BRIGHAM AND WOMEN'S HOSPITAL
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Department of Rehabilitation Services
Physical Therapy

Standard of Care: Thoracic Outlet Syndrome (non-operative)

Case Type / Diagnosis:

Thoracic outlet syndrome (TOS) is described by a cluster of symptoms in the upper extremity. These include: pain in the shoulder and proximal upper extremity with or without neck pain, paresthesias and/or numbness into the distal upper extremity and hand, fatigability, swelling, discoloration, and Raynaud's phenomenon. There have been four symptom patterns described: upper plexus, lower plexus, vascular, and mixed. [25] Lower plexus symptom patterns are the most common. [25]

Generally, TOS is the result of compression of the neural and/or vascular structures between the interscalene triangle and the inferior border of the axilla. The structures that can cause compression of either neurological and/or vascular structures include: pectoralis minor tendon hypertrophy, clavicular deformity, cervical ribs, anomalous fibromuscular bands, or hypertrophy/injury to the scalene musculature. Developmental anatomical anomalies have been shown to be present in individuals that have symptoms of TOS. Makhoul and Machleder [18] reported in 1992 that 66% (132 of 200) of patients who underwent transaxillary surgical procedures for rib resection for the treatment of TOS had anatomic anomalies. They reported 17 cases of cervical or first thoracic rib abnormalities and 20 supernumerary scalene muscles. Incidentally, they also found 86 individuals with scalene and 39 with subclavius muscular developmental variations with regards to their insertions.

The terminology TOS was first introduced by Peet in 1956.[27] In 1958, Rob [29] first described TOS symptoms as arising from either compression of the brachial plexus and/or the subclavian vessels in the thoracic outlet region.
However, the first reports of cervical rib compression dates back to the Second Century AD. [1] In 1814, Coote was unsuccessful in resecting the cervical rib in a case of TOS. [9] It was not until 1905 that the first successful cervical rib resection was performed on a patient with TOS and a subclavian artery aneurysm. [23] In 1920, Law first described the possibility of soft tissue structures causing TOS. [13] The role of the scalene muscle in TOS was investigated in 1927. [1] The first successful surgical resection of the anterior scalene muscle was performed by Oschner et al [26] in 1935.

The diagnosis of TOS depends heavily on the subjective rather than objective criteria. Commonly the distinction between vascular thoracic outlet syndrome (VTOS) and neurogenic thoracic outlet (NTOS) is made. Hence published results of both conservative and surgical management vary greatly. [8] Ancillary studies are most helpful to rule out other conditions rather

than confirm the diagnosis of TOS. The diagnosis of VTOS is typically suspected by history and clinical presentation, and is confirmed by angiography or venography.

Potential Imaging Studies: These studies may be used (either individually or in combination) by physicians for the work-up of TOS.

Radiographs:

- Cervical: May demonstrate a skeletal abnormality.

- Chest: May demonstrate a cervical or first rib (elevated or enlarged), clavicle deformity, and pulmonary disease.

Electromyograms (EMG):

- Sensory
- Motor

Vascular studies:

Angiography/ Venography: Establishes the diagnosis of axillary-subclavian deep venous thrombosis. Angiography/venography is an x-ray method in which contrast material is injected into a blood vessel to visualize it. The physician may perform a complete examination by injecting contrast material into the affected arm and also rotating the arm to provoke compression of the vein. Indications for angiography/venography include evidence of peripheral emboli in the upper extremity and suspected subclavian stenosis or aneurysm. Conventional angiography is typically performed when surgical intervention is considered in order to confirm the extrinsic compression of the artery. MR angiography is a non-invasive approach and allows for a good evaluation of the subclavian artery in both adducted and abducted positions of the arm.

Color flow duplex scanning (ultrasound): Color-flow duplex ultrasonography (CDS) assesses the presence and severity of stenosis and yields a combination of anatomic and hemodynamic information. CDS allows veins to be surveyed longitudinally and facilitates the identification of veins. It also decreases the need to assess Doppler flow patterns and venous compressibility. [21]

Magnetic Resonance Imaging(MRI): MRI is commonly used for vascular imaging. Many different MRI techniques are used and each exploits different properties of blood flow to achieve contrast. Phase display imaging has proven useful in differentiating signal of slow flow from that of intravascular thrombus. Imaging of peripheral vessels can be achieved with gradient refocused sequences, which provide bright intravascular signal over a wide range of flow velocities. These sequences may be combined with subtraction strategies to eliminate the signal from stationary tissues in order to generate an angiographic image. The advent of three-dimensional MR angiographic imaging techniques provides an effective way to display peripheral vessels [14]

Methemoglobin is the product of a stage of a blood clot that reflects the oxygenation state of hemoglobin within the red cells. Methemoglobin acts as an endogenous contrast agent. Using a T1-weighted magnetic resonance sequence (Magnetic Resonance Direct Thrombus Imaging, MRDTI) methemoglobin is identified as a high signal. Subactute thrombosis can be identified by MRDTI. [22]

Treatment:

Typically, the initial management for individuals with TOS is nonoperative with an emphasis on rehabilitative exercises. Surgical indications include: acute vascular insufficiency, progressive neurologic dysfunction, and/or unmanageable pain that failed conservative treatment. There are many surgical techniques; typically they involve the release and/or removal of the structures that cause compression (i.e. scalene/pectoralis minor muscle release, first rib resection, cervical rib excision, and resection of fibromuscular bands).

In terms of surgical management of TOS, careful selection of patients is required for satisfactory surgical results. A well-coordinated team of thoracic surgeons, neurologists, and physical therapists is key. [3] In addition, in more severe cases it has been shown that physical therapy cannot replace surgery. [2] Optimal treatment of TOS, either neurogenic or vascular, is highly controversial, especially regarding the role of surgery.

Surgical decompression for patients with TOS has been shown to be both an efficient and dependable treatment intervention; however, results worsen over time. [4] It has been reported that there is no significant difference in terms of relief of symptoms in postoperative outcomes between individuals who have had excision of either a cervical rib or of a first rib. [10] Landry et al. [12] reported on their series of 79 patients at mean follow-up of 4.2 years. Of the 79 patients, 15 had a first rib resection and 64 were managed conservatively. They found that most patients who were conservatively managed, in their nonrandomized series, returned to work and had significant improvement in symptoms. In contrast, those individuals who underwent a first rib resection did not have an improved functional outcome.

This Standard of Care outlines the conservative physical therapy evaluation and management of a patient with TOS. Please see the separate Standard of Care for patients with VTOS.

Possible ICD.9 codes:

353.0 Thoracic Outlet Syndrome
719.41 Shoulder Pain

Indications for Treatment:

1. Impaired range of motion: shoulder / upper extremity
2. Impaired function: shoulder / upper extremity
3. Poor posture; cervical spine, shoulder girdle/upper quarter
4. Weak posterior (scapular, shoulder, trunk extensors) musculature
5. Tight anterior neck, shoulder and chest musculature
6. Pain and / or parathesias in one or both upper extremities

Precautions for Treatment:

- No contraindications for physical therapy interventions.

- If suspected diagnosis of Vascular TOS upon physical therapy examination of the upper quarter, then immediately collaborate with the referring physician, nurse practitioner, physician's assistant, etc. for proper diagnosis and timely intervention. After collaboration with referring source(s), appropriate referral(s) will be made.

Examination:

Medical History: Review the Rehabilitation Department's medical history questionnaire (on an ambulatory eval), patient's medical record (during the inpatient stay) and medical history reported in the Hospital's Computerized Medical Record. Review any diagnostic imaging, tests, work up and operative report listed under LMR. Thoroughly review the attending physician's note(s) to determine underlying involved structure (which vascular tissue(s) are compromised). Inquire if any history of trauma ever to clavicle, neck (whiplash), shoulder. Typically patients with TOS have no previous injury, and symptoms are insidious in nature.

History of Present Illness: Interview the patient to review history and any relevant information. If the patient is unable to give a full history, then interview the patient's legal guardian or custodian. Note when and where on body symptoms first appeared, how frequently symptoms are currently appearing, nature of current symptoms, worsening pattern to symptoms, duration of symptoms. Ask patient what is his/her current level of physical activity. What is the patient's goal of coming to therapy. Assess patient's current knowledge and understanding of diagnosis.

Social History: Review the patient's home, work, recreational, and social situation. Areas to focus on are upper extremity weight-bearing activities, excessive reaching, lifting, or carrying loads with upper extremities. Inquire if any environmental issues-such as position or movements (including sleep positions) which may irritate symptoms.

Medications: Patient may be on anti-inflammatory medication, pain medications, and possibly anti-depressants. Patients may be on other medications for secondary medical conditions.

Examination (Physical / Cognitive / applicable tests and measures / other)
This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.

Pain: As measured on the Visual Analog Scale/Verbal Rating Scale/Numerical Rating Scale, activities that increase symptoms decrease symptoms, location of symptoms and irritability level. Use body diagram to indicate all areas where symptoms are reported and which are most frequently present.

Visual Inspection: Attention to the healing of the incision (if they have any surgical invention), ensuring there are no signs of infection, swelling or adhesions. In addition, visual inspection of the involved entire spine and upper extremities in regards to edema, discoloration, specific hypertrophy and/or atrophy and overall appearance(scoliosis, c-spine and l-spine curves, height of scapulae and iliac crests). In women, pendulous breasts maybe a factor affecting posture.

Palpation: Comparison of involved and uninvolved extremity.

- Palpate entire shoulder girdle and upper extremity. Focus on presence and extent of musculature atrophy and swelling.
- Pulses: Carotid, Brachial, and Radial.
- There may be pain with palpation of the scalene musculature, the sublavius muscle as it attached to the 1st rib, and also along the brachial plexus.
- There maybe a positive Tinel sign over the superclavicular area at the insertion of the anterior scalene muscle.

Edema: If swelling is present, then girth measurements to be taken on both involved and uninvolved upper extremity (in centimeters):

- Widest part of upper arm. (Document level as # of cm. distal to the tip of the acromion)
- Elbow (around the olecrenon process).
- Wrist
- Severe edema can be assessed using upper extremity volumetric measurements.

Range of Motion:

- Initial ROM assessment of the cervical spine, involved shoulder, and entire upper extremity as compared to the uninvolved side. Observe and note critically the scapulo-humeral quality of movement
- Muscle length testing: Pectoralis Major & Minor, Scalenes, Sternocleidomastoid.

Neurologic exam: Reflexes are typically intact.

Muscular Performance: Manual Muscle Testing (MMT) is used to get a baseline of a patient's strength. Particular attention should be placed on upper back strength and proximal shoulder strength. Likely poor strength in these areas will be present leading to poor posture and overall poor shoulder mechanics. Handgrip with dynamometer testing is recommended at baseline. Muscle weakness is typically not noted. However, if present, it is typically mild and most prominent in the thenar, hypothenar, and interosseous muscles inervated by the ulnar nerve.

Sensation: Hypestehesia may occure in the C8-T1 dermatomes. If sensation is found to be abnormal via objective dermatomal screen, further assessment would be indicated. Perform Tinel testing of ulna and median nerves; carpal tunnel compression. In addition,

additional neural tension testing can be utilized. Documentation should be specific regarding the point/ position of positive symptoms. Subsequent re-testing can be used to compare progress or decline of symptoms of irritability. A Semmes-Weinstein Monofilament Screen may be used in order to identify patients with peripheral nerve branch involvement as well as to track their progress. In general, monofilament testing has been shown to be a sensitive monitor of peripheral nerve function. [16, 24] The Semmes-Weinstein monofilaments have been shown to vary relatively little in terms of their application force. These forces are consistently reproducible over time in clinical testing.[7]

Posture/alignment: Primary focus on sitting and standing upper quadrant and upper back posture. These patients tend to be at the extremes of rounded shoulders and forward head positions. It is important that positions which strain/ overuse the upper torso be analyzed such as posture/ positioning of musical instrument or work/ tools, time spent doing task, ability to modify task or tools. Note whether patient is able to tolerate correction of posture in standing to neutral without symptoms and if patient is able to sustain corrected posture (x seconds or minutes during examination).

Breathing: With relaxed breathing the scalene musculature is active on inspiration through full inspiratory excursion. However, patients with TOS often are unable to keep the scalene musculature quiet during inspiration. Patient typically have difficulty with diaphragmatic breathing.

Neurodynamic Testing: The nervous system should be examined both functionally and specifically. Functional examination consists of having the patient elevate their arms with the elbow extended and with the elbow flexed. The point of tension is noted during the elbow range of motion. This is position is compared to specific examination of upper limb tension testing. There are 4 main tests that assess the extensibility of neural structures, with each one biasing a different aspect of the nervous system. Full description of each test can be found in Chapter 3: The Cervical Spine of Orthopedic Physical Therapy Assessment by Magee. [17]

Gait & Balance: Gross assessment to determine patient's safety and to ensure independence with transfers, gait, and stairs. Further in depth assessment to be conducted if impairments noted in screening.

Special Tests: Potential thoracic outlet special tests:

- Allen
- Wright
- Adson
- Halstead
- Roos
- Costoclavicular
- Hyperabduction

Full description of each test can be found in Chapter 5: The Shoulder of Orthopedic Physical Therapy Assessment by Magee. [17]

A cluster of special tests is recommended when evaluating a patient with suspected TOS. Gillard et al. [11] prospectively assessed 48 patients with a clinical presentation of TOS. They used a number of standardized provocative tests (three of which were the Adson, Hyperabduction Test, Wright), an electromyogram, a Doppler ultrasonogram, and a helical CT arterial and/or venous angiogram to evaluate for the presence of TOS. They found that the cluster of these provocative tests had mean sensitivity and specificity values of 72% and 53%, respectively, with improved values for the Adson test (positive predictive value [PPV], 85%) and the hyperabduction test (PPV, 92%). The more positive the provocative tests, the higher the specificity. Doppler ultrasonography visualized vascular abnormalities and supported the diagnosis in patients with at least five positive provocative tests. Electrophysiological studies were found to be helpful for differential diagnosis and for detecting concomitant abnormalities.

Differential Diagnosis:

- VTOS as a stand-alone issue or in conjunction with neurological compromise.
- Shoulder Pathology
- Pathologic Lesion (tumor/cyst/infection)
- Cervical Radiculopathy
- Brachial Plexus Neuritis / Injury
- Postural Palsy
- Raynaud Disease
- Ulnar Nerve Compression (at the elbow)
- Overuse
- Peripheral nerve entrapment

Functional Assessment:

Use of a shoulder specific functional capacity questionnaire is recommended to establish early post-op status and track progress.

Possible tools:

- Simple Shoulder Test (SST)
- American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES-SF)
- Shoulder Pain and Disability Index (SPADI)

The SST [15]and the ASES-SF[6], and the SPADI [28] are all standardized self- assessments of shoulder function and have been found to have fairly high responsiveness as well as high test-retest reliability as compared to other shoulder outcome tools. [5] The SST has a standardized response mean of 0.87, confidence interval 0.52, 1.22; while the ASES-SF had a standardized response mean of 0.93, confidence interval 0.57, 1.29.

The intraclass correlation coefficients for the SST and ASES-SF are 0.99 and 0.96, respectively. They both are very simple and quick for the subject and investigator to fill out. The SST has been shown to be sensitive for various shoulder conditions as well as sensitive to detect changes in shoulder function over time. [19, 20] The SPADI is another subjective questionnaire that has a pain and disability/function components. This scale uses a visual analog scale to measure pain while subjective questions are used to assess function of the shoulder. The pain and function components are weighted accordingly since there are 5 pain scales and 8 functional questions, and then the total score is computed by averaging the pain and functional score. With the SPADI, unlike the other outcome measures a higher value indicates greater pain and disability.

Evaluation / Assessment:

Establish underlying reason for need of Skilled Services.

Potential Problem List (Impairment(s) and/ or dysfunction(s))

1. Pain
2. Decreased ROM Shoulder / Upper Extremity
3. Decreased Strength Upper Back Musculature / Upper Extremity Musculature
4. Decreased Function as compared to baseline
5. Decreased Knowledge of Activity Modification
6. Decreased Knowledge of Rehabilitation Progression

Prognosis/Expected Outcomes: Literature Review:

Patients with TOS treated with conservative management have varying degrees of outcomes. Upon discharge from skilled physical therapy intervention, are advised to continue with their home exercise program indefinitely.

The alternative to conservative (medical and physical therapy) management for patients with TOS is surgical intervention that resects the pathological symptom provoking structure (first rib, scalenes, or other muscular structures).

Goals of Intervention
Goals of intervention are individualized for each patient's current health status. Potential goal categories are:

1. Decrease Pain
2. Independent in activity modulation and use of any adaptive device(s) for function.
3. Restore ROM
4. Restore Strength
5. Improve Posture
6. Enhanced / Normalized Breathing
7. Improve Body Mechanics

8. Increase Function-include specific goals patient has identified for self care, ADLs, work and/or recreation.
9. Independent with Home exercise program

Treatment Planning / Interventions

Established Pathway ___ Yes, see attached. _X_ No

Established Protocol ___ Yes, see attached. _X_ No

Interventions most commonly used for this case type/diagnosis.
This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.

Typically these patients present with impairments that require:

- Patient / family education as below
- Potential use of modalities to assist with pain reduction
- A gradually progressed anterior (cervical spine and trunk) muscular stretching program
- Gradually progressed upper back strengthening program
- Joint mobilization as indicated (rib, glenohumeral, scapulothoracic, cervical spine joints)
- Restoration of shoulder / upper extremity ROM through Active / Passive ROM, Hold/Relax, Contract/Relax Techniques
- Establishment of appropriate diaphragmatic breathing
- Gradual functional activity progression including work and recreational activities.

Frequency & Duration

Initial physical therapy assessment should be completed as soon as possible (hopefully within 24 hours) of physician referral.

Outpatient Care: 1-2x week/ for 2-3 months as indicated by patient's status and progression.

Patient / family education

1. Instruction in HEP (home exercise program)
2. Instruction in correct posture
3. Instruction in appropriate breathing
4.
5. Instruction in correct body mechanics
6. Instruction in pain control and ways to minimize inflammation
7. Instruction in activity level modification / joint protection

Recommendations and referrals to other providers.

Problem solving adaptive equipment must be done in conjunction with the attending physician. Adaptive equipment can be quite expensive- eg musical instrument adaptation with mandible (chin rests) bars for violins, clarinet or flute extension pieces. Solutions for professional musicians must be analyzed with involvement by the patient's instructor(s) and the person(s) doing the work. If work station changes seem to be indicated that would required the employer to make or modify the patient's job, the referring physician should be involved in prescribing work modification.

Re-evaluation / assessment

Standard Time Frame- 30 days or less if appropriate

Other Possible Triggers- A significant change in signs and symptoms

Discharge Planning

Commonly expected outcomes at discharge – Patient should be/have:

- Independent with Home Exercise Program
- Independent with self management of symptoms
- Independent with Posture correction
- Independent with correct Body Mechanics
- Full Shoulder / Upper Extremity ROM
- Upper back strength of all musculature of at least 4/5
- Shoulder / upper extremity musculature strength of at least 4/5

Transfer of Care – Possibly a physical therapist closer to where the patient lives, if traveling to BWH is too inconvenient for consistent rehabilitation care. In this case the therapist in the community will be given a copy of this standard of care to assist them in guiding the patient's treatment.

Patient's discharge instructions – Continue with individualized home program indefinitely to ensure maintenance of ROM, strength, posture and function.

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