

Thoracic Outlet Release

Surgical Indications and Considerations

Anatomical Considerations: There are three potential spaces for compression or entrapment through the thoracic outlet. The first is the interscalene triangle located within the posterior triangle of the neck. Within this triangle, the subclavian artery and brachial plexus lie. The subclavian vein usually lies anterior to the anterior scalene, outside the triangle. Therefore, compression usually produces neurological and/or arterial symptoms. The second potential space is the costoclavicular interval, which is between the clavicle and first rib. The final potential space is the axillary interval. This area is made up of the deltopectoral fascia, the pectoralis minor, and the coracoid all of which can put pressure on the neurovascular bundle composing the thoracic outlet.

Pathogenesis: The etiology of TOS symptoms can be vascular (venous or arterial), neurologic, autonomic, or a combination of the three. Compression usually creates symptomatology in the medial cord distribution (radial three digits and volar aspect of the forearm). Late neurological symptoms may include pain and/or sensory changes and paresthesias distributed over the face, posterior and lateral neck, anterior shoulder, and posterior/lateral aspect of the humerus. Venous symptoms could include distal edema (especially after activity) and pain (described as a dull ache and non-specific) in same peripheral distributions. There are two different kinds of thoracic outlet, entrapment vs compressive and distinguishing between them is important. A patient with compressive TOS usually has poor posture and describes an insidious onset with no history of any trauma. The subclavian artery and brachial plexus may be subjected to mechanical compressions at one of the potential sites if there is a presence of a cervical rib, abnormal first rib, transverse enlargement of C7, hypertrophy of the surrounding muscles, abnormal costocoracoid ligament, abnormalities of the clavicle, regional enlargements. In comparison, a patient with entrapment TOS usually has co-morbidity(ies) including cervical and/or shoulder trauma or may be related to long standing repetitive stress activities. This patient's symptoms are usually delayed in relationship to the initial trauma and the pain is constant. Treatment to patients with entrapment TOS usually provokes their symptoms.

Epidemiology: The incidence of TOS is between 50%-80% in women usually manifesting in their forties. Because of the two kinds of TOS, poor posture, people who adopt poor body mechanics especially sitting at a desk, and/or trauma to surrounding areas can predispose a person to TOS. There also seems to be a high correlation between worker compensated patients and outcomes of TOS treatment.

Diagnosis:

- Neurovascular compression tests: Adson test (positive in 60% of TOS patients), Wright test (positive in 18%), McGowan-Velinsky test (positive in 38%), elevated arm stress test (EAST – positive in 68%)
- Positive for TOS on electromyography
- Positive Doppler fluximetry (with dynamic tests post-operatively)

Indications for Surgery in Neurogenic TOS:

1. Confirmed diagnosis based on history and physical examination. Does not require objective findings, such as neuroelectric studies, arterial vascular studies, or angiograms.
2. All associated or differential diagnoses have been evaluated and treated.
3. Appropriate physical therapy has been tried for at least 3-6 months and has failed.
4. The patient is experiencing some degree of disability at work, recreation, sleep or activities of daily living.

Nonoperative vs. Operative Management: Surgery has been shown to be successful when conservative treatment of TOS has failed or when patients have too severe of symptoms to tolerate conservative treatment. TOS release should be performed only on people with non-disputed TOS (neurogenic, arterial, or venous forms), however objective diagnosed cases are rare. Therefore, most surgeries are done on people with disputed TOS. The most favorable results of treating TOS have been shown through conservative management. However, a study by Landry, GJ. et al (2001) stated that follow up data of 70 patients indicated that there were no significant difference between the patients that had surgery and the patients that were treated with non operative management. Another study by Toso, C et al (1999) stated that follow up data of 28 patients would chose to have TOS surgery again if symptoms were to reappear and 13 said to have had a poor outcome. However, this article also admitted that conservative treatment should always be tried first because most cases of TOS are due to muscle imbalance and poor posture. Most authors agree that strengthening and stretching exercises should be administered and surgery can be proposed when symptoms are too severe to be treated conservatively or after 6-12 months of unsuccessful conservative management.

Surgical Procedure: There is no surgical procedure proven to be better than any other. These techniques include scalenotomy, scalenectomy, neurolysis, claviclectomy, and pectoralis minor release. Some researchers state that if a cervical rib is present, surgeons can either resect it or resect the first rib. If the surgeon chooses to resect the cervical rib, they can choose a supraclavicular approach. If they choose to remove the first rib, they can choose a transaxillary or transthoracic approach. If there a cervical rib is absent, then any of the three approaches (supraclavicular, transaxillary, and transthoracic) are available. Neurolysis, another surgical option, is considered easy to perform over C5, C6, and C7 nerves. C8 and T1 nerves are often covered by various tissues including the scalene minimus muscle in 25% of people, which must be removed. The scalenotomy procedure begins by retracting the C5 nerve medially and identifying the long thoracic nerve (LTN), which arises from C5, C6, and C7 nerve. Once this nerve is identified any or all of the three scalene muscles can be excised. The middle scalene is the most common scalene excised. Once a scalenectomy and neurolysis are complete, the operation can continue through the same incision with a first rib resection. Research, however, as shown that success rates for scalenectomies with and without rib resections is 70% indicating that there may not be need for a rib resection if scalenectomie(s) have occurred. Long-term results indicate that complete scalenectomies (all three scalene muscles) did not have a better success rate than subtotal or partial scalenectomies.

Preoperative Rehabilitation: Preoperative rehab tends to be heavily performed in hopes of avoiding any form of surgery since most TOS can be corrected. Therefore, a preoperative protocol is intensive and individualized.

Stage one – The goal in this stage is to decrease and control the patient's symptoms. It is imperative in this stage that the patient and therapist identify activities, positions, and treatments that exacerbate and relieve the patient's symptoms.

Stage two – This stage is initiated once control and comfort has been achieved. In this stage tissues directly related to the TOS component can be addressed. This includes treating these tissues that are creating structural limitations of motion or compression. During this stage, treatment may exacerbate the patient's symptoms, however, it should not last beyond the treatment session. This stage introduces techniques such as soft tissue mobilization. These manual techniques are to improve flexibility of involved tissues, restore normal resting lengths of musculotendinous units, and assist in restoring normal posture. This protocol includes joint mobilization of the acromioclavicular, sternoclavicular, and scapulothoracic joints, first rib, and cervical spine. In addition, deep massage and stretching of the pectoralis group and stretching of the scalene muscles should be performed. This is thought to potentially increase the size of the space and minimize compression of neurovascular structures. In addition, this stage should introduce postural awareness and correction as well as brachial plexus gliding and peripheral nerve mobilization to decrease neural tension.

Stage three – This stage is when treatment gets intense. It involves all treatment techniques from stage two but now introduces conditioning and strengthening of the muscles necessary to maintain the postural correction.

The home exercise program proposed by Walsh, M. (1994) includes scalene stretching, cervical protraction and retraction, diaphragmatic exercises, pectoralis stretching, and shoulder-circle exercises. Scalene stretching involves the anterior and medial scalene which is done preferable in supine to maximize cervical muscles relaxation to maximally benefit from the stretch. Cervical retraction is to assist with decreasing the patient's forward head and rounded shoulder posture. For diaphragmatic exercises the patient rests in supine, arms at his/her side, takes an inspirational breath and exhales maximally using abdominal muscles to stabilize the inferior portion of the rib cage. Pectoralis stretching is obtained many ways. Many choose to place forearm against a doorway and stretch the pectoralis muscle as the patient steps through the doorway. The same stretch can be achieved by placing both hands on opposite walls of a corner while the patient leans into the corner. Shoulder-circle exercises are performed with the patient sitting, arms at his/her lap, and then forms large shoulder circles forward and backward to strengthen the scapulothoracic and involved structures in the patient's TOS. Additional exercises may be given as needed.

Post operative Rehabilitation: This post-operative rehabilitation protocol is for patients who have undergone scalenectomy and neurolysis. If the first rib has been excised than slight modifications may need to be made. Initially post operative rehab closely resembles pre operative with emphasis on wound care, edema control and scar management while incorporating range of motion (ROM) exercises and nerve gliding techniques.

Early Care: Patients are seen in therapy day one after leaving the hospital. The first area of focus is on wound care and the patient may have a drain in the wound covered by Tegaderm. Patients are instructed to keep track of the amount of drainage and when there is less than 10 ml per 8 hours of 25 ml per 24 hours, the drain is removed. The drain site continues to be covered to further reduce the chance of infection. If the wound continues to drain a bandage is applied and the patient is instructed to keep sutures clean and dry. The patient is, however, allowed to shower and swim once drain sites are closed and wound has not drained for a few days. A pressure bandage should be applied to decrease edema and should be worn full time for the first 7-10 days post op, however can be removed temporarily if it interferes with cervical range of motion. Sutures are removed 7-10 days post operatively and a scar pad can be worn at night. The physical therapist can assist by educating the patient in edema control techniques as part of their home exercise program (HEP). Retrograde massage for the involved upper extremity can be performed. An arm sling should be worn for the first 2 weeks when walking around or riding in a car, but should be encouraged to keep their arm out of the sling and elevated on pillows when sitting or sleeping. Patients should sleep on their uninvolved side with a pillow supporting the involved side. Scar management begins 24-48 hours after sutures have been removed.

Postoperative

Day 1 (week 1): ROM and nerve gliding exercises, review/education of cervical ROM, shoulder pendulum exercises and hand tendon gliding exercises should occur. Patients should be encouraged to use their uninvolved side. Gentle ROM, active, and active assisted ROM should be started as tolerated. Instruct the patient to perform these exercises holding the position for 5 seconds just before the point of pain or strain. These exercises should be done 3-4 times daily. Remember drain removal occurs at approximately 3-5 days.

Day 8 (week 2): Sutures are removed and continue gliding exercises for neck and upper extremity.

Day 15 (week 3): Scar massage and desensitization, possibly the introduction of weights.

Day 22 (week 4): Phonophoresis to scar site, brachial plexus massage, and start strengthening exercises. This part of the treatment is very individualized depending largely on the patient's pre operative activity level. Increases are applied to the program at least weekly while the patient monitors their pain. If patients are expecting to return to work, an ergonomic and body mechanic analysis may need to occur. This in combination with adequate strengthening are the most important to return to a job.

Day 29 (week 5): Progress the strengthening exercises

Day 36 (week 6): Ergonomic training, work-simulated activities, possibly a Functional Capacity Evaluation (FCE) for worker compensated patients.

Day 43-83 (weeks 7-12): Work hardening exercises

Therapy typically lasts 3 months with patients attending 2-3 times per week. A HEP is necessary from day one. Stretches should occur on a daily basis for at least 2 years because of scar contraction, which can occur for this duration. Occasionally patients return in 6-12 months because they do not keep up with their HEP. This course of therapy usually includes phonophoresis to reduce inflammation and scarring. Again, a thorough review of posture, stretching, and strengthening exercises needs to occur because TOS can usually be prevented.

Precautions: Patients should not lift more than 5 pounds until 6 weeks post-operative. Therapist should not push patient through increased or new pain. If swelling occurs at surgical site, in the involved upper extremity or periscapular area, report immediately to surgeon or supervising physician. Report any increased heat, redness, marked increased pain or drainage from the surgical site, as well as any onset of headache, dizziness, numbness in hands, feet, groin, or low back pain that is new. Symptoms lasting longer than 2 hours would indicate a need for the therapist to modify the exercise program.

Selected References:

Landry GJ, Moneta GL, Taylor LM, Edwards JM, Porter JM. Long-term functional outcome of neurogenic thoracic outlet syndrome in surgically and conservatively treated patients. *Journal of Vascular Surgery*. 2001;33:312-319.

Marinoni EC, Bonfiglio G, Boletti M, Passarelli O. Thoracic Outlet Syndrome: Proposed Protocol for Diagnosis and Treatment. *Institute of Clinical Orthopaedics and Institute of Vascular Surgery, University of Milan*. Pgs. 379-386.

Sanders RJ, Hammond SL. Supraclavicular first rib resection and total scalenectomy: technique and results. *Hand Clin*. 2004;20:61-70.

Toso C, Robert J, Berney T, Pugin F, Spiliopoulos A. Thoracic outlet syndrome: influence of personal history and surgical technique on long-term results. *European Journal of Cardio-thoracic Surgery*. 1999;16:44-47.

Walsh, M.T. Therapist management of thoracic outlet syndrome. *J Hand Therapy*. 1994;7:131-144.

Wishchuk JR, Dougherty CR. Therapy after thoracic outlet release. *Hand Clin*. 2004;20:87-90.