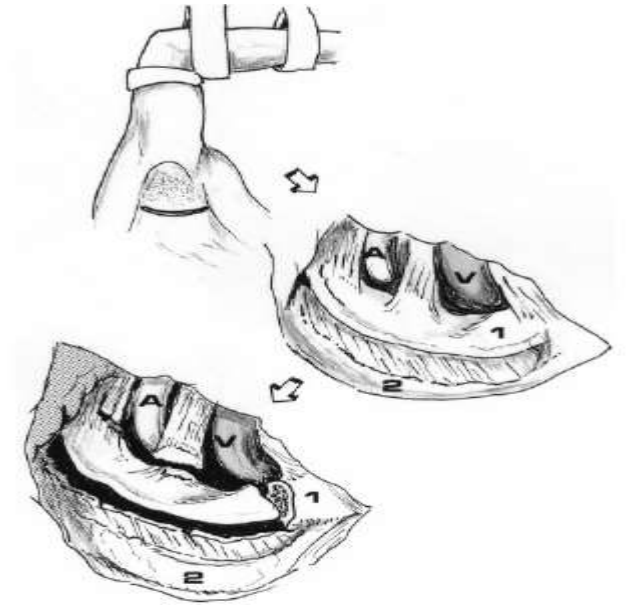
Figure(18) : Posterior Thoracoplasty Approach

(4) Double-incision Approach : or double-route technique or combined posterior and transaxillary approach for neurogenic TOCS .It is a new operative procedure described & entailing two stages using two separate incisions : transaxillary and posterior incision done at the same sitting that accomplishing complete removal of the 1st rib with less risk. This combined approach is done with the help of a new arm holder device during the transaxillary stage (Fig 19) followed by a small incision behind the trapezius ridge for posterior access to the rib [61] .

Operative Tachnique: First stage ; the transaxillary stage is done first , with the patient in a straight lateral decubitus position . The arm is held in the desired position by a special arm holder device (Fig 19). The rib is dissected exactly as proposed by Roos, in an extrapleural manner. The inferior border of the rib is dissected, allowing the pleura to fall away from the rib until the entire inferior surface of the rib is completely isolated. The intercostal space between the 1st &2nd ribs is quite wide, so it is usually easy to pass a finger under the rib from the front toward the back. The

1st rib is now divided flush to the sternum, but left in place, (Fig 20). The anterior scalene muscle tendon is exposed on the superior aspect of the rib behind the subclavian vein and infront of the subclavian artery. The muscle tendon is divided 1 cm above the rib, but not higher to prevent any possible damage to the phrenic nerve. Anterior to the vein , toward the sternum, the subclavius tendon should also be divided [61] .

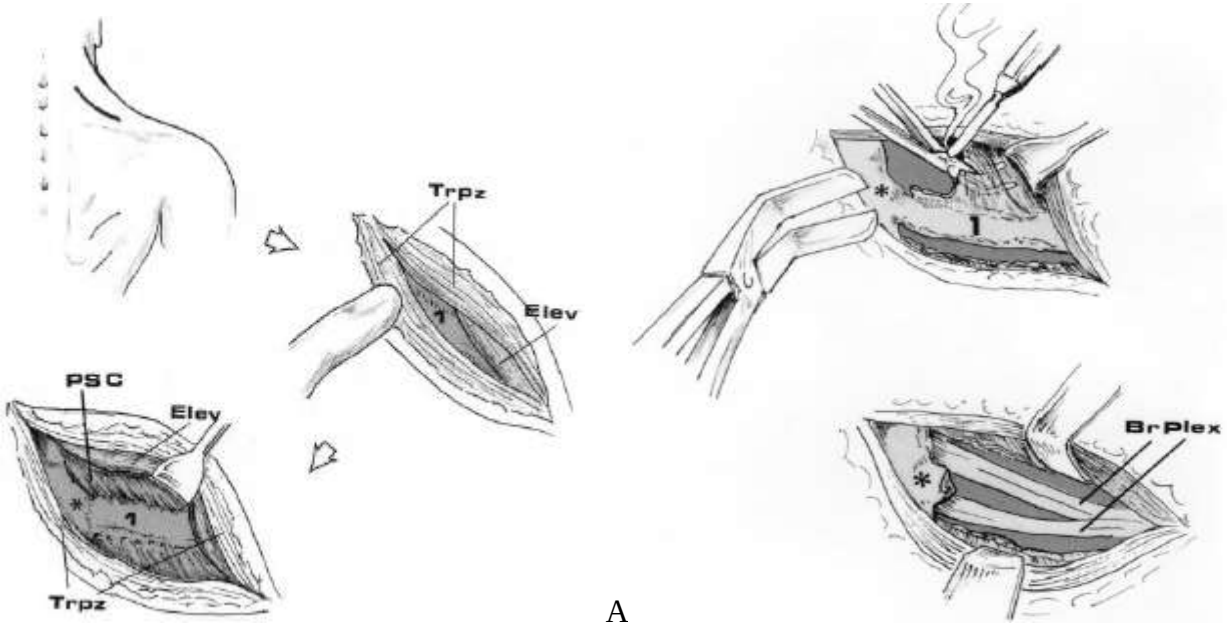
Figure(19) : Posterior Thoracoplasty Approach : Sterile arm holder attached to the operative table.



Figure(20) : Double route technique (First Stage) (from J. Am. Coll. Surg. 1998;187:42)

After these structures are transected, the dissection is continued posteriorly past the subclavian artery for a short distance. Some of the middle scalene muscle fibers should be visible, with the brachial plexus behind. These fibers are divided above the rib for some distance , to the point where the rib starts changing direction toward the spine in the back. The arm is then taken down from the arm holder and placed straight alongside the patient's body.

Second stage ; the posterior stage, an incision is made from the midline of the spine in the back , parallel to the trapezius ridge toward the shoulder (Fig 21 A). The incision is about 6 cm long and enters the skin and subcutaneous layers. On reaching the trapezius muscle, we spread the fibers of this muscle in their direction back toward the spine as well as toward the shoulder. Deeper to the trapezius, the next muscle encountered is the elevator of the scapula. Its inferior border is identified and dissected off, and the muscle is retracted superiorly (Fig 21A).



A

B

Figure(21) : Second Stage A. location of the posterior incision to approach the 1st rib with upward retraction of the elevator of scapula, B. division of the 1st rib at its insertion with the transverse process.(from J. Am. Coll. Surg. 1998;187:43)

The bottom of the incision now consist of the 1st rib and the posterior scalene muscle inserting into it. Using a fine right angle clamp, we divide all the fibers of the posterior scalene muscle, usually with cautery to keep a dry field (Fig 21 B).

We do so from the transverse process level down toward the shoulder, following the superior border of the rib until the space created from the transaxillary dissection is entered. The inferior border of the rib is now freed, and the rib is divided at the transverse process junction & removed (Fig 21 B). Hemostasis is revised with cautery and any sharp spike of the rib can be trimmed .

Advantages ; 1. it avoid any risk of vascular or neurologic injury 2. no need for reoperation because the rib is excised completely and complete removal of obstructing mechanisms 3. avoid transection of the large muscles of the back.

Dorsal Sympathectomy & TOCS Management by VATS :

Video-assisted thoracic surgery (VATS) offers better visualization of anatomical structures in a deep hole [62] . Video assistance is employed in two techniques :-

1. One involves the sympathectomy through three ports, with the standard VATS.
2. Second technique involves a transaxillary incision with removal of the 1st rib using video assistance magnification and light.

Major indications for dorsal sympathectomy include ; hyperhidrosis, Raynaud's phenomenon & disease, causalgia, reflex sympathetic dystrophy, and vascular insufficiency of the upper extremity.

When Raynaud's phenomenon of a minor to moderate degree is associated with TOCS, the simple removal of the 1st rib with any cervical rib, and stripping of the axillary-subclavian artery(neurectomy) will relieve most symptoms following initial operation & it is rarely necessary to perform a sympathectomy unless Raynaud's is a very sever type, in which case a dorsal

sympathectomy is carried out with 1st rib resection. In contrast, with recurrent TOCS and causalgia it has been found that dorsal sympathectomy should be performed with the initial reoperation procedure [62] . 2-1 : Material & Methods :

This is a retrospective study of 45 patients with Thoracic Outlet Compression Syndrome who were treated surgically in the department of Thoracic & Cardiovascular Surgery at the " Medical City Teaching Centre – Specialized Surgeries Hospital " , from January 1st,1997 to December 31st ,2006.

During 10 years, 51 patients were admitted to the Spcialized Surgeries Hospital , 45 patients were involved in this study , and 6 patients excluded (3 patients were treated conservatively, two patients refused surgical intervension & one patient died preoperatively due to CVA).(Table 1)

Table (1) : Patients with TOCS

Patients with TOCS from 1997-2006	No.
● Patients admitted to Specialized Surgeries H.	51
● Patients involved in the study	45
● Patients excluded from study :	6
- patients treated conservatively	3
- patients refuse surgery	2
- patients died preoperatively	1

Those 45 patients who were treated surgically, 39 patients(87%) were females and 6 patients(13%) were males, and their ages ranging from 18-54 years, and most of the cases were between 20 - 29 years (24 cases) , while (5 cases) was found below 20 years, (9 cases) between 30-39 years and(7 cases) was 40 years and above (Diagram 1 & 2)

The 6 male patients included in the study; one patient below 20 years & 5 patients between 20-29 years.

Those 45 patients included in the study , 21 patients(46.7%) with bilateral manifestations, 13 patients(28.9%) with right-sided manifestations, and 11 patients(24.4%) with left-sided manifestations. (Table 2) In those 21 patients with bilateral manifestations , the severity of symptoms was equal in both sides in 6 cases, right-side predominate in 8 cases, while left-side predominate 7 cases.

Table (2) : Sites of TOCS

Site of the TOCS	No.	%

Bilateral TOCS	21	46.7
Right-sided TOCS	13	28.9
Left-sided TOCS	11	24.4
Total	45	100

The duration of symptoms ranging between 2-10 years. Most of the patients presented with neurological manifestations 23 cases(51%), which include pain ,numbness and parasthesia in different levels of the upper limb associated with exercise, while vascular manifestations found in 7 cases(15.5%), represented by ischemia, edema and color changes of the affected upper limb which was found later to be caused by subclavian artery thrombosis or aneurysm and subclavian vein thrombosis in one patient ,and 15 cases(33.5%) had mixed neurological & vascular manifestations including Raynauds phenomenon in 3 patients.(Table 3 , Diagram 3)

Table(3): Clinical Manifestations

Symptoms	No.	%
-Neurological	23	51
-Vascular		
Arterial	5	11
Venous	2	4.5
-Mixed (Including Raynaud's Phenomenon)	15	33.5
Total	45	100

By clinical examination ; physical tests were performed in all patients but not uniformally and not well recorded in the patient's case sheets . All the patients had changes in sensation over the affected limb, while changes in radial pulse found in 40 cases, 15 cases of them had changes in hand color , and only 2 cases had supraclavicular bruit, and 2 cases had wasting in hand muscles, while ulceration of the hand was not recorded in any patient.(Table 4).

Table(4) : Physical Findings

Physical Findings	No.	%
-Changes in Radial Pulse	40	89
-Changes in the color of the hand	15	33
-Changes in the sensation over the limb	45	100
-Wasting of the muscles of the hand	2	5
-Ulceration of the hand	0	0
-Supraclavicular bruit	2	5

By Radiological Examination ; 32 cases (71%)out of the 45 patients had Cervical Ribs, which was bilateral in 17 cases , right-sided in 9 cases , & left-sided in 6 cases.(Table 5) Among those with bilateral cervical ribs , 5 patients had bilateral manifestations and was bilaterally operated.

Table (5) : The sites of the Cervical Ribs

Site Of Cervical Rib	No.	%
- Bilateral Cervical Rib - Right-Sided Cervical Rib - Left-Sided Cervical Rib	17 9 6	
Total	32	71

Doppler study done in 15 patients(33%) ; it was normal in 7 cases, while in 5 cases it demonstrated pressure on vessels, and in one patient there was subclavian artery aneurysm, and in one patient there was subclavian artery thrombosis, and axillary - subclavian vein thrombosis found in one patient (Table 6). Only five cases required angiography which was normal in 3 and confirmed the diagnosis of subclavian artery aneurysm and thrombosis in the two patients mentioned before.(Table 7)

Table (6): Doppler study

Patients With Doppler Study	No.	%
Patients With Normal Study Patients With Pressure On Vessels Patients With Subclavian A. Aneurysm Patients With Subclavian A. Thrombosis Patients With Subclavian V. Thrombosis	7 5 1 1 1	
Total	15	33

Table (7): Angiographic study

Patients With Angiography	No.	%
Normal Angiography Subclavian A. Aneurysm Subclavian A. Thrombosis	3 1 1	
Total	5	11

The results of ulner nerve conduction velocity & EMG study was recorded in the case sheets of 22 patients (49% of cases) ; 18 cases had abnormal study (pressure on C8, T1), while it was normal in 4 cases. (Table 8)

Table (8): UNCV & EMG study

Patients With Electrodiagnostic Study	No.
Normal Study Abnormal Study	4 18
Total	22 (49%)

In the case sheets of those 45 patients included in the study, there were no records of performing CT scan or MRI .

2-2 : Surgical Procedures :

Out of all patients operated upon, 10 patients(22%) refused conservative treatment because of sever symptoms, complications, or delayed surgical counsultation , and 35 patients (78%) were given a chance of conservative treatment by physiotherapy and analgesias of at least 3 months and was judged according to the patients waitancy for operation, and surgery was performed upon failure to response to conservative treatment.(Table 9)

Table (9) : Conservative management

	No.	%
Patients Whose Conservative Treatment Not Applied	**10**	**22**
Patients Whose Conservative Treatment Applied :	**35**	**78**
- Physiotherapy		
- Medications		
(Duration 3 Months – 1 Year)		

There was 51 operations performed in 45 patients ; which was right-sided in 21 patients(47%) , left-sided in 18 patients(40%) , and bilateral in 6 patients(13%).(Table 10)

Operations for recurrent cases found in one patient only, which was operated previously by transaxillary approach.

Those patients with bilateral operations (6 cases) ; in 4 cases right side operated first , and in only 2 cases left side operated first. The intervals between the 1st and 2nd operation ranging between 1-4 years.

Table(10) : Surgical Statistics

Operations		

Patients operated upon	45	
No. of Operations	51	
Sides of Operation		
- **Bilateral**	6	13
- **Right**	21	47
- **Left**	18	40
Operations by posterior approach	50	98
Operations by other approaches(transaxillary)	1	2
Operations for recurrent cases	1	

Indications for operation include:

- Symptomatic Cervical rib & abnormalities of Clavicle or 1st rib.
- Subclavian artery dilatation due to cervical rib or fibrous bands.
- Peripheral ischemia.
- Embolic phenomenon
- Failure of conservative treatment.
- Moderate to Sever discomfort with abnormal EMG study.

Posterior thoracoplasty approach was performed in 44 patients(98%), and transaxillary approach in 1 patient(2%). (Table 10)

In the surgical procedures which was performed in those 45 patients; the dorsal 1st rib was removed in all(51) operations(100%), cervical rib was removed in 37 operations(72%) , scalenotomy & fibrous bands division was in all operations (100%), abnormal transverse process of C7 was removed in 2 operations(4%), sympathectomy in one operation(2%), endarterctomy in one operation(2%), and grafting for subclavian artery aneurysm in one operation(2%).(Table 11)& (Diagram 4).

Table (11) : Operative Techniques

Techniques	No.	%
First Rib Removal	51	100
Cervical Rib Removal	37	72
Scalenotomy	51	100
Fibrous Bands Division	51	100
Abnormal C7 Transverse Process Removal	2	4
Others		
- **Sympathectomy(Via Thoracotomy)**	1	2
- **Endarterctomy**	1	2
- **Graft For Subclavian A. Aneurysm**	1	2
Total No. Of Operations	51	

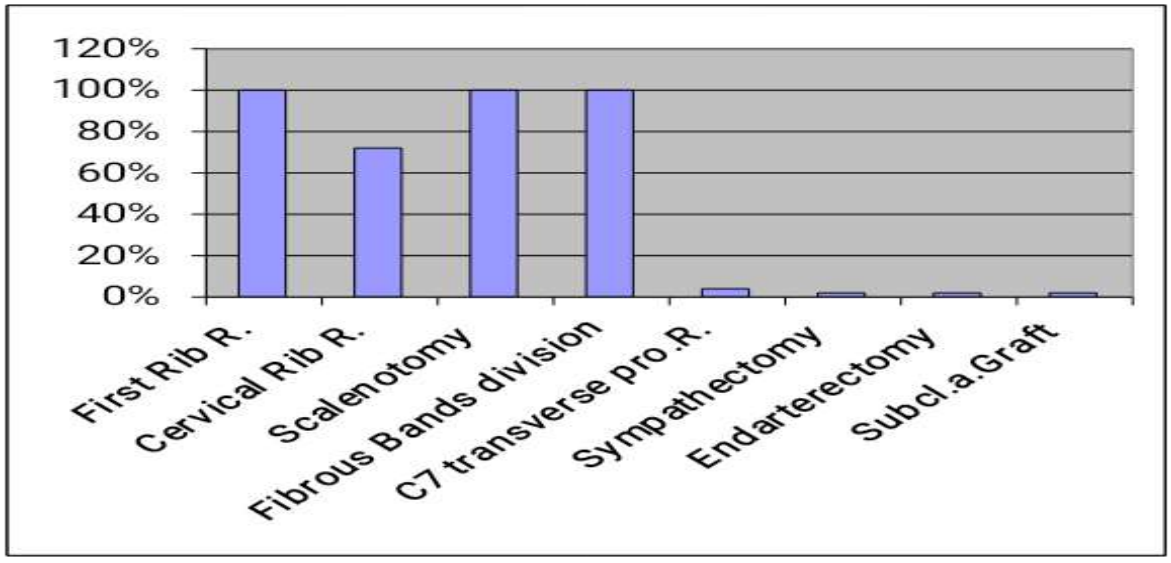


Diagram 4 : Operative Techniques (Removal & Divisions)

Operative complications (whether intraoperative or postoperative) encountered in 5 operations(10%) ; in two cases postoperative wound infection occurred and in 3 cases the pleura opened accidentally which required chest tube insertion for 24 hr postoperatively.(table 12)

Table (12) : Operative complications

	No.	%
Wound infection	2	
Pleura opened	3	
Bracial plexus injury	0	
Total Complications	5	10

Early postoperative relieve of symptoms occurred in allmost all patients and all patients were advised to go on exercise postoperatively, and with time most of the surgical incision pain and discomfort disappeared.

2-3 : Results :

In this study; the total number of patients operated upon were 45 patients, subjected to 51 operations (during 10 years), including 6 patients had bilateral operations, and only one patient had previous surgery with no relief of symptoms, and there were no recorded mortality in those 45 patients.

In all operations performed; most of the first rib excised together with fibrous bands division and scalenotomy, while cervical rib excised in 37 operations(72%) and the abnormal transverse

process of C7 vertabra excised in only two operations(4%), while sympathectomy , endarterectomy , and subclavian artery grafting for aneurysm occurred once(2% for each).

Early postoperative relieve of symptoms occurred in almost all patients subjected to operation, and those patients with preoperative negative pulse due to vascular compression, thrombosis, or aneurysm had positive pulses postoperatively. And the patient that had recurrent symptoms develops complete relieve .

Brachial plexus injury was not encountered in any operation, while wound infection occurred twice and tube thoracostomy needed in three operations due to pleural opening accidentally during operation.

In only one case , thoracic outlet decompression with thoracotomy for sympathectomy was performed and necessitate chest tube insertion (to increase the number of chest tubes insertion to 4 cases).

Only one patient (who was a known case of epilepsy) developed seizure postoperatively which was unrelated to the operation , but may be to anaesthesia, and in only two cases there was severe motor deformity with contracture of hand muscles preoperatively not get benefit from surgery more than relieve of symptoms, while hand deformity remained.

3-1 : Discussion :

" Thoracic Outlet Compression Syndrome " , a term coined by Rob and Standeven in 1958 , refers to compression of the brachial plexus and subclavian vessels at the superior aperture of the chest [66]

The surgical approach of TOCS remains controversial ; different operations have been proposed with similar , and sometimes different , results in complications and long term results [67] .

In our study , 45 patients retrospectively taken in the last 10 years from January 1997 to December 2006 . They are studied according to their age , sex , causative factors , clinical features , side of affection and compliance , diagnostic measures , theraputic planing , surgical approaches , and surgical outcomes.

Thoracic Outlet Compression Syndrome is underdiagnosed in most societies and its incidence is dificult to be mentioned exactly.

Thoracic Outlet Compression Syndrome is more common in female than male , as appeared in our study , and many different studies [55,60,61,64] taken for purposes of comparism with our study, and this can be explained on the basis of weak muscles of shoulder girdle in female and existed weight of the pendulous breasts together with house hold activities , that cause neurovascular compression in the thoracic outlet [68].

Regarding to the age , TOCS is more in the third & fourth decades of life , and in our study it is more in the third decade , and this may be explained on the basis of being involved in heavy works and responsibilities which can be seen when the patient reach the third & fourth decades of life.

TOCS can affect any side , right or left or both , but it is slightly more common in the right side because it is the dependent side in most of the general population, our study confirm this and agreed with other researches , as mentioned in table(1).

Different etiological factors as cause of TOCS are present , but cervical rib remain the most important factor . In our study it is the causative factor in about 72% of cases , and it was so in

many different researches mentioned in table(1) , inspite of that many patients presented with clinical features of TOCS but without cervical rib.

The diagnosis of TOCS remains controversial [55] because of the subjectivity of patient complaints and the difficulty in objectively quantifying these complaints. The clinical evaluation therefore remains the most critical component in the diagnosis of TOCS. The symptoms of thoracic outlet syndrome fit, with some overlap,into four groups: neurological, arterial, venous and non-specific.

Neurological symptoms consist of pain, paraesthesia, anaesthesia and motor weakness , mostly involving the lower plexus (ulnar nerve) distribution.

Arterial symptoms include aching, fatigue, upper limb claudication and signs of distal embolization. Autonomic vascular symptoms include pallor, excessive sweating and Raynaud's phenomenon. Venous symptoms were not seen in many series, but include swelling , cyanosis of arm , acute deep vein thrombosis.

Doppler ultrasound, arteriography , and venography may show vascular abnormality or its sequelae.

Neurological manifestations whether pure or in combination with vascular manifestations are more common than vascular manifestations alone. This role appeared in our study in ratio of 5.5 : 1 , and it was not largely different from other previously mentioned researches.

Bilateral TOCS present in most patients but usually one side manifestations predominate, and little of them ask for bilateral surgery , this was clear in our study and other studies , table(1).

Table (13): Comparisim between our study & 4 different studies

Hg Study	Our Study	Study A[60]	Study B[55]	Study C[64]	Study D[61]
No. of pat.	45	50	60	47	33
Study period	10 years	8 years	10 years	15 years	-
Mean Age	28 years	27 years	30 years	37.9 years	38 years
♀:♂ ratio	39 : 6	40 : 10	49 : 11	41 : 6	25 : 8
Rt. : Lt.	13 : 11	28 : 22	35 : 22	16 : 14	19 : 14
Bilateral	21	3	3	17	-
Cervical Rib	72%	42%	95%	40%	-
Neuro.:Vasc.	85% : 15%	84% : 16%	87% : 13%	89% : 11%	-

The physical provocative tests , used for the clinical diagnosis of TOCS , are important in all cases but they don't confirm the diagnosis and the need for radiological and electrodiagnostic studies are important to reach the provisional diagnosis of TOCS .

Radiological examination of the cervical spine and the chest can demonestrate bony abnormalities like cervical rib , long transeverse process of C7 vertebra , & first rib abnormalities. In our study all of the cases were asked for x-ray of the neck and upper chest , and in unclear cases further

evaluation by CT-scan assist in reaching the precise cause of TOCS , while doppler study and angiographic study were very helpful in vascular TOCS in confirming or excluding vascular compression , thrombosis , or aneurysm but should be done in adson's maneuver to elicit any existing compression.

In our study the doppler study were in 33% of cases and only 11% required further evaluation by angiography .

Electrodiagnostic studies like electromyographic study and nerve conduction velocity study play important role in reaching the provisional dignosis of neurological TOCS particularly in the identification of associated sites of distal nerve compression at the carpal tunnel or cubital tunnel level. In our study EMG study were asked in 49% of cases and in most of the abnormal findings there were be compression of the lower trunk of the brachial plexus by which C8 & T1 nerve roots were compressed.

Since the beginning of the 20th century the treatment of TOCS has been controversial. Many issues, including the indications for surgery and the correct surgical approach, have not yet been resolved At present, conservative management--consisting of a weight reduction program and physiotherapy is effective in relieving mild to moderate symptoms in most patients. Surgical decompression is necessary when symptoms are intolerable and not relieved by conservative therapy [65] .

The decision to recommend or not is determined by a careful preoperative evaluation of patients who have neurologic symptoms attributable to compression of the upper or lower roots after eliminating other neurologic conditions and the patient's degree of disability and motivation [65] .

In our study 78% of patients given a chance of conservative treatment by physiotherapy and analgesia for at least 3 months but not exceed 1 year , and then surgical decompression is recommended , and only 22% of patients refuse the initial conservative way , because of sever symptoms resulted from late presentation to the physician , or because of vascular TOCS.

Throughout the years , the consensus of surgeons treating neurogenic TOCS has been that clinical assessment is the only way to determine the need for surgery. Several surgical approaches have been described, but a few are more frequently done. One option is the supraclavicular route going anteriorly above the clavicle, as described by Mc Cleery and coauthors, Falconer and Li, Cheng and colleagues, Cheng and Stoney, and others. The transaxillary route introduced by Roos was initially recommended for all TOCS types, but most patients reported by Roos were actually neurogenically or arterially compromised. The posterior approach, introduced by Clagett, is a formidable operation derived from thoracoplasty incisions. According to Urschel and coworkers, it is recommended only when the previous intervention has failed and the patient returns with more symptoms. The supraclavicular approach is preferred by several surgeons as a primary operation, even sparing removal of the first rib. The transaxillary approach, however, has been by far the most common and popular. Any of these operations for TOCS can have potentially serious complications, as outlined by Leffert. As a first step, conservative treatment of neurogenic TOCS is always recommended, but more often than not, it fails and only postpones the inevitable surgical intervention. A wide variety of factors can lead to neurogenic TOCS. Green and colleagues found that neurogenic symptoms of TOCS respond more favorably to surgery if they are caused by

trauma, particularly in men. This finding was also reported by Sanders and associates, who performed transaxillary resections with a 72% success rate [61].

In our study there was 51 operations done ; in all these operations the most of first rib excised together with scalenotomy and fibrous bands division , while cervical rib removal done in 37 operations(72%) . The most widely used approach was posterior thoracoplasty approach which was applied in 98% of operations and it was the most preferred approach by most thoracic surgeons in our centre for many reasons ; it is safe approach , with good exposure and less risk of vascular injury and no risk of phrenic nerve injury and easier exposure of the lower elements of the brachial plexus , and there was no reports of recurrence of TOCS or reoperations in patients operated by posterior approach ,therfore in spite of being approach with unacceptable scar and division or transection of the large muscles of the back it is still the most preferred approach by our thoracic surgeons.

If we compare our study with the four taken studies (Study A , B , C , & D) mentioned previously ;

In the (study A) [60] , similar result was found for many reasons ; it was from the same thoracic centre and most of the thoracic surgeons was the same or from the same thoracic school which consider the posterior approach the most effective approach with a lot of advantages mentioned previously and little disadvantages , of cosmetically unacceptable scar , which is unimportant in our society whom considered the success of surgery related to the relief of the symptoms .

In the (study B) [55] , the preferred approach was the transaxillary approach which is related to many reasons ; it is cosmetically appealing , in females , and doesn't involve muscle cutting with minimal blood loss and little risk of entering pleura , in addition to short operative timing and safe regarding neurovascular injury. But in spite of that , there was important disadvantages which include ; difficulty to resect type I & II cervical ribs , posterior fibrous bands, costoclavicular ligament & posterior aspect of the 1st rib & difficulty in dealing with subclavian artery aneurysm

In the (study C) [64] , the preferred approach was supraclavicular approach (or anterior approach) and in some of cases of this study combined supraclavicular and transaxillary approaches were applied . In this approach arterial reconstruction can be carried out easily and cervical ribs can easily be resected , and it was useful in TOCS due to clavicular fracture . But in this approach subclavian vein reconstruction may require clavicular resection and there is risk of brachial plexus injury , also extensive 1st rib resection needs supraclavicular and transaxillary approaches , and pleura may be opened and requiring tube thoracostomy , also in this study recurrent TOCS occurred in two cases which require reoperations.

In the (study D) [61] , 33 patients were taken and a new operative procedure is described entailing two stages using two separate incisions: a transaxillary and posterior incision done at the same sitting that accomplishes complete removal of the first rib with less risk. This combined approach is done with the help of a new arm holder device during the transaxillary stage followed

by a small incision behind the trapezius ridge for posterior access to the rib. It was found that double-route technique for patients with neurogenic TOCS seems to work very well. It avoids any risk of vascular or neurologic injury as well as any need for reoperation, because the rib is excised completely every time. It also ensures complete removal of the obstructive mechanism, involving not only the brachial plexus trunks but also the subclavian artery. It is pertinent to emphasize that the subclavian vein as well as the artery can also be involved in cases of neurogenic TOCS.

Recurrences & Reoperations [60,62] , may occur from 1 month to 7 years after initial rib resection but usually the first 3 months . There are two types of recurrences :-

● Pseudorecurrence ; who never completely relieved of symptoms after the initial operation. Causes ; technical error at the initial operation like resection of the 2nd rib instead of the 1st, or resection of the 1st rib with a cervical rib left in place, or resection of the cervical rib with an abnormal 1st rib left.

● True recurrence ; those relieved of symptoms after the initial operation but had recurrence of symptoms after 3-18 months. Causes ; a substantial posterior stump>1 cm , or excessive scar formation on the brachial plexus, or unrecognized adventitious or muscular bands or unresected tight periosteal bands or the resection of the rib was subperiosteal.

Physiotherapy should be given to all patients with symptoms of neurovascular compression after 1st rib resection. If the symptoms persist and/or the conduction velocity remains below normal, reoperation is indicated.

The basic elements of reoperation include ; resection of persistent or recurrent bony remnants of a cervical,first rib, neurolysis of the brachial plexus and nerve roots, and dorsal sympathectomy.

Reoperation is performed with the posterior thoracoplasty approach . The transaxillary or supraclavicular approach is inadequate for reoperation .

3-2 : **Conclusion :**

► Thoracic Outlet Compression Syndrome is more common in females than males.

► Thoracic Outlet Compression Syndrome is more on the right side than the left side.

► Thoracic Outlet Compression Syndrome is more common in the third and fourth decades of life.

► Thoracic Outlet Compression Syndrome is most commonly caused by cervical rib.

► Thoracic Outlet Compression Syndrome is not necessarily caused by cervical rib.

► Thoracic Outlet Compression Syndrome even when bilateral one side predominates.

► Thoracic Outlet Compression Syndrome neurological symptoms (whether pure or in combination with vascular symptoms) are more than vascular symptoms alone.

► The physical provocative tests are useful but not confirm the diagnosis.

► The Radiographic and Electrodiagnostic studies are important in all cases.

► The Doppler study and Angiography are important in the vascular TOCS.

► The CT-scan and MRI are very effective.

► The conservative measures have to be started in all cases but are usually of little value in our patients because of late presentation.

► The posterior approach of surgery (parascapular approach) is prefered by most of our surgeons.

► Scalenotomy, fibrous band division & 1st rib removal are important points in the surgical treatment.

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