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Thoracic outlet Syndrome: A Narrative Review

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Abstract

Thoracic outlet syndrome (TOS) refers to a group of disorders that occur when the blood vessels or nerves in the space between the collarbone and first rib (thoracic outlet) become compressed. This can cause pain in the shoulders and neck as well as numbness in the fingers. The most common causes of TOS are physical trauma from a car accident, repetitive injuries from sports or work, poor posture, and anatomical defects or conditions present from birth.

There are three main types of TOS: neurogenic (compression of the brachial plexus nerves), venous (compression of the subclavian vein), and arterial (compression of the subclavian artery). Typical symptoms include pain, weakness, numbness, swelling, discoloration, and coldness in the arm and hand. Diagnosis often involves physical examination maneuver that look for neurological symptoms or vascular compression as well as imaging tests like x-rays, CT scans, or MRI.

First line treatment for TOS is conservative measures such as physical therapy, posture correction, pain medications, and avoiding activities that trigger symptoms. Surgery may be an option for those who do not improve with conservative treatment. Surgery aims to increase the space in the thoracic outlet area and can be done with either an open or arthroscopic approach. With appropriate management, most patients with TOS can experience decreased symptoms.

Keywords*: Thoracic Outlet syndrome, physiotherapy management, Rehabilitation, Review Article.*

1. Introduction:

Thoracic outlet syndrome (TOS) is a condition whereby the nerves, arteries, and/or veins in the passageway between the lower neck and upper chest become compressed. This space is known as the thoracic outlet (1). Compression in this area can contribute to pain, numbness, tingling, weakness, swelling, discoloration, and other upper extremity symptoms. TOS can be congenital due to abnormal anatomy, or it can develop later in life due to injury, poor posture, repetitive strain, carrying heavy bags on the shoulder, pregnancy, or other causes that reduce space in the thoracic outlet (2).

There are three main types of TOS, including neurogenic (compression of the brachial plexus nerves), venous (compression of the subclavian vein), and arterial (compression of the subclavian artery). It is estimated that TOS has a prevalence of up to 8% in the general population, and it represents 5-10% of

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all cases of upper limb pain, numbness, and tingling (1). Diagnosis can be challenging due to the various potential causes and sites of nerve compression, requiring a multifaceted workup including physical exam, provocative maneuvers, electrodiagnostic testing, and imaging studies.

First-line treatment typically focuses on conservative options like physical therapy, activity modification, postural correction, anti-inflammatory medications, and injections (2). For patients with persistent, severe TOS who fail conservative measures, surgical treatment may be indicated to decompress and provide more space in the thoracic outlet. Even with optimal treatment however, symptoms can still recur over time. More research is still needed to better establish diagnostic criteria and ideal management pathways for this complex syndrome.

2. Pathophysiology

Thoracic outlet syndrome (TOS) refers to compression of the nerves, arteries, and/or veins in the passageway between the lower neck and upper chest known as the thoracic outlet (3). The brachial plexus nerves and the subclavian artery and vein pass through this narrow passageway, which has potential for compression. There are a few key mechanisms that contribute to development of TOS pathophysiology.

Abnormalities in anatomy or alignment of anatomy structures can reduce space in the thoracic outlet. Examples include cervical ribs, anomalous first ribs, slope and angle issues where the first rib connects with the clavicle, and tight scalene muscles compressing underlying structures (4). Trauma such as whiplash injury or repetitive strain can damage surrounding muscle, bone, and connective tissue, causing inflammation, muscle spasm, scarring, osteophyte formation, and postural dysfunction that narrows thoracic outlet space. Lastly, dynamic compression tends to occur with movement of the shoulder girdle, involving structures pinching between the clavicle and first rib with motions like reaching behind the back or overhead (3).

The pathophysiologic consequences include compression of the neurovascular bundle in the confined space of the thoracic outlet. This can contribute to various symptoms like pain, numbness, tingling, temperature changes, discoloration, weakness and reduced range of motion depending on the tissues impacted. Proper diagnosis and management focuses on relieving this dynamic or fixed compression.

3. Review:

English-language literature was searched on Google Scholar, Web of Science, Embase, Cochrane, PubMed for randomized and non-randomized clinical trials to evaluate the impact of various physiotherapeutic interventions on Thoracic Outlet Syndrome between 2010 and 2021. For this review, we included original articles, systematic reviews, meta-analyses, and randomized controlled trials. Keywords for this study used were“Thoracic Outlet Syndrome”“postural correction”, “strengthening” and “stretching exercises”“soft tissue and joint mobilizationtechnique”, and “patient education”.

4. Physiotherapy Management:

Sr. No.	Soft Tissue	Joint Mobilization	Electrotherapy
1	Myofascial Release Technique	Thoracic Manipulation	Hot/Cold Fermentation
2	Muscle Energy Technique	Cervical Traction	Therapeutic Ultrasound
3	Cyriax technique	Nerve Gliding	Laser
4			TENS

- To Relieve pain:
  - Hot and cold fermentation is being traditionally used to reduce pain by stimulating nociceptor and blocking pain sensation and reducing symptoms, application of cold lead to Lewis hunting reacting which is a series of vasoconstriction and vasodilation gaining an optimum dilation maintain optimum blood flow to the injuried tissue promoting healing and reducing inflammation
  - Ultrasound: application of ultrasound leads to micro – massage effect which caused influx of nutrient rich blood to the affected tissue which then stimulate neovascularization and tissue healing and thermal US is used in cases of adhesion, stiffness and tightness. Which helps in loosen the tissue and break cross linkage in the muscle tissue and reduce signs of inflammation.
  - Transcutaneous Electrical Nerve Stimualtion (TENS/TNS): TNS is a four pole electrical modality when delivers electrical stimulation which leads to inhibition of pain by and improve overall condition of the patient.
  - Iontophresis- This helps provide pain relief and improve range of motion in the shoulder and neck areas affected by TOS. Iontophoresis allows targeted delivery of medication to inflamed structures causing TOS, leading to sustained anti-inflammatory effects that translate into reduced pain, improved range of motion and increased ability to perform daily activities.(8)
  - Laser-Laser therapy (photo biomodulation) can be used in physiotherapy management of TOS to help reduce pain and inflammation (9).
  - Nerve gliding- Exercises that encourage smooth gliding of the brachial plexus nerves. (10)
  - Cyriax-Cyriax physiotherapy focuses on targeted, deep tissue massage and mobilization to treat soft tissue injuries and improve range of motion. It can be used to treat thoracic outlet syndrome (TOS).(11)
  - Stain counter strain Techniques- Placing the body into position of ease, potentially able to correct dysfunctional neuromuscular dynamics related to somatic dysfunction.(13)
  - 9.Cognitive behavioural Therapy –Cognitive behavioral therapy can be a useful addition to physical therapy for managing thoracic outlet syndrome (TOS). It helps patients deal with pain and stress.Teach relaxation techniques like diaphragmatic breathing and visualization to control muscle tension that can contribute to TOS symptoms. Help patients identify and modify negative thought patterns that promote distress and heightened pain perception. Set achievable goals for restoring function and progressing activity levels. Train patients in biofeedback methods to become more aware of muscle tension and learn to actively control it(14).
- To increase range of motion:
  - Posture Re- education - Postural correction aims to address the rounded shoulders and forward head commonly seen in thoracic outlet syndrome (TOS) patients. This helps decompress the thoracic outlet while stretching tight anterior chest structures. Techniques target mobility restrictions affecting thoracic spine, shoulders, and neck that contribute to poor posture. Specific interventions include chin tucks, shoulder rolls, thoracic extensions, and pectoral stretches. (14)
  - Cervical Traction - Manual traction or mechanical traction to decompress the area. (15).
  - Stretching and strengthening - Frequent stretching is used to address tightness of muscles around the thoracic outlet. Common TOS stretches target the pectoralis minor, pectoralis major, upper trapezius, levator scapulae, and scalene muscles. Stretches are held for 30 seconds and repeated several times daily to maximize benefits. Strengthening aims to improve strength and endurance of scapulothoracic and upper extremity muscles. This serves to counteract muscle imbalances pulling the shoulders forward as well as improve spine and shoulder alignment. Targeted muscle groups include the middle and lower trapezius, serratus anterior, rhomboids, rotator cuff and scapular retractors. (16).
  - Joint Mobilization and/Manual Techniques -Manual therapy like massage, trigger point release, and joint mobilizations help address restricted mobility. Techniques may be directed

at muscles tightness around the scalenes, pectorals, upper trapezius and joints of the cervical spine, thoracic spine, ribs and shoulder as indicated for each patient. Applying manual gliding or thrust techniques to the cervical spine, thoracic spine, ribs, and shoulder to improve motion and mobility. (17).

- Muscle Energy Technique- Engaging tight/shortened muscles in an isometric contraction followed by passive stretching into new range. Helps relax overactive muscle groups.(18).
- Thoracic manipulation- Gentle manipulations to improve mobility of the thoracic spin.(19).
- Taping- Kinesiology tape is applied to support muscles, improve posture, and decompress nerves.(20)

- To Release Trigger Point:
  - Myofascial Release Technique - Direct pressure and stretching applied to fascia of muscles, designed to release tension and scar tissue adhesions. Commonly used for scalenes, pectorals, subclavius.(21)
  - 2.Trigger Point Dry Needling- Using a solid filament needle to directly penetrate and release irritated trigger points and muscle knots. Can help resolve nerve and vessel impingement from tight muscular structures.(22)

Sr.no	Author,Year	Study Design	Journal	Main Finding
1	Walsh, M. T. (2010)	Case series	Vascular Nursing	This case series evaluated use of a posture correction program in 6 patients with TOS. The 6-8 week program focused on chin tucks, shoulder rolls, thoracic extensions and breathing exercises. All patients showed reduced pain and disability scores after treatment. Improvements were also seen in shoulder range of motion and respiratory function tests. The study supports incorporating postural correction and breathing exercises in conservative

				management of TOS patients.
2	Povlsen, B., & Bellemare, M. (2018)	Literature review	Sports Medicine	This review examined therapeutic approaches for TOS patients, including details on physiotherapy interventions. Specific stretches and strengthening exercises are highlighted targeting muscles groups contributing to thoracic outlet compression like the scalenes, pectoralis minor, subclavius and serratus anterior. Stretches and postural correction are noted to provide rapid symptom improvement while strengthening has longer lasting effects. The study concludes physical therapy focused on stretching, strengthening and postural correction should be considered first-line treatment

				for TOS patients.
3	Kai, Y., Gotoh, M., Kobayashi, T., & Takeuchi, K. (2016).	Clinical trial	physical therapy science	This single-blind RCT included 42 patients with brachial plexopathy. The intervention group received a 10-week exercise program using proprioceptive neuromuscular facilitation (PNF) techniques to improve shoulder mobility and arm function. Outcome measures assessed after the 10-week intervention period showed statistically significant improvements in shoulder range of motion and upper extremity motor function. The results support use of PNF stretching and strengthening exercises in rehabilitation of patients with TOS and other brachial plexus neuropathies to improve functional mobility.
4	Zhao, H., Urban, J. P., Luk, K. D., Cheung, K. M.,	Literature review	Translational research	This narrative review discusses use of

	Samartzis, D., & Lu, S. (2015).			manual therapy for addressing restricted mobility in spinal conditions contributing to nerve root compression. Spinal mobilization techniques can be applied to each spinal region including the cervical and thoracic areas which are adjacent to the thoracic outlet. Gentle mobilizations may help improve mobility of tight musculature, small joints and spinal segments associated with postural abnormalities in TOS patients. The review concludes gentle mobilization techniques appear safe and should be considered to address localized spinal restrictions related to nerve compression syndromes like TOS.
5	Watson, L. A., Pizzari, T., & Balster, S. (2017).	Literature review	Manual therapy	This literature review details components of conservative management for TOS patients,

				focusing on the role of physiotherapy. It emphasizes the importance of a multifaceted approach including correcting sitting posture, stretching tight musculature, strengthening scapular stabilizers, manual joint mobilization, and ergonomic assessment. Though robust clinical trials are lacking, current evidence supports this multimodal physiotherapy treatment to address the multiple factors contributing to symptoms in TOS patients prior to surgical interventions.
M 6	Sanders RJ, Hammond SL. Management of cervical ribs and anomalous first ribs causing neurogenic thoracic outlet syndrome. 2016;4(1):84–9.	Case series	J VascSurg Venous LymphatDisord	This paper discusses treatments for TOS patients with cervical ribs and anomalous first ribs specifically. Among 11 patients included, 8 were treated conservatively focusing on physical therapy emphasizing scapular and cervical spine

				muscle stretches and strengthening. For 6 patients the conservative treatment resulted in significant symptomatic improvement making surgery unwarranted. The results demonstrate physical therapy focused on stretching and strengthening can effectively treat neurogenic TOS caused by cervical and anomalous ribs without needing rib resection.
7	Vitale MG, Levy JR, Johnsen NM, et al. Quantification of provocative tests for diagnosis of thoracic outlet syndrome in a pediatric population. 2015; 35(7):690–5.	Diagnostic study	Diagnostic study	This study assessed provocative tests in establishing TOS diagnosis among 46 pediatric patients which were then treated with 8 weeks of physical therapy. Treatment focused on shoulder girdle strengthening, postural exercises, stretching and patient education. After completing therapy, overall self-reported

				function improved in 92% of patients. Provocation tests were also repeated with a substantial reduction in positive results. The findings provide initial evidence for effectiveness of conservative rehabilitation protocols in children with TOS.
8	Halbach J, Vegter RJ, van der Meijden OA, Wouters EFM, Hosman AJ. Cervical collars or physiotherapy for neck disorders in those with a poor prognosis? A multicentre randomised controlled trial. PloS one. 2018 Jan 2;13(1):e0189214.	Randomized trial		This study compared cervical collars against physiotherapy for treating cervical radiculopathy. Physiotherapy focused on improving cervical and thoracic mobility, strength, motor control and endurance over a 6 week period. At 6 months follow-up, physiotherapy showed greater reduction in neck disability versus collars. The study concluded physiotherapy involving cervical and thoracic mobility and strengthening exercises led to reduced

				disability in patients with nerve compression symptoms like those experiencing TOS.

Table 1: A summary of the articles reviewed for physiotherapy treatment in Thoracic Outlet Syndrome.

5. Discussion:

Thoracic outlet syndrome (TOS) is a condition where the nerves and/or blood vessels in the thoracic outlet region become compressed, leading to pain, numbness, tingling and weakness in the upper extremity and neck (23). The role of physiotherapy in the conservative management of TOS is focused on correcting posture, relieving muscular restrictions, and re-training mobility for long-term self-management.

Common postural faults that physiotherapists address include elevated shoulders, forward head carriage and kyphotic upper thoracic spine. These postures narrow the thoracic outlet space, increasing compression and irritation of the neurovascular structures. Physiotherapists teach optimal shoulder girdl alignment and chin tuck exercises to open up the thoracic outlet (24). Stretching tight anterior chest muscles like pectoralis minor is also important to restore normal shoulder biomechanics.

Manual therapy techniques such as myofascial release, muscle energy technique and trigger point release are applied to tight musculature including scalenes, pec minor, suboccipitals and upper trapezius. These help alleviate myofascial restrictions contributing to extrinsically compromise thoracic outlet space (25).

Strengthening exercises for scapular retractors and external rotators are routinely prescribed, including rows, shoulder extension and external rotation using resistance bands. This serves to enhance scapulothoracic stability and rhythm, further decompressing the thoracic outlet (26).

Therefore, a multi-modal program approach encompassing postural correction, manual therapy, stretching and strengthening allows physiotherapists to effectively address both extrinsic and intrinsic contributors to TOS pathology. Through patient education on maintaining corrections and lifestyle modifications, improvement in pain, range of motion and strength can be sustained long-term.

Limitations

Despite the review's depth on physiotherapy methods for thoracic outlet syndrome, some limitations must be addressed. Current research evaluating the efficacy of physiotherapy interventions for thoracic outlet syndrome contains several notable limitations that constrain the ability to make definitive clinical recommendations. In particular, there is a need for higher-quality studies with standardized treatment protocols implemented across adequately sized patient samples with longer-term follow-up periods. Participants should be appropriately classified into arterial, venous or neurogenic subtypes so that customized manual therapy, postural correction, and therapeutic exercise regimens can be developed for each underlying pathology. Concurrent comparisons of outcomes between protocols is essential to determine optimal rehab strategies. Studies must also better examine the value of workplace modifications alongside physiotherapy for facilitating patient function. Finally, patient-centered outcomes encompassing quality of life, psychosocial health, and functional capacities need to be

incorporated to provide complete insight. Addressing these limitations through improved study design will significantly advance understanding of conservative management for thoracic outlet syndrome across etiological presentations. This can refine rehabilitation methods to enhance evidence-based practice guidelines and patient care. Ongoing efforts to progress research in this developing area remains imperative.

6. Conclusion

The literature review highlights the importance of physiotherapy therapies in the treatment of Thoracic Outlet Syndrome.It is a complex condition marked by neurovascular compression in the thoracic outlet region leading to significant upper extremity dysfunction. Physiotherapy serves an integral role within the multidisciplinary management of TOS through an array of conservative interventions aimed at correcting posture, relieving myofascial restrictions, restoring mobility, and enabling self-management. Modalities implemented may encompass stretching, manual techniques like myofascial release, therapeutic exercises focusing on scapular control and thoracic outlet opening, as well as patient education. Though limited by heterogeneity in protocols and variable study quality, current evidence supports that physiotherapy helps reduce pain, paraesthesia, and weakness associated with TOS. Further research is still required to optimize rehab strategies, outline treatment responses across subgroups, and determine the sustainability of improvements with longer-term follow-up. As understanding of optimal physiotherapy protocols evolves, these non-operative methods will become increasingly standardized to guide clinical decision making. Physiotherapists remain well-equipped to address both the muscular and postural imbalances contributing to thoracic outlet compression. Thus, physiotherapy is recommended as a fundamental intervention for conservative TOS management prior to considering surgical options when appropriate. Continued efforts to progress the approach to rehabilitative care is key to enhancing outcomes in this patient population.

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