

Provocative Tests in Diagnosis of Thoracic Outlet Syndrome: A Narrative Review

Fahmi H. Kakamad^{1*}, Berun A. Abdalla², Saywan K. Asaad¹, Hawkar A. Nasralla², Abdullah K. Ghafour², Hiwa S. Namiq³, Nasren S. Sabr², Yadgar N. Abbas^{2,4}, Lawen J. Mustafa⁵, Omed M. Hussein⁵, Azad S. Hattam², Choman S. Omer², Sakar O. Arif², Ahmed H. Ahmed², Ali D. Sadullah²

¹College of Medicine, Clinical Science Department, University of Sulaimani, Madam Mitterrand Street, Sulaymaniyah, Iraq. ²Scientific Affairs Department, Smart Health Tower, Madam Mitterrand Street, Sulaymaniyah, Iraq. ³College of Pharmacy, Department of Basic Science, University of Sulaimani, Madam Mitterrand Street, Sulaymaniyah, Iraq. ⁴Shahid Doctor Hemn Psychiatric Hospital, Qanat Street, Sulaimaniyah, Iraq. ⁵Rheumatology Department, Ministry of Health, Shorsh Street, Sulaymaniyah, Iraq.

*Corresponding author: Dr. Fahmi Hussien Kakamad (Doctor City, Building 11, Apartment 50, Zip code: 46001, Sulaymaniyah, Iraq). fahmi.hussein@univsul.edu.iq

Received: May 21, 2025

Revised: May 31, 2025

Accepted: Jun 07, 2025

First Published: Jun 22, 2025

Thoracic outlet syndrome (TOS) is a group of conditions caused by the compression of the neurovascular bundle within the thoracic outlet. It is classified into three main types based on the affected structure: neurogenic, arterial, and venous TOS. Diagnosis remains challenging due to symptom overlap with other conditions and a lack of universally accepted criteria. Provocative tests are integral to clinical evaluation, aiming to reproduce symptoms by stressing anatomical structures prone to compression. This review evaluates the commonly used provocative tests for TOS, analyzing their diagnostic performance, limitations, and clinical utility. Individual provocative tests vary widely in diagnostic performance. The Roos test demonstrates high sensitivity but poor specificity, while tests like the Cyriax Release and Wright's hyperabduction offer better specificity at the cost of sensitivity. Most tests show significant overlap in symptom reproduction with other upper limb or cervical pathologies, contributing to high false-positive rates. Combining multiple tests improves diagnostic accuracy but still falls short of a definitive standard. While provocative tests are valuable for screening and clinical assessment of TOS, their standalone diagnostic reliability is limited. A multimodal approach integrating clinical examination, imaging, and electrodiagnostic studies is essential for improving diagnostic confidence and patient outcomes. Future research should aim to standardize testing protocols and validate findings through large-scale, population-based studies.

Keywords: Neurogenic thoracic outlet syndrome, Neurovascular compression, Upper limb, Clinical examination, Thoracic outlet

How to cite this article: Kakamad FH, Abdalla BA, Asaad SK, Nasralla HA, Ghafour AK, Namiq HS et al. Provocative Tests for Thoracic Outlet Syndrome: A Narrative Review. Judi Clin. J. 2025;1(1):46-50. <https://doi.org/10.70955/JCJ.2025.5>

 **Copyright** ©2025 Kakamad et al. This open access article is distributed under the CC BY 4.0 license, permitting use, distribution, and reproduction with proper attribution to the authors and source.

1. Introduction

Thoracic outlet syndrome (TOS) is a group of conditions characterized by the compression of the neurovascular bundle within the thoracic outlet [1]. Based on the affected structure, TOS is categorized into three primary types: neurogenic (nTOS), arterial (aTOS), and venous (vTOS) [2].

The most common subtype is nTOS, representing more than 90% of cases, and is more frequently observed in females [1]. vTOS makes up 3–5% of cases, while aTOS is the least common, accounting for just 1% [3]. The overall incidence of TOS in the general population is estimated at 2.5 to 4 cases per 100,000 individuals per year [3]. Patients with aTOS and vTOS typically display noticeable signs of vascular issues in the upper limbs, such as venous thrombosis, swelling, or arterial emboli affecting the fingers. On the other hand, diagnosing nTOS mainly depends on the patient's clinical history and reported symptoms [4]. These subgroups can be linked to congenital, traumatic, or functionally acquired causes. Congenital etiologies may involve the presence of a cervical rib or an anomalous first rib. Traumatic causes are most commonly associated with whiplash injuries and falls. Functional acquired causes are often related to intense, repetitive activities linked to sports or work [5].

Diagnosing TOS is challenging because its broad spectrum of symptoms often mimics other conditions such as cervical radiculopathy, carpal tunnel syndrome, or rotator cuff disorders, resulting in frequent misdiagnoses. The absence of a universally accepted diagnostic standard adds to its complexity, leading to a heavy reliance on clinical evaluations and inconsistent use of diagnostic tests [6, 7]. Specifically, diagnosing nTOS is difficult due to the wide range of conditions that can cause shoulder and arm pain, weakness, and neuropathy. These conditions include various musculoskeletal and neurological disorders, which may either serve as primary causes or contribute as additional factors to the patient's symptoms [8].

Provocative tests are essential in diagnosing TOS by reproducing symptoms linked to nerve or vascular compression. These tests intentionally stress the thoracic outlet structures to elicit symptoms. Each test targets specific mechanisms of compression, whether neurogenic or vascular compression [9]. This study reviews the provocative tests used in the diagnosis of TOS, with all references evaluated for relevance and eligibility [10].

2. Provocative tests in diagnosing TOS

2.1. Adson's Test

Adson's test, also known as Adson's maneuver, is a diagnostic tool primarily used to assess aTOS. During the test, the patient extends their neck, turns their head toward the affected side, and holds their breath. If this position causes a reduction in the radial pulse or reproduces symptoms, it suggests vascular compromise due to muscular compression. The maneuver is named after Alfred Adson, a neurosurgeon at the Mayo Clinic in the early 20th century [11]. Since its initial description, multiple researchers have challenged Adson's test. In 1945, Wright observed that pulse obliteration could occur when turning the head to either the ipsilateral or contralateral side [12]. In 1965, Woods reported that among TOS patients, Adson's test was positive more frequently when the head was turned to the contralateral side (63%) compared to the ipsilateral side (22%) [13].

A review of various studies on nTOS patients who underwent Adson's test found that the rate of positive responses varied between 22% and 100%, with a median of 31% [14]. In 2001, Gillard et al. reported that Adson's test was among the better-performing tests commonly studied for TOS, with a positive predictive value of 85%, a sensitivity of 79%, and a specificity of 76% [15]. In an asymptomatic population, Rayan (1998) found that Adson's test had a false positive rate of 13.5% for diminished or absent pulse but only 2% for neurological symptoms [16]. Similarly, in 1998, Plewa and Delinger reported a similar false positive rate of 11% for pulse loss, a higher rate of 11% for paresthesia, and a notably low rate of 2% for pain reproduction [17].

Although Adson's test is useful, it has notable limitations. A primary concern is its reliance on vascular signs to diagnose nTOS, which can lead to misinterpretation. Many individuals with nTOS may not exhibit vascular compromise, resulting in false negatives [14]. Anatomical variations, such as cases where the brachial plexus roots pass through the anterior scalene muscle, can produce negative results even when TOS symptoms are present [18]. The variability in results across different populations also raises concerns about the test's reliability, with some studies suggesting that a considerable number of healthy individuals may also test positive on provocative tests like Adson's [19]. Therefore, while Adson's test can offer valuable insights when used alongside a thorough clinical evaluation, it should not be relied upon as the sole diagnostic tool for TOS.

2.2. Roos Test

In 1963, Gilroy and Meyer modified Adson's test by introducing the 90-degree abduction and external rotation maneuver, a provocative test later popularized by David B. Roos in 1966 [20, 21]. The Roos test, or elevated arm stress test, is a key diagnostic tool for nTOS, designed to provoke symptoms by dynamically compressing the thoracic outlet. The patient holds their arms in 90 degrees of abduction and external rotation while continuously opening and closing their hands for three minutes. A positive result is characterized by symptom reproduction, such as neck-to-arm radiating pain, finger paresthesia, or vascular manifestations like pallor or cyanosis [21, 22].

The Roos test has an estimated sensitivity of about 84%, making it effective in detecting individuals with TOS by eliciting symptoms in most cases. However, its specificity is considerably lower, around 30%, meaning that it produces a high number of false positives. As a result, individuals without TOS may still exhibit symptoms during the test due to factors such as muscle fatigue or other conditions like carpal tunnel syndrome [15, 23].

Research has used transcutaneous oxygen pressure measurements to investigate microvascular responses during the Roos test. A transcutaneous oxygen pressure reduction of more than 15 mmHg during the test has been linked to arterial compression, demonstrating 67% sensitivity and 78% specificity compared to ultrasound findings [22].

These findings emphasize that while the Roos test is valuable for screening due to its high sensitivity, its low specificity limits its ability to confirm TOS definitively. Therefore, it should be combined

with other diagnostic methods and clinical evaluations for a more accurate diagnosis, such as electrodiagnostic studies and vascular imaging.

2.3. Wright's Hyperabduction Test

In 1945, Dr. Irving S. Wright introduced the hyperabduction test to reproduce the arterial and neurological symptoms of TOS [12]. The test is conducted with the patient in a seated position. The examiner first palpates the radial pulse before passively abducting (90 degrees) and externally rotating the arm to ensure the elbow remains flexed at no more than 45 degrees. The arm is held in this position for one minute while monitoring the radial pulse and assessing the onset of symptoms. The procedure is then repeated with the arm placed in full hyperabduction (end-range abduction). A positive test is indicated by a diminished radial pulse and/or symptom reproduction, suggesting possible compression within the retropectoralis minor space [24].

The study by Gillard et al. (2001) remains a cornerstone for understanding the diagnostic performance of Wright's hyperabduction test. The test was evaluated for its diagnostic utility in detecting TOS among 48 patients (31 diagnosed with TOS and 17 without). Their findings revealed critical variations in sensitivity and specificity depending on interpretation criteria. When pulse abolition alone was used as a positive indicator, the test demonstrated moderate sensitivity (52%) but high specificity (90%), with a positive predictive value of 92% and a negative predictive value of 47%. These metrics underscore its utility in confirming arterial compression, particularly when corroborated by imaging evidence of subclavian artery stenosis. Conversely, when symptom reproduction (e.g., paresthesia, weakness) served as the diagnostic criterion, sensitivity improved to 84%, but specificity plummeted to 40%, reflecting the test's susceptibility to false positives in nTOS due to overlapping symptoms with conditions like cervical radiculopathy or peripheral neuropathy. The authors emphasized that combining Wright's test with other provocative maneuvers, such as Adson's and Roos's tests, significantly enhanced specificity to 92%, though sensitivity remained suboptimal for neurogenic cases [15].

This test evaluates positional subclavian artery compression, focusing on the artery rather than the brachial plexus. Consequently, it is only indirectly related to nTOS. Additionally, the test often yields positive results in healthy, asymptomatic individuals, making it nonspecific [25].

2.4. Elvey Test (Upper Limb Tension Test)

Australian physiotherapist Robert Elvey introduced the Upper Limb Tension Test (ULTT) in 1986 as a diagnostic tool to assess brachial plexus tension [26]. The test involves the patient sequentially abducting the arm to 90 degrees with a straight elbow, extending the wrist, and tilting the head to the opposite side. Each step incrementally stretches the brachial plexus. The test results are categorized as negative, mild positive (symptoms without distress), or strong positive (severe distress or inability to perform). This method is designed to evaluate the brachial plexus by inducing nerve elongation [25].

The ULTT is commonly incorporated into a comprehensive clinical evaluation for TOS. While specific studies detailing its sensitivity and specificity for TOS are limited, the ULTT is considered a valuable screening tool. A negative ULTT can effectively rule out brachial plexus compression, whereas a positive result suggests the need for further assessment. Clinicians often combine the ULTT with other provocative tests, such as the Elevated Arm Stress Test and Adson's test, to enhance diagnostic accuracy. Utilizing multiple tests in conjunction has been shown to improve specificity, aiding in the accurate diagnosis of TOS [9].

2.5. Eden's Test (Military Brace Test or The Costoclavicular Maneuver)

The costoclavicular space lies between the clavicle and the first rib, and it contains the subclavian artery, subclavian vein, and the brachial plexus. A reduction in this space, caused by congenital anomalies such as a cervical rib, poor posture, or muscle hypertrophy, can compress these structures, leading to vascular insufficiency or neurogenic symptoms. The costoclavicular maneuver (CCM), also known as the Military Brace Test or Eden's Test, deliberately decreases this space by approximating the clavicle and first rib, replicating positions that intensify compression [27].

During this test, the patient is instructed to push the chest forward and retract the shoulders, mimicking a military posture, while the therapist assesses the strength of the radial pulse. Expanding the chest moves the first rib forward, while retracting the shoulder girdle pulls the clavicle backward, reducing the space between them. A weakened radial pulse indicates a positive test, suggesting compression of the subclavian artery within the costoclavicular space. Given this arterial compression, it is likely that the brachial plexus is also affected [25]. If the patient reports sensory symptoms such as pain, tingling, or numbness in the upper extremity during the test, these are also considered a positive finding, indicating direct compression of the brachial plexus within the costoclavicular space [27].

Despite the widespread use of CCM, comprehensive studies evaluating its diagnostic accuracy are limited. In a blinded assessment involving 93 patients diagnosed with TOS, the CCM demonstrated a sensitivity of 67.74%. Specificity was not explicitly reported; however, the study emphasized that combining multiple tests could achieve sensitivities exceeding 90% [28].

Overall, while the CCM is a well-established provocative test for TOS, its diagnostic accuracy is limited when used in isolation. Combining multiple clinical tests may improve sensitivity and specificity; however, clinicians should be mindful of the risk of false positives and interpret results within the broader clinical context.

2.6. Cyriax Release Test

The Cyriax Release Test is a methodical procedure designed to detect nTOS. It is based on the differential diagnosis and selective tissue tension testing techniques developed by Dr. James Cyriax [29]. To perform the test, the patient sits while the examiner stands behind, holding the patient's forearms just below the elbows with elbows bent at 80–90 degrees. The examiner then leans the patient's upper body backward by approximately 15 degrees to reduce tension in the shoulder blades and passively lifts the shoulder girdle. This position is maintained for up to three minutes. A positive result is indicated if the patient experiences typical symptoms, such as tingling or pain, during or immediately after the procedure [30].

A study conducted by Brismée et al. (2004) evaluated the specificity of the Cyriax Release Test in an asymptomatic population. They found that specificity was highest at one minute (97.4%) and decreased over time, reaching 77.4% at 15 minutes. This indicates that shorter test durations may reduce the likelihood of false-positive results [30].

Another study by Hixson et al. (2017) highlighted that while the Cyriax Release Test, along with other clinical diagnostic tests, can provoke symptoms in patients with upper extremity pathology, these tests do not exclusively differentiate TOS from other conditions such as cervical radiculopathy, carpal tunnel syndrome, or rotator cuff pathology. Therefore, while the test has high specificity, especially within the first few minutes, it should be used with other diagnostic procedures to accurately identify TOS [31].

2.7. Scalenus Tenderness (Supraclavicular Pressure Test)

The Supraclavicular Pressure Test (SPT) focuses on the interscalene triangle area by exerting manual pressure on the supraclavicular fossa, compressing the anterior scalene muscle and the nearby brachial plexus. In this test, the patient sits with their arms relaxed while the examiner places their thumb on the anterior scalene muscle near the first rib, applying steady pressure for 30 seconds. A positive

result is indicated by the onset of pain or tingling sensations in the same-side upper extremity (Table 1), which suggests neurogenic compression at the scalene triangle [32].

The sensitivity of the SPT has been reported inconsistently across studies due to variations in diagnostic criteria and testing methods. A systematic review that examined data from various provocative maneuvers, including the SPT, found a combined sensitivity of 72% for detecting nTOS [33]. However, this percentage reflects the performance of several maneuvers rather than the SPT alone. Notably, the individual sensitivity of the SPT remains largely unquantified in large-scale studies, as most research evaluates clusters of tests to enhance diagnostic accuracy [31].

In their prospective study, Plewa and Delinger found that the SPT induced symptoms in 21% of healthy participants during controlled testing, indicating a high false-positive rate and raising concerns about its standalone sensitivity. Based on a 10% false-positive rate in asymptomatic individuals, they determined the SPT's specificity to be 90% [17].

The European Association of Neurosurgical Societies emphasizes that a diagnosis of nTOS requires at least three positive provocative tests, including the SPT. This strategy helps reduce the risk of overdiagnosis, especially considering the SPT's high false-positive rate in asymptomatic individuals [33].

3. Future perspectives

Advancing the diagnosis of TOS requires a shift toward more standardized, objective, and reproducible assessment methods. While provocative tests remain a cornerstone in clinical evaluation, their variability in sensitivity and specificity underscores the need for improved diagnostic accuracy. Future research should focus on refining these tests through large-scale, multicenter studies that validate their sensitivity and specificity across diverse patient populations.

Emerging imaging modalities, such as dynamic ultrasound and functional MRI, hold promise in providing real-time visualization of neurovascular compression, potentially reducing reliance on subjective clinical tests.

Ultimately, the future of TOS diagnosis and treatment lies in a multidisciplinary approach that combines clinical expertise with technological advancements. Establishing universally accepted diagnostic criteria and evidence-based treatment guidelines will be essential in improving patient care and reducing misdiagnosis.

4. Conclusion

TOS remains a complex and often misdiagnosed condition. While provocative tests play a crucial role in reproducing symptoms associated with neurovascular compression, no single test can definitively confirm TOS. Instead, clinical evaluation, imaging, and electrophysiological studies are essential for enhancing diagnostic accuracy.

Declarations

Conflicts of interest: The authors have no conflicts of interest to disclose.

Ethical approval: Not applicable.

Consent for participation: Not applicable.

Consent for publication: Not applicable.

Funding: The present study received no financial support.

Table 1. Clinical summary of provocative tests for thoracic outlet syndrome.

Tests	Types of TOS	Procedures	Duration	Results
Adson's Test	nTOS, aTOS	Extend neck, turn head toward either side, and hold breath.	~1 minute	A positive test is indicated by a diminished radial pulse and/or symptom reproduction.
Roos Test	nTOS	Holds arms in 90 degrees of abduction and external rotation while continuously opening and closing hands for three minutes.	3 minutes	A positive result is characterized by symptom reproduction.
Wright's Test	nTOS, aTOS	Abducting (90-degree) and externally rotating the arm for one minute while monitoring the radial pulse and assessing symptom onset.	~1 minute	A positive test is indicated by a diminished radial pulse and/or symptom reproduction.
Elvey Test	nTOS	Abducting the arm to 90 degrees with a straight elbow, dorsiflexing the wrist, and tilting the head to the opposite side.	~1 minute	A positive result is characterized by symptom reproduction.
Eden's Test	aTOS, nTOS	Pushing the chest forward and retracting the shoulders.	~30 seconds	A positive test is indicated by a diminished radial pulse.
Cyriax Release Test	nTOS	The patient sits while the examiner stands behind, holding the patient's forearms just below the elbows with elbows bent at 80–90 degrees. The examiner passively lifts the shoulder girdle.	Up to 3 minutes	A positive result is indicated if the patient experiences typical symptoms.
Scalenus tenderness	nTOS	Exerting manual pressure on the supraclavicular fossa, compressing the anterior scalene muscle and the brachial plexus.	Immediate	A positive result is indicated by the onset of pain or tingling sensations in the same-sided upper extremity.

TOS: thoracic outlet syndrome, **nTOS:** neurogenic thoracic outlet syndrome, **aTOS:** arterial thoracic outlet syndrome

Acknowledgments: None to be declared.

Authors' contributions: FHK, SKA, BAA, and HAN: Major contributors to the conception of the study, as well as the literature search for related studies, and manuscript writing. AKG, HSN, NSS, YNA, ASH, CSO, SOA, AHA, ADS, LJM, and OMH: Equal contribution to Literature review, design of the study, critical revision of the manuscript, and processing of the table. All authors have read and approved the final version of the manuscript.

Use of AI: ChatGPT-3.5 was used to assist with language refinement and improve the overall clarity of the manuscript. All content was thoroughly reviewed and approved by the authors, who bear full responsibility for the final version.

Data availability statement: Not applicable.

References

- Kakamad FH, Tahir SH, Rashid RJ, Asaad SK, Ghafour AK, Kareem PM, et al. Phrenic Nerve Block for Management of Post-Thoracic Outlet Decompression Cough: A Case Report and Literature Review. *Barw Med J*. 2024;**2**(4):74-79. <https://doi.org/10.58742/bmj.v2i4.149>
- Kakamad FH, Asaad SK, Ghafour AK, Sabr NS, Tahir SH, Radha BM, et al. Recurrent Neurogenic Thoracic Outlet Syndrome (TOS): A Systematic Review of the Literature. *Barw Med J*. 2023;**1**(4):40-45. <https://doi.org/10.58742/bmj.v1i2.45>
- Maślanka K, Zielinska N, Karauda P, Balcerzak A, Georgiev G, Borowski A, et al. Congenital, acquired, and trauma-related risk factors for thoracic outlet syndrome—review of the literature. *Journal of Clinical Medicine*. 2023;**12**(21):6811. <https://doi.org/10.3390/jcm12216811>
- Fisher AT, Lee JT. Diagnosis and management of thoracic outlet syndrome in athletes. In *Seminars in Vascular Surgery*. 2024;**37**(1):35-43. <https://doi.org/10.1053/j.semvascsurg.2024.01.007>
- Jones MR, Prabhakar A, Viswanath O, Urits I, Green JB, Kendrick JB, et al. Thoracic outlet syndrome: a comprehensive review of pathophysiology, diagnosis, and treatment. *Pain and Therapy*. 2019;**8**:5-18. <https://doi.org/10.1007/s40122-019-0124-2>
- Kakamad FH, Asaad SK, Ghafour AK, Sabr NS, Namiq HS, Mustafa LJ, et al. Differential Diagnosis of Neurogenic Thoracic Outlet Syndrome: A Review. *Barw Med J*. 2025;**3**(2):36-44. <https://doi.org/10.58742/bmj.v3i2.161>
- Lukadi JL. Controversies in thoracic outlet syndrome. *Barw Med J*. 2025;**3**(2):36-44. <https://doi.org/10.58742/bmj.v1i2.40>
- Weaver ML, Jordan SE, Arnold MW. Differential Diagnosis in Patients with Possible NTOS. *Thoracic Outlet Syndrome*. 2021:99-107. https://doi.org/10.1007/978-3-030-55073-8_10
- Cavanna AC, Giovanis A, Daley A, Feminella R, Chipman R, Onyeukwu V. Thoracic outlet syndrome: a review for the primary care provider. *Journal of Osteopathic Medicine*. 2022;**122**(11):587-99. <https://doi.org/10.1515/jom-2021-0276>
- Abdullah HO, Abdalla BA, Kakamad FH, Ahmed JO, Baba HO, Hassan MN, et al. Predatory Publishing Lists: A Review on the Ongoing Battle Against Fraudulent Actions. *Barw Med J*. 2024;**2**(2):26-30. <https://doi.org/10.58742/bmj.v2i2.91>
- Adson AW, Coffey JR. Cervical Rib*: A Method of Anterior Approach for Relief of Symptoms by Division of the Scalenus Anticus. *Annals of Surgery*. 1927;**85**(6):839-57.

12. Wright IS. The neurovascular syndrome produced by hyperabduction of the arms: the immediate changes produced in 150 normal controls, and the effects on some persons of prolonged hyperabduction of the arms, as in sleeping, and in certain occupations. *American Heart Journal*. 1945;**29**(1):1-9. [https://doi.org/10.1016/0002-8703\(45\)90593-X](https://doi.org/10.1016/0002-8703(45)90593-X)
13. Woods WW. Personal experiences with surgical treatment of 250 cases of cervicobrachial neurovascular compression syndrome. *The Journal of the International College of Surgeons*. 1965;**44**:273-83.
14. Sanders RJ, Hammond SL, Rao NM. Diagnosis of thoracic outlet syndrome. *Journal of Vascular Surgery*. 2007;**46**(3):601-4. <https://doi.org/10.1016/j.jvs.2007.04.050>
15. Gillard J, Pérez-Cousin M, Hachulla É, Remy J, Hurtevent JF, Vinckier L, 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. [https://doi.org/10.1016/S1297-319X\(01\)00298-6](https://doi.org/10.1016/S1297-319X(01)00298-6)
16. Rayan GM. Thoracic outlet syndrome. *Journal of Shoulder and Elbow Surgery*. 1998;**7**(4):440-51. [https://doi.org/10.1016/S1058-2746\(98\)90042-8](https://doi.org/10.1016/S1058-2746(98)90042-8)
17. Plewa MC, Delinger M. The false positive rate of thoracic outlet syndrome shoulder maneuvers in healthy individuals. *Acad, Emerg Med* 1998;**5**:337-42. <https://doi.org/10.1111/j.1553-2712.1998.tb02716.x>
18. Leonhard V, Landreth R, Caldwell G, Coleman M, Smith H. A new anatomical variation in the brachial plexus roots and its implications for neurogenic thoracic outlet syndrome. *The FASEB Journal*. 2015;**29**(1):864-3. https://doi.org/10.1096/fasebj.29.1_supplement.864.3
19. Povlsen S, Povlsen B. Diagnosing thoracic outlet syndrome: current approaches and future directions. *Diagnostics*. 2018;**8**(1):21. <https://doi.org/10.3390/diagnostics8010021>
20. Gilroy J, Meyer JS. Compression of the subclavian artery as a cause of ischaemic brachial neuropathy. *Brain*. 1963;**86**(4):733-46.
21. Roos DB, OWENS JC. Thoracic outlet syndrome. *Archives of Surgery*. 1966;**93**(1):71-4. <https://doi.org/10.1001/archsurg.1966.01330010073010>
22. Henni S, Hersant J, Ammi M, Mortaki FE, Picquet J, Feuilloy M, et al. Microvascular response to the Roos test has excellent feasibility and good reliability in patients with suspected thoracic outlet syndrome. *Frontiers in Physiology*. 2019;**10**:136. <https://doi.org/10.3389/fphys.2019.00136>
23. Lee J, Laker S, Fredericson M. Thoracic outlet syndrome. *PM&R*. 2010;**2**(1):64-70. <https://doi.org/10.1016/j.pmrj.2009.12.001>
24. Watson LA, Pizzari T, Balster S. Thoracic outlet syndrome part 1: clinical manifestations, differentiation and treatment pathways. *Manual therapy*. 2009;**14**(6):586-95. <https://doi.org/10.1016/j.math.2009.08.007>
25. Thompson RW. Diagnosis of neurogenic thoracic outlet syndrome: 2016 consensus guidelines and other strategies. In *Thoracic outlet syndrome*. Cham: Springer International Publishing. 2021:67-97. https://doi.org/10.1007/978-3-030-55073-8_9
26. Elvey RL. Treatment of arm pain associated with abnormal brachial plexus tension. *Aust J Physiother*. 1986;**32**(4):225-30.
27. Aisu Y, Hori T, Kato S, Ando Y, Yasukawa D, Kimura Y, et al. Brachial plexus paralysis after thoracoscopic esophagectomy for esophageal cancer in the prone position: a thought-provoking case report of an unexpected complication. *International Journal of Surgery Case Reports*. 2019;**55**:11-4. <https://doi.org/10.1016/j.ijscr.2018.12.001>
28. Calis M, Altuncuoglu M, Demirel A. Diagnostic values of clinical diagnostic tests in thoracic outlet syndrome. *Turkiye Fiziksel Tip Ve Rehabilitasyon Dergisi-Turkish Journal of Physical Medicine and Rehabilitation*. 2010;**56**(4):155-60.
29. Cyriax J. Textbook of orthopedic medicine. In *Textbook of Orthopaedic Medicine* 1975:12-756.
30. Brismée JM, Gilbert K, Isom K, Hall R, Leathers B, Sheppard N, et al. Rate of false positive using the cyriax release test for thoracic outlet syndrome in an asymptomatic population. *Journal of Manual & Manipulative Therapy*. 2004;**12**(2):73-81. <https://doi.org/10.1179/106698104790825374>
31. Hixson KM, Horris HB, McLeod TC, Bacon CE. The diagnostic accuracy of clinical diagnostic tests for thoracic outlet syndrome. *Journal of Sport Rehabilitation*. 2017;**26**(5):459-65. <https://doi.org/10.1123/jsr.2016-0051>
32. Hooper TL, Denton J, McGalliard MK, Brismée JM, Sizer PS. Thoracic outlet syndrome: a controversial clinical condition. Part 1: anatomy, and clinical examination/diagnosis. *Journal of Manual & Manipulative Therapy*. 2010;**18**(2):74-83. <https://doi.org/10.1179/106698110X12640740712734>
33. Dengler NF, Pedro MT, Kretschmer T, Heinen C, Rosahl SK, Antoniadis G. Neurogenic Thoracic Outlet Syndrome: Presentation, Diagnosis, and Treatment. *Deutsches Ärzteblatt International*. 2022;**119**(43):735. <https://doi.org/10.3238/arztebl.m2022.0296>