THORACIC OUTLET SYNDROME (TOS) WITH INVOLVEMENT OF ALL THREE ENTRAPMENT SPACES – A CASE STUDY

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ABSTRACT
Thoracic Outlet Syndrome (TOS) is an upper extremity pain and paraesthesia with or without vascular symptoms as a result of compression to the neurovascular structures such as brachial plexus, subclavian artery and vein at three exit spaces of Thoracic Outlet. There are three exit spaces for neurovascular structures which are Interscalene Triangle space, Costoclavicular Space, Subpectoral space. These three exit spaces are vulnerable to compression of neurovascular structures which exits through it. Compression of neuro-vascular structures in any of these three exit spaces causes TOS, involvement of one space at time by narrowing down its cross-sectional geometry is common, the involvement of three spaces is rare and this study details the involvement of all three spaces, its patho-mechanism and management with orthopaedic manual physiotherapy in a male college student. OBJECTIVE: To assess and manage a case of TOS with involvement of neurovascular structures in all three entrapment spaces in a physiotherapy out patient clinic. PROCEDURE: By physical examination the shoulder and cervical pathologies were ruled out. With positive Adson test, Wright’s test, Moto-clavicular test and Roo’s tests ruled in TOS with involvement of all three spaces and addressed with trigger point release technique to deactivate myofacial trigger points, Muscle Energy Technique for elongation of shortened muscles, Articular technique for cervical, upper thoracic spine and first rib dysfunction followed by rehabilitation and postural re-education. CONCLUSION: Involvement of all three entrapment spaces is rare and healthcare practioners either mis/under diagnose TOS with involvement of all three spaces. Precise physical evaluation of biomechanical dysfunctions helps to manage TOS conservatively with orthopaedic manual physiotherapy.

I. INTRODUCTION
In this twentieth century both white collar and industrial population are prone to cervical and upper extremity pain and paraesthesia due to their job nature, job task and habitual postures.

Thoracic Outlet Syndrome (TOS) is a common causative factor of cervical and upper extremity pain and paraesthesia, excluding cervical radiculopathy, cervical myelopathy, cervical brachialgia and brachial plexopathy. TOS is a compression of neuro-vascular structures such as brachial plexus, subclavian artery and vein, axillary artery and vein.

There are three subtypes of TOS, the first is Neurogenic TOS caused by entrapment of C5 to T1 nerve roots of brachial plexus, 90% of the TOS accounts for the Neurogenic type, the second subtype is Venous TOS occurs with entrapment of subclavian vein at costo-clavicular space which accounts for 10%- 15% of TOS, the third subtype is Arterial TOS at scalene triangle which comprises 2% to 5% of TOS¹.

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In TOS three entrapment sites exists which causes entrapment of neuro vascular structures, the proximal entrapment site is inter scalene triangle space which causes anterior scalene syndrome, the middle entrapment site is costo-clavicular space which causes costo-clavicular syndrome and distal entrapment site is sub-pectoral or retro-pectoral space which causes hyperabduction syndrome.

**Anatomy**

The thoracic outlet is a passage through which neuro-vascular structures, the brachial plexus, subclavian artery and vein passes from base of the neck to upper extremity.

Three passages or spaces plays crucial role in exit of neuro vascular structures².

Interscalene Triangle space – is proximal most space, anteriorly bordered by scalene anterior, posteriorly bordered by scalene middle and inferiorly bordered by medial surface of first rib and this space contains brachial plexus trunk, subclavian artery and vein.

Costo-clavicular space – is a middle space, anteriorly bordered by clavicle, postero-medially covered by first rib and postero-laterally by superior part of scapula, this space contains brachial plexus trunk, subclavian artery and vein.

Sub-Pectoral space – this space is distal most space, here the brachial plexus and subclavian artery and vein passes through sub-pectoral space which is deep to pectoralis minor tendon.

**Etiology**

Cervical Rib³, Fibrous Bands, Whiplash Injuries, Repetitive Injuries, Overhead Activities, Sports, Faulty Postures, Pancoast Tumour, Fractures, High velocity trauma such as RTA⁴.

**Clinical Manifestation**

Pain in neck, head, chest , arm and interscapular pain

Pain and paraesthesia in upper extremity

Raynaud’s phenomenon⁵

Intrinsic muscle weakness⁶

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**II. CASE STUDY**

A 22 years male physiotherapy student came to physiotherapy outpatient clinic through self-referral with the complaint of neck pain and paraesthesia in right forearm and hand. On subjective examination he disclosed about the forward head posture which he assumed during his online classes for past 8 months and his habitual posture of sleeping in semi-prone position towards right side with right arm in hyperabduction. On physical examination there was presence of myofacial triggers points in upper trapezius, rhomboids major and minor, levator scapula, serratus posterior superior, sternocleidomastoid, scalene anterior, middle and posterior and pectoralis minor muscle. There was presence of tightness of upper trapezius, rhomboids major and minor, levator scapula, serratus posterior superior, sternocleidomastoid, scalene anterior, middle and posterior and pectoralis minor muscle. There was no hand intrinsic muscle weakness and vascular symptoms. On somatic diagnosis and passive accessory inter vertebral motion there was restriction in right occipital condyle for anterior nodding, presence of restriction in C1 for left side bending, restriction of C2 for right rotation, closing dysfunction of left C3 and opening dysfunction of left T1, elevated right 1st rib, posteriorly rotated and superiorly migrated clavicle. The Wainner’s cluster test for cervical radiculopathy was negative⁷. The Wright’s test, Adson’s test, Costa-clavicular test and Roo’s test⁸ were positive and provoked the symptoms in forearm and hand on ulnar nerve distribution. The three clinical special test for TOS which are distinctly separate for three different entrapment spaces was positive for all spaces and revealed entrapment of neuro-vascular structures in all three spaces. With subjective and objective findings diagnosis is made as TOS with involvement of all three spaces inter-scalene triangle, costo-clavicular space and sub-pectoral space. Addressed the clinical findings with myofascial trigger points release to deactivate myofascial trigger points, elongated the tight muscles with Muscle Energy Technique (MET), applied articular technique for upper & middle cervical spine and thoracic spine dysfunction, and for posteriorly and superiorly migrated clavicle. MET to right
elevated 1st rib dysfunction, with the following treatment for 4 weeks the TOS symptoms was completely resolved, and it is followed by rehabilitation exercises and postural re-education.

III. CASE DISCUSSION

The TOS is common neuro-vascular problem, often it is under/mis diagnosed by clinicians. The TOS has three vulnerable spaces of entrapments which are the inter scalene triangle space proximally, costo-clavicular space in the middle and sub-pectoral space distally. The involvement of any one space at a time is common, involvement of all three spaces is rare and till date there is no any research publications on it. This single case study details how three spaces of TOS involved in this subject and how orthopaedic manual physiotherapy techniques completely resolved the TOS by reversing patho-mechanism and by addressing patho-anatomic structures.

The subject in this study is a final year physiotherapy student, who is attending his college lectures in online platform for past 8 months due to global pandemic Covid 19, while attending online classes he use to assume Forward Head Posture (FHP).

The FHP alters cervico-thoracic and shoulder alignments, causes tightness of scalene anterior, middle muscles and pectoralis minor muscle. Chronic tightness of scalene anterior and middle is prone to narrow inter-scalene space by elevating 1st rib, hence the proximal entrapment space inter scalene triangle was involved9,10.

The next two entrapment spaces middle costo-clavicular and distal sub-pectoral spaces would be involved due to following patho-mechanism, the subject assumes right semi-prone lying position during sleeping habitually with hyper abduction of right shoulder to 180 degree, the hyperabduction of shoulder narrows the sub-pectoral space which is under the pectoralis minor tendon and coracoid process, the hyper abduction of shoulder during sleeping normally narrows the sub-pectoral space and stretches the brachial plexus, axillary artery and vein (the subclavian artery and vein becomes axillary artery and vein in sub-pectoral space)11. The Pectoralis Minor muscle which is been tight due to FHP had further increased the tension of muscle and narrowed the sub-pectoral space.

The costoclavicular space which is above the sub-pectoral space is also narrowed due to hyper abduction of shoulder, which causes posterior rotation and superior migration of clavicle, this posterior rotation and superior migration of clavicle along with tight anterior scalene narrows the spaces and entraps the brachial plexus, subclavian artery and vein11. On assuming right semi-prone lying on sleeping, the subject used to side bend his neck to right side, hence on the right side all scalene muscles shortened, became tight and elevated the 1st rib on right side.

The above discussed patho-mechanism had caused involvement of all three entrapment spaces due to the habitual posture of the subject.

Addressing patho-anatomic structures reversed the patho-mechanism. The myofascial trigger point release particularly in scalene muscles and pectoralis minor muscles relieved muscular tension11,12 adjunctively MET elongated the tight patho-anatomic structures scalene anterior and middle and pectoralis minor13,14. Articular technique to upper & middle cervical and upper thoracic spine T1 realigned the spinal malalignment10 which was due to faulty habitual posture. MET applied to the 1st right rib to realign the structure from its elevated position to neutral position, it increased interscalene triangle space15, MET for pectoralis minor elongated it, relieved the tension on it and increased the diameter of sub-pectoral space14, the anterior and inferior glide to acromioclavicular joint and posterior and superior glide to sternoclavicular joint with articular technique realigned the posteriorly rotated and superiorly migrated clavicle to neutral position and increased the diameter of costoclavicular space10.

The habitual sitting and sleeping posture had caused involvement of all three TOS entrapment spaces in this subject with above described patho-mechanism and patho-anatomic structures. Reversing of patho-mechanism had been achieved by addressing the patho-anatomic structures in this subject with orthopaedic manual physiotherapy and followed by postural correction and rehabilitation exercises.

IV. CONCLUSION

Physiotherapy clinicians often under-diagnose or mis diagnose TOS and they skip to consider TOS in a differential diagnosis for upper extremity pain and paraesthesia. The conservative management with physiotherapy for TOS can give significant results with manual approaches for the involvement of all three entrapment spaces unless there
is a presence of cervical rib, fibrous bands and tumour. This case study is first to report with involvement of all three entrapment spaces of TOS and was managed conservatively with orthopaedic manual physiotherapy techniques. Though there was chronic involvement of all three spaces in this subject, there was no vascular symptoms for unknown reasons, it needs further research in this regard.

REFERENCES