

Thoracic Outlet Syndrome: An Overview of Anatomy, Diagnosis and Treatment

Blair Burnette, SPT

Objectives:

- The learner will be familiar with the anatomical structures associated with Thoracic Outlet Syndrome (TOS).
- The learner will understand basic psychometric principles and be able to apply them to TOS specific tests.
- The learner will be able to evaluate and clinically diagnose patients with TOS.
- The learner will be able to recognize the need for outside referral for the diagnosis of TOS.

Table of Contents

- Introduction to Thoracic Outlet Syndrome
- Anatomical Overview of the Region and Involved Structures
- Etiology
- Thoracic Outlet Syndrome Symptoms/ Presentation
- Regions of the Thoracic Outlet and Associated Special Tests (Sternocostovertebral, Scalene Triangle, Costovertebral, and Pectoralis Minor)
- Psychometric Properties of Special Tests
- Treatment Options
- References

Introduction to Thoracic Outlet Syndrome

- Thoracic Outlet Syndrome is defined as “as series of neurovascular syndromes in the shoulder region⁵”.
- There are three “types” of compression in TOS²:
 - Venous TOS
 - Arterial TOS
 - Neurogenic TOS

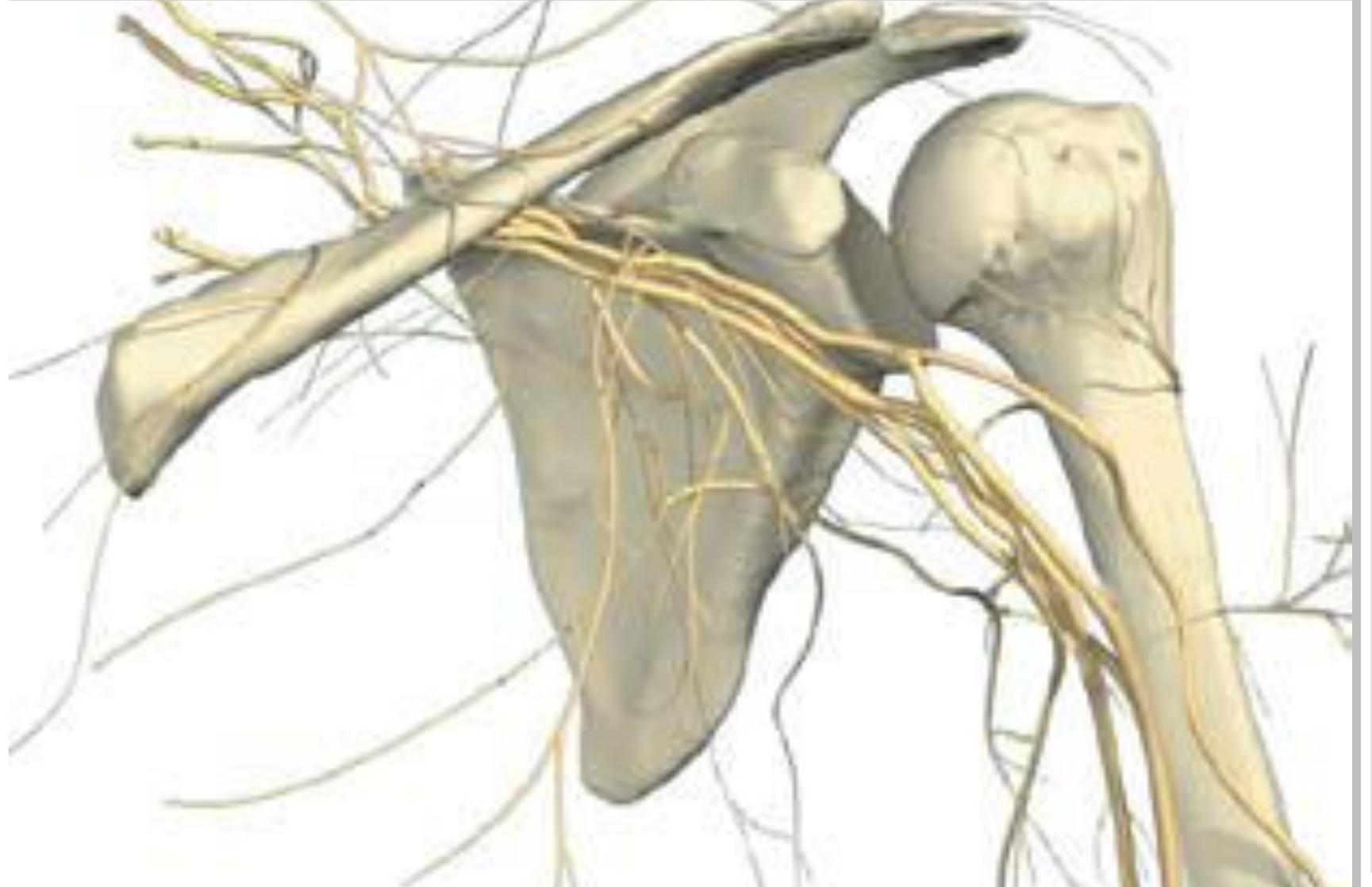
Types of Thoracic Outlet Syndrome

- Venous Thoracic Outlet Syndrome is associated with compression of the sub-clavian or axillary vein. This type of TOS is thought to be relatively rare and only occur in approximately **2-3%** of cases².
- Arterial Thoracic Outlet Syndrome is associated with compression of the sub-clavian or axillary artery. This type is considered to be even more rare than venous TOS occurring **in greater than 1 but less than 2% of cases**².
- Neurogenic Thoracic Outlet Syndrome is by far the most common form of TOS and is associated with compression of the brachial plexus as it passes through the thoracic outlet²

Anatomy

Who remembers the brachial plexus?

Picture Reference: Bayford T. THORACIC OUTLET SYNDROME: AN OVERVIEW OF DIAGNOSIS AND TREATMENT. *Sportex Medicine* [serial online]. April 2010;(44):13-17. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed January 21, 2015.

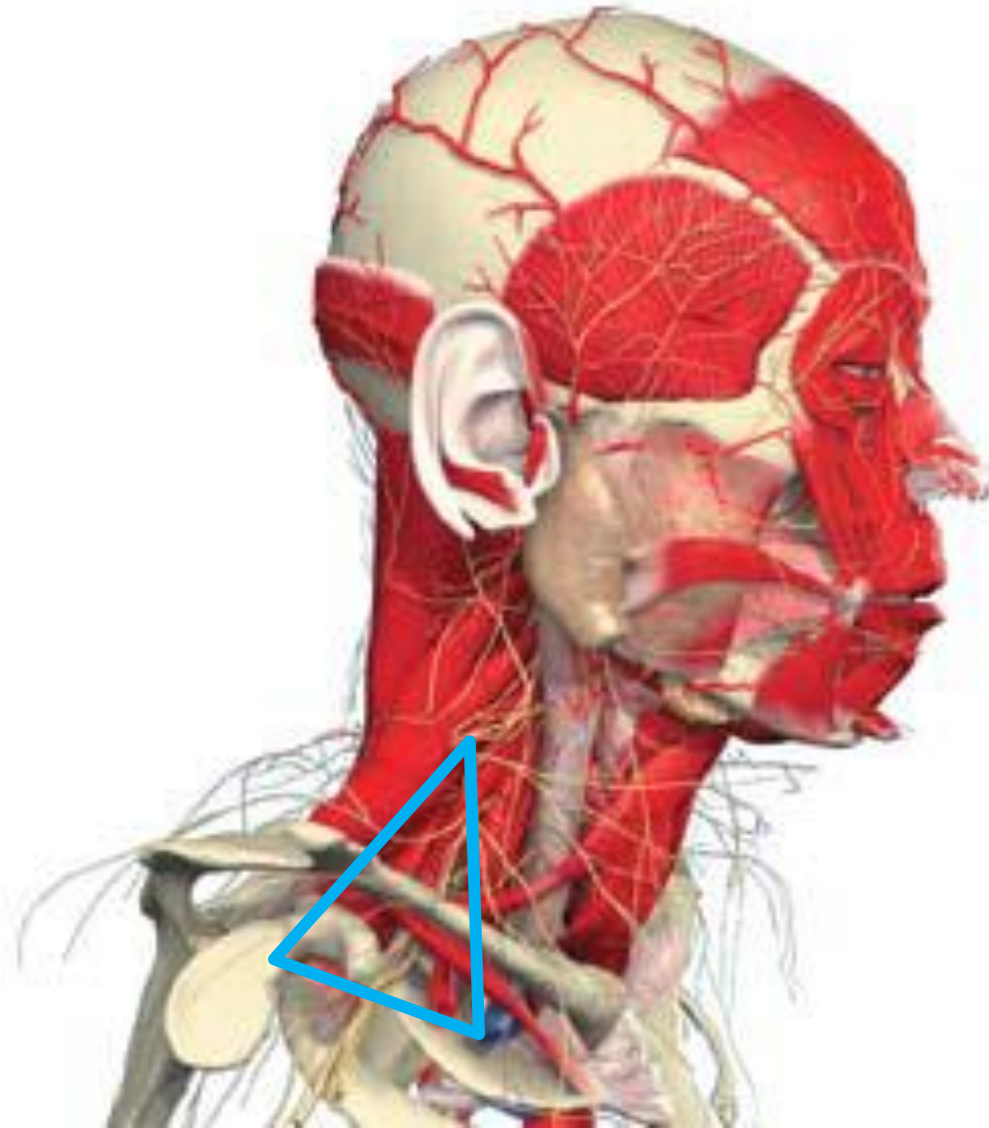


Anatomy

- The thoracic outlet is the region between the **first thoracic vertebrae, first rib** and **the manubrium of the sternum**⁴.
- Within the compartment the sub-clavius tendon runs next to the subclavian vein, the brachial plexus runs posterior-laterally to the sub-clavian artery and is also accompanied by the middle scalene muscle⁴.

Anatomy

Picture Reference: : Bayford T.
THORACIC OUTLET SYNDROME: AN
OVERVIEW OF DIAGNOSIS AND
TREATMENT. *Sportex Medicine* [serial
online]. April 2010;(44):13-17. Available
from: SPORTDiscus with Full Text,
Ipswich, MA. Accessed January 21, 2015.



Anatomy

- Researchers have further divided the thoracic outlet into 4 specific regions where compression is most likely to occur. They are³:
 - Sternocostovertebral Space
 - Scalene Triangle
 - Costoclavicular Space
 - Pectoralis Minor Space

Etiology

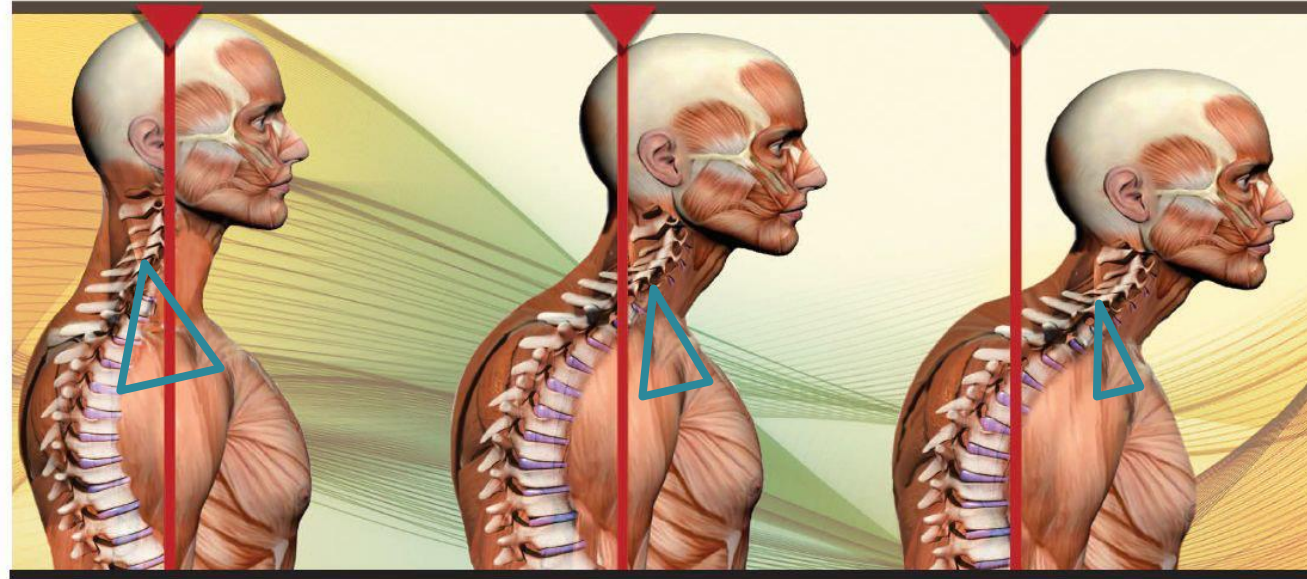
Traumatic⁴

- Motor Vehicle Accident
- Whiplash Injury
- Sports Injuries

Non-Traumatic⁴

- Repetitive Activities
- Poor standing, sitting, or sleeping posture
- Osseous or soft tissue causes

Etiology: Forward Head Posture



NORMAL POSTURE

2 INCHES FORWARD

3 INCHES FORWARD

<http://thepowerofposture.net/wp-content/uploads/2014/02/Forward-Head.jpg>

Symptoms/ Presentation

- **Neurogenic Thoracic Outlet Syndrome³**
 - Weakness
 - Pain
 - Paresthesia
 - Symptoms worsen with contributing factors (posture, overhead activities, accessory breathing)³
 - Upper Trapezius Pain
 - Scalene Pain
- Venous Thoracic Outlet Syndrome³
 - Swelling, cyanosis (blue tint to skin), heavy feeling, and venous distension of the arm and shoulder.
- Arterial Thoracic Outlet Syndrome³
 - Coldness, pale skin, and Raynaud's color changes

Break!

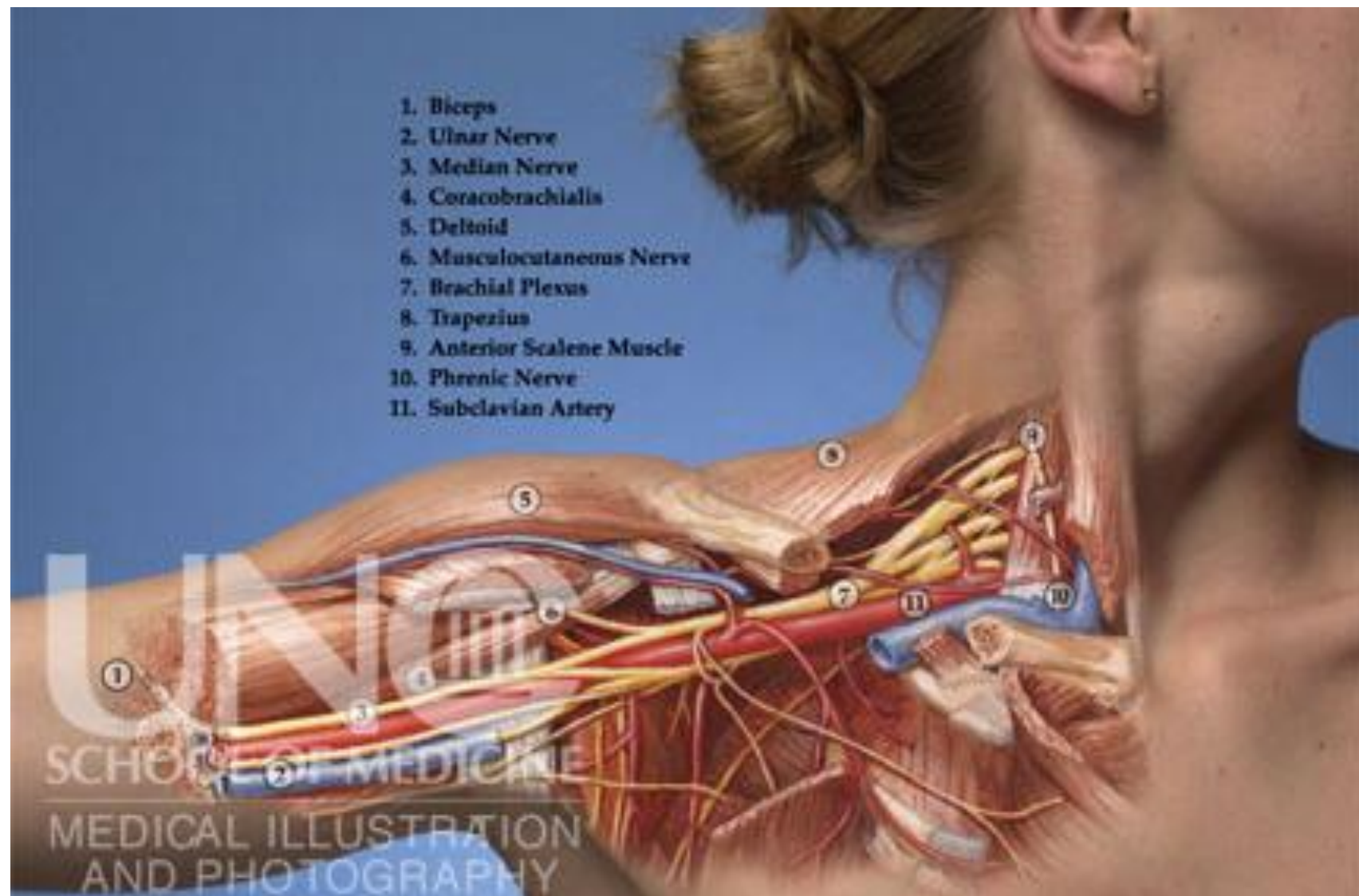


Sterno- costovertebral Space: Anatomy

- The sternocostovertebral space is bound by the **sternum, first rib,** and **first thoracic vertebrae**³.
- The sub-clavian artery and vein, as well as all **5** roots of the brachial plexus pass through this region³.
- In addition to the structures passing through this area. This space also contains the apex of the lung, pleura, many lymphatics and the jugular vein³.

Sterno- costovertebral Space

Photo from:
<https://realityot.wordpress.com/what-you-should-know-about-tos/>



Sterno- costovertebral Space

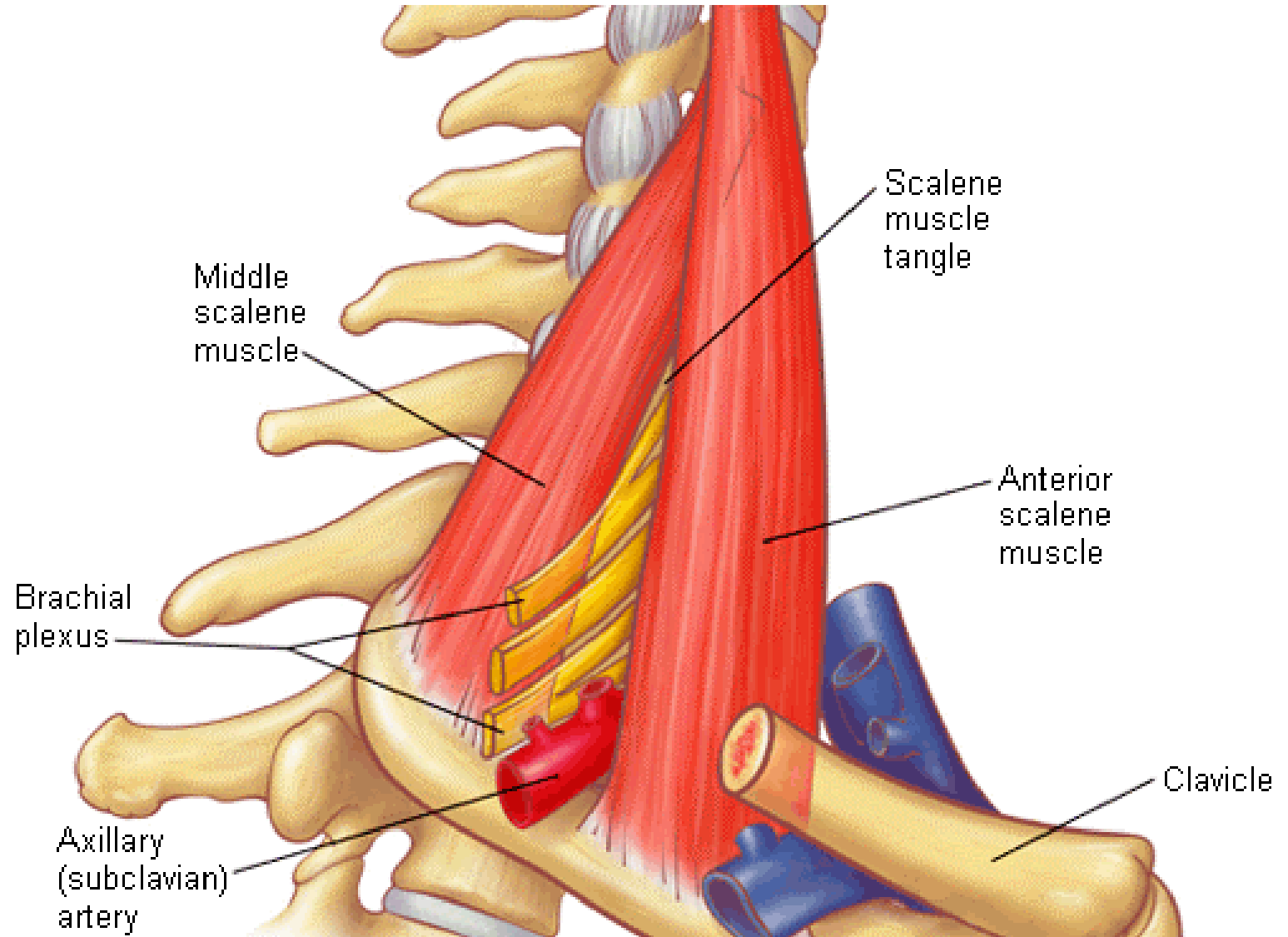
- Compression of the nerves and vascular structures that pass through this region is relatively rare³.
- Compression in this region is usually only caused by tumor formation, specifically Pancoast tumors in and around this area⁵.
- For this reason, there none of the current special tests or conservative treatment techniques are appropriate for diagnosing and managing TOS symptoms resulting from compression in this area³.

Scalene Triangle Anatomy

- The Scalene Triangle is bordered anteriorly by the **anterior scalene muscle**, posteriorly by the **middle scalene muscle**, and inferiorly by the **medial surface of the first rib**⁶.
- This space is arguably the MOST common site of compression within the Thoracic Outlet. Due to:
 - The extremely dynamic nature of the space and its vulnerability to muscle spasm and swelling³
 - Nerves of the brachial plexus may exit through the scalene muscles too high³.
 - Nerves of the brachial plexus may pierce 1-2 of the scalene muscles³
 - Presence of a cervical rib⁷

Scalene Triangle Anatomy

Photo from:
http://www.edoctoronline.com/media/19/photos_a.gif



Scalene Triangle: Specific Tests

- Adson's Test is the most appropriate test for diagnosing TOS in this region³.
- Adson's Test Procedure⁸:
 - Patient is seated at edge of table or chair
 - Therapist palpates radial pulse on the affected arm
 - Patient is instructed to take a deep breath in and hold it
 - Therapist then abducts and extends the affected arm, and instructs the patient to rotate/turn their head toward the affected arm
 - The test is then repeated on the other side
 - **A positive result:** a diminished or absent pulse OR presence of the patient's symptoms
- The psychometric properties for this test are **good**. It has been reported to have a sensitivity of 79% and a specificity of 76%^{8,9}

Scalene Triangle: Adson's Test

Photo from:
<http://www.mhhe.com/hper/physed/athletictraining/illustrations/ch22/2-18a.jpg>

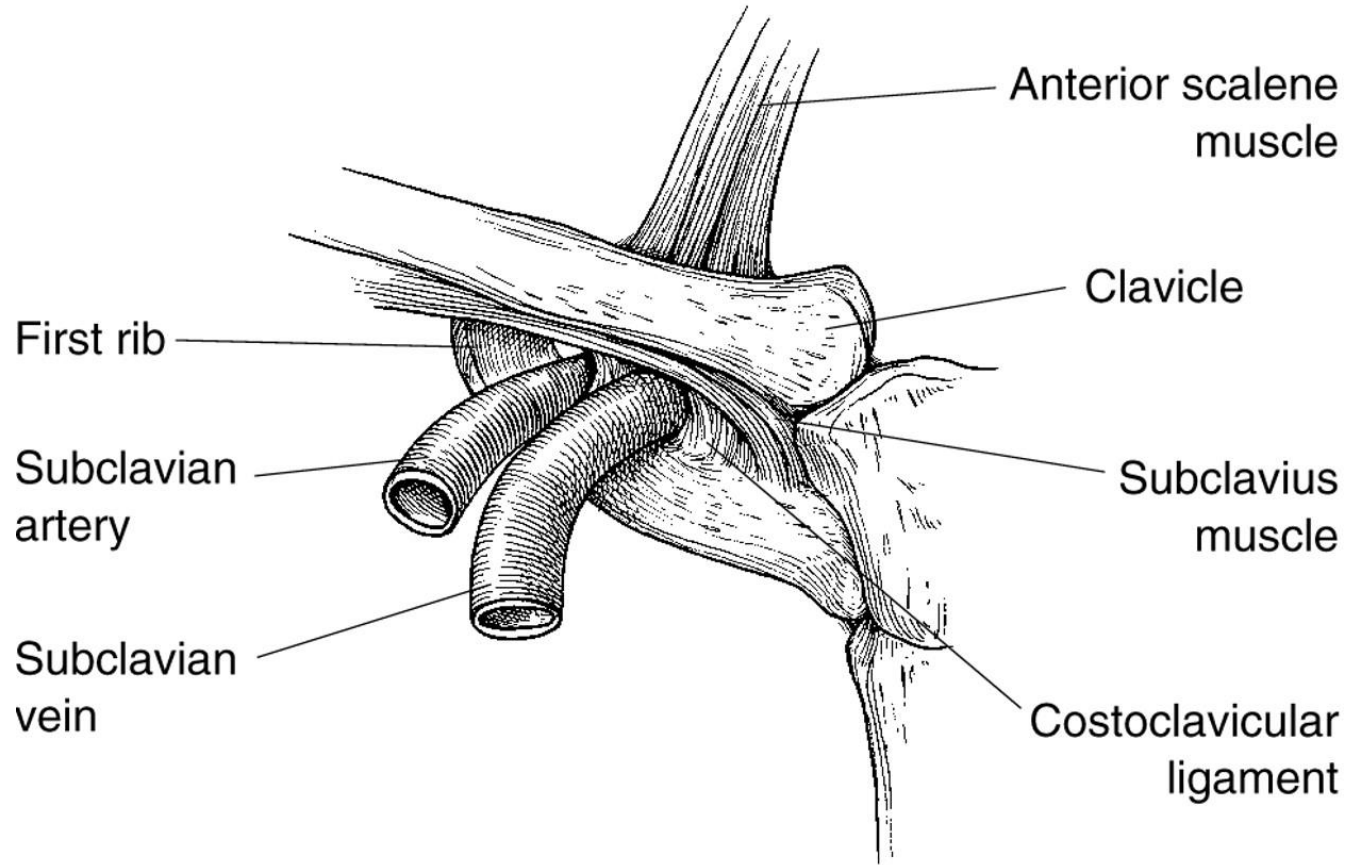


Costoclavicular Space Anatomy

- The costoclavicular space is bordered anteriorly by the **medial third of the clavicle**, posteromedially by the **first rib**, and posterolaterally by the **upper border of the scapula**⁴.
- The anatomical composition of this space makes it vulnerable to compression associated with *accessory breathing*⁴.
- Other Potential Causes for Compression in this Space⁴:
 - Calluses from clavicle fracture
 - Protracted Scapula
 - Variable shapes of the first rib
 - Drop at the distal end of the clavicle
 - Depressed clavicle
 - Elevated first rib
 - Spasms/Tightness of the Scalene Muscles

Costoclavicular Space Anatomy

Photo from:
<http://www.jaaos.org/content/10/6/401/F1/graphic-1.large.jpg>

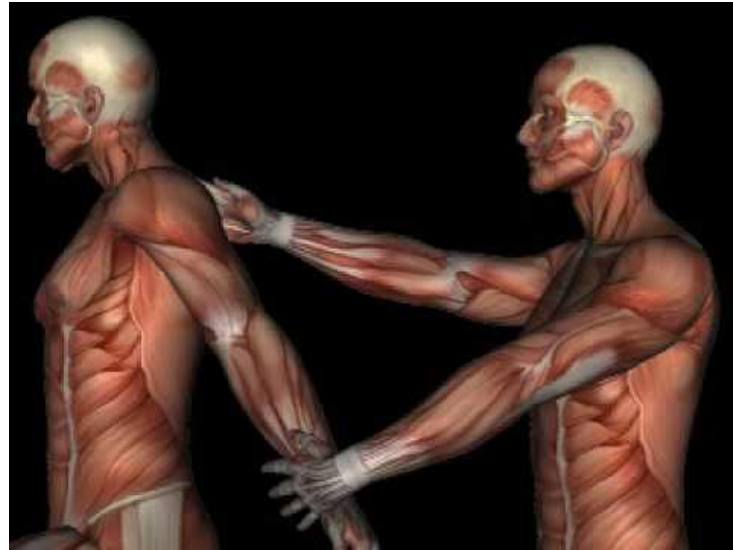


A

Costoclavicular Space Special Tests

- There are two tests that are most effective in diagnosing TOS compression in the costoclavicular space. They are:
 - Halstead Maneuver
 - Military Bracing Test or Costoclavicular Test

Costoclavicular Space: Halstead Maneuver



Youtube Video:

<https://www.youtube.com/watch?v=3JrYAKiDxdw>

- Halstead Maneuver⁹:
 - Patient is sitting at the edge of the table and therapist palpates the radial pulse of the affected arm with the arm slightly extended
 - Patient is instructed to rotate the head away from the affected arm
 - The therapist then applies distal traction to the affected limb.
 - **Positive Test:** reduction or absence of radial pulse.
 - *Unfortunately, there is limited information about the psychometric properties of this test in the diagnosis of TOS.*

Costoclavicular Space: Military Bracing Test

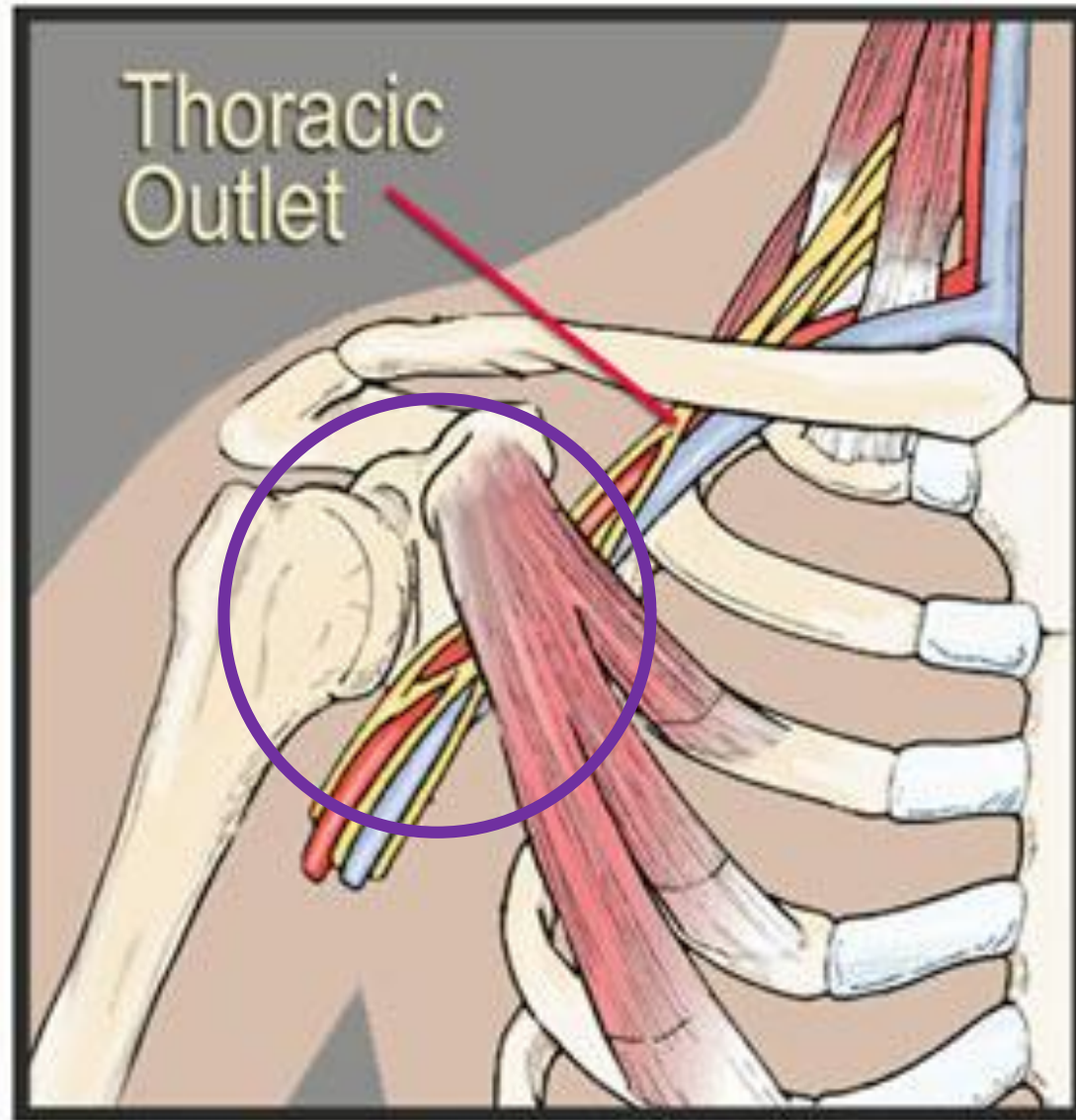
- Costoclavicular Maneuver⁹
 - Patient sits straight (exaggerated military position), both arms placed at sides and the therapist palpates the radial pulse on the affected arm.
 - The patient is instructed to retract and depress the shoulders while protruding the chest
 - The position is held for 1 minute. While the examiner palpates the radial pulse
 - **Positive Test:** Absent or diminished radial pulse AND/OR the patient's symptoms.
 - Psychometric Properties for this test are **very good**. Reporting a 100% specificity for pain, and 85% specificity for paresthesia.
- Costoclavicular Maneuver¹⁰
 - Patient sits at edge of table and therapist palpates the radial pulse
 - Therapist draws the patient's shoulder down and back (depressing the shoulder slightly)
 - Patient is instructed to take a deep breath and hold it in.
 - The therapists palpates radial pulse of the affected arm.
 - **Positive Test:** reproduction of symptoms or loss of pulse

Pectoralis Minor Space Anatomy

- In this region the neurovascular bundles pass under the **coracoid process** deep to the **pectoralis minor muscle**⁴.
- This anatomical configuration makes this area especially vulnerable to compression with abduction of the upper extremity and/ or tightness or spasm of the pectoralis minor muscle⁴.

Pectoralis Minor Space Anatomy

Photo from:
http://erikdalton.com/images/newsletter_april07A.jpg



Pectoralis Minor Space Special Tests

Hyperabduction Test⁹

- Patient is asked to sit very straight at the edge of the table with both arms at his/her side while the therapist palpates the radial pulse on the affected arm
- The patient is then instructed to move their arm into > 90 degrees of abduction and full external rotation
- The patient's head remains in a neutral position and the position is held for > 1 minute
- The examiner palpates the radial pulse in an extended position
- **Positive Test:** A diminished or abolished radial pulse AND/OR reproduction of the patient's symptoms

Pectoralis Minor Space: Hyperabduction Test

Photo from:
<http://ajs.sagepub.com/content/32/4/1063/F7.large.jpg>



Pectoralis Minor Space Psychometric Properties

- The psychometric properties of the Hyperabduction test are **fair**.
 - One study found that the test was 52% sensitive and 90% specific⁸ when using pulse abolition as a positive test.
 - However, when using symptom reproduction the test was only 84% sensitive and 40% specific⁸

Break



Psychometric Properties of Special Tests

- Roo's Test (EAST- Elevated Arm Stress Test)⁹
 - Highly Variable Psychometrics, High Rate of False Positives
 - Sensitivity 82%, Specificity 100%
 - Specificity 47%
 - Sensitivity 84%, Specificity 30%
- Tests Combined⁹
 - Wright's test, Adson's test, Hyperabduction test, Roo's test, and Tinel's sign

Number of Positive Tests	Sensitivity	Specificity
2/5 positive findings	90%	6%
3/5 positive findings	90%	29%
4/5 positive findings	87%	38%
5/5 positive findings	84%	84%

Other Diagnostic Tests

- Nerve Conduction Velocity^{6,8}
 - Despite its common use in the diagnosis of Thoracic Outlet Syndrome. NCV is primarily used to RULE OUT the existence of other conditions, and not diagnose/ locate TOS compression.
- Magnetic Resonance Imaging¹¹
 - Gold Standard for Diagnosis. Can specifically locate and visualize the site of compression, especially in a provocative position.
- Doppler Ultrasound⁸
 - This test is more effective when a positive test result is combined with a series of positive provocation tests such as Adson's test, Hyperabduction test, Wright's test, Tinel's sign or Roo's test

Conservative Treatment

- Activity Modification
- Mobilizations
- Relaxation Techniques
- Strengthening

Surgical Treatment

- Anterior and Middle Scaleneotomy
- 1st/Cervical Rib Resection
- Supraclavicular Neuroplasty

Summary

- Thoracic Outlet Syndrome is a complex condition that involves the compression of the brachial plexus neurovascular bundle as it passes from its origins in the cervical and thoracic spine out to the upper extremities.
- Compression can occur at four locations within the thoracic outlet.
- There are different special tests to assess for compression in the different regions. The more positive tests the patient has, the stronger the diagnostic power.
- Thoracic Outlet Syndrome is most commonly treated with conservative management including activity modification and elimination, relaxation and stretching exercises, mobilizations and postural strengthening exercises.

References

1. Sanders RJ, Hammond SL, Rao NM. Thoracic outlet syndrome: a review. *Neurologist*. 2008;14(6):365-73.
2. Bayford T. THORACIC OUTLET SYNDROME: AN OVERVIEW OF DIAGNOSIS AND TREATMENT. *Sportex Medicine* [serial online]. April 2010;(44):13-17. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed January 21, 2015.
3. Gross, M (2012). *Thoracic Outlet Compression Syndrome* (lecture). Accessed November 18, 2014.
4. Freischlag J, Orion K. Understanding thoracic outlet syndrome. *Scientifica* (Cairo). 2014;2014:248163.
5. Hertling D, Kessler RM. Management of Common Musculoskeletal Disorders, Physical Therapy Principles and Methods. Lippincott Williams & Wilkins; 2006.
6. Huang JH, Zager EL. Thoracic outlet syndrome. *Neurosurgery*. 2004;55(4):897-902.
7. Sanders RJ, Hammond SL. Management of cervical ribs and anomalous first ribs causing neurogenic thoracic outlet syndrome. *J Vasc Surg*. 2002;36(1):51-6.
8. Gillard J, Pérez-cousin M, Hachulla E, et al. Diagnosing thoracic outlet syndrome: contribution of provocative tests, ultrasonography, electrophysiology, and helical computed tomography in 48 patients. *Joint Bone Spine*. 2001;68(5):416-24.

Reference

9. Cook C, Hegedus EJ. Orthopedic Physical Examination Tests, An Evidence-Based Approach. Prentice Hall; 2011.
10. McMorris, M (2012). *Shoulder Special Tests: Technique Sheet* (handout). Accessed February 3, 2015.
11. Demirbag D, Unlu E, Ozdemir F, et al. The relationship between magnetic resonance imaging findings and postural maneuver and physical examination tests in patients with thoracic outlet syndrome: results of a double-blind, controlled study. Arch Phys Med Rehabil. 2007;88(7):844-51.
12. Povlsen B, Belzberg A, Hansson T, Dorsi M. Treatment for thoracic outlet syndrome. Cochrane Database Syst Rev. 2010;(1):CD007218.
13. Nichols AW. Diagnosis and management of thoracic outlet syndrome. Curr Sports Med Rep. 2009;8(5):240-9.

Any Questions??

You made it!

Thanks for your attention!



