Successful Conservative Management of an Adolescent Musician with a Rare Occurrence of True Neurogenic Thoracic Outlet Syndrome and Cervical Ribs: A Case Report

The Thoracic Four Syndrome: A Case Report and New Insights in Pathophysiology, Diagnosis and Treatment

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colleague q & a

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dear colleagues:

we hope you’re enjoying the cooler weather and gearing up for the holidays. we’ve had a really productive year so far, and are excited about starting new projects in 2017, including the launch of our dry needling app.

2017 is right around the corner, so if you’re interested in taking a course, or sponsoring a course, click on this link, fill out the form at the bottom of the page and we’ll see what we can work on together.

we hope you enjoy this latest issue of the iaom-us connection. let us know what you think. we would love to hear your feedback in a “letter to the editor” segment, so let us know what’s on your mind.

as always, thanks for being part of the iaom-us family, and enjoy the rest of 2016!

joel, john, sharon, tanya & valerie
Successful Conservative Management of an Adolescent Musician with a Rare Occurrence of True Neurogenic Thoracic Outlet Syndrome and Cervical Ribs: A Case Report

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ABSTRACT

Study Design: Case Report

Background: Forty-eight percent of musicians develop upper extremity entrapment neuropathy. This case presents clinical examination, electro-diagnostic and radiographic findings of an adolescent musician with true neurogenic thoracic outlet syndrome (TOS), interpretation of the examination findings, and multimodal management.

Case Description: A sixteen year-old right hand dominant male French horn player presented to physical therapy with a two-year history of right upper extremity symptoms. Clinical findings included: symptom provocation during elevated arm stress test and Cyriax release maneuver, first rib limitation bilaterally, right scapulothoracic dyskinesia, and sternoclavicular joint hypomobility. There were sensory and motor deficits at C8 and T1 that were confirmed by axonal conduction loss demonstrated in electro-diagnostic testing along with bilateral rudimentary cervical ribs’ (CR) radiographic findings. Clinical findings were consistent with neurogenic TOS with contributory dysfunctions in the musculoskeletal kinetic chain. The Disabilities of the Arm, Shoulder and Hand (DASH) score was 53.6 and sport/performance 75. The patient was treated with manual therapy (cervical and thoracic spine, ribs, sternoclavicular and glenohumeral joints), bracing/taping (thoracic spine, elbow and wrist), and neuromuscular re-education.
Outcomes: On final examination, Cyriax release test and the cervical rotation lateral flexion test were negative, while sensation and motor testing were normalized. The DASH score was 2.0 and sports/performance 0.0. Improvements were maintained at three months follow up.

Discussion: This is the first case study in orthopedic literature to report successful management of true neurogenic TOS in an adolescent musician with axonal conduction loss and the presence of CR.

"Level of Evidence": Therapy, level 4C

Key Words: double crush syndrome, manual therapy, neurogenic pain, scapulothoracic dyskinesia

BACKGROUND
Thoracic outlet syndrome (TOS) is characterized mainly by pain and paresthesia into the upper extremities with arm elevation. It is classified into two distinctive categories: vascular and neurogenic. Vascular TOS is further subdivided into arterial and venous, whereas neurogenic TOS is characterized as true neurological or symptomatic. While the majority of cases in adults are symptomatic TOS without objective findings of axonal conduction loss, adolescents can present more frequently with unequivocal signs and symptoms of vascular changes and/or axonal conduction loss. Repetitive upper extremity use in musicians is associated with the development of neurogenic and vascular TOS, which can lead to loss of shoulder girdle stability and hypertrophy or imbalance of the anterior/middle scalene or pectoralis minor muscles or both.

The reported incidence of entrapment neuropathy in musicians is 4% to 48%. The most common entrapment neuropathies in musicians include carpal tunnel syndrome, ulnar neuropathy at the elbow and TOS. Fifty percent of musicians diagnosed with TOS present with drooped shoulder configuration. One of the consistent findings of neurogenic TOS is scapular depression, which can lead to traction and/or compression of the neurovascular structures at the posterior scalene triangle, costoclavicular space and thoraco-coraco-pectoral space. Aberrant scapular position includes depression, downward rotation and winging. Patients presenting with drooped shoulders and neurogenic TOS tend to demonstrate late and insufficient upward rotation of the scapula during elevation in abduction. Similar dysfunction can be seen in flexion; scapular winging, however, can be more prominent in flexion. In addition, increased scapular anterior tilt may be coupled with increased downward rotation of the scapula, which is seen more frequently in abduction. These positions can be influenced by an alteration of recruitment, intensity and/or force of the scapular musculature.

TOS signs and symptoms may begin to manifest secondary to congenital abnormalities predominantly in the adolescent age group. A cervical rib (CR) can predispose an individual to TOS because of tension/compression and/or irritation to the brachial plexus and/or subclavian vessels. A CR is described as a rudimentary rib, which arises from the transverse process of C7 and has a free end into the soft tissue or articulates with the first rib posterior to the scalene tubercle. The incidence of CR in adults is 0.05% to 3%. Symptoms from CR are poorly described in children; a large retrospective study on children from birth to 18 years over a 10-year period was performed to identify the presence of CR in asymptomatic and asymptomatic populations. The diagnosis of CR was made incidentally in 88.2% of cases with 11.2% cases having TOS symptoms. Common presentation of symptomatic CR include: non-inflammatory neck mass (50%), neck pain (41.7%) and rarely upper extremity paresthesia and pain. When TOS is suspected and CR is confirmed, the age group tends to be significantly older (16 years) versus a non-TOS group (11 years). Although the association of CR and TOS in adolescents is a rare occurrence, the prognosis is much better when identified and treated in this age group.

This case report presents the examination, interpretation of findings and successful multimodal treatment of an adolescent musician with true neurogenic TOS with presence of bilateral CRs, interventions used during the rehabilitation process and the outcomes of the treatment.

CASE DESCRIPTION
A right hand dominant 16 year-old male student French horn player was referred to physical therapy for evaluation and treatment for complaints of a two-year history of right shoulder pain and upper extremity paresthesia, pain and weakness. The patient was initially evaluated in a military hospital with complaints of insidious onset of shoulder pain; at that time shoulder X-ray imaging was performed without significant findings. Symptoms persisted and became significantly worse four months later following marching band season worsening with writing at school and playing the French horn. By the time the patient initiated physical therapy (at 6 months after his
first medical consult) he was reporting constant right shoulder/arm pain and paresthesia with limited function in carrying, grasping, lifting, pulling or reaching. Pain was experienced in the right costoclavicular space, anterior shoulder, medial elbow, medial forearm and the ring and little fingers. The patient complained of occasional right neck pain and tightness. On initial examination he reported constant pain rated 5/10 at best and 7-8/10 at worst. The quality of pain was described as constant acheing, occasional sharp pain into the right shoulder, right-sided neck stiffness, burning into the right medial elbow and tingling into the ulnar aspect of the forearm and ring to little fingers of the right hand. The Disabilities of the Arm, Shoulder and Hand (DASH) score was 53.6 and performance sport/music was 75 (scores range from 0 to 100, higher scores indicate increased disability).

Clinical Examination
Findings of the initial clinical examination are reported in Table 1. Only the positive tests are listed.

| TABLE 1. Clinical Findings |
|--------------------------------------------------|--------------------------------------------------|
| **Cervical Spine Active Range of Motion**       | **Cervical Spine Active Range of Motion**       |
| Cervical flexion                               | No limitation; moderate pain right shoulder/arm |
| Cervical extension                             | No limitation; moderate pain right shoulder/arm |
| Cervical right rotation                         | 5 degree limitation; severe pain right shoulder/arm |
| Cervical left rotation                          | No limitation; mild pain right shoulder/arm      |
| Cervical right sidebending                      | No limitation; mild pain right shoulder/arm      |
| Cervical left sidebending                       | 5 degree limitation; mild pain right shoulder/arm with tingling digits 4 & 5 |
| **Upper Extremity Resisted Testing**            | **Upper Extremity Resisted Testing**            |
| 3/5 fifth digit abduction test right            | 3/5 fifth digit abduction test right            |
| **Sensory Testing**                             | **Sensory Testing**                             |
| C5, C8 diminished light touch right             | C5, C8 diminished light touch right             |
| **Thoracic Outlet Testing**                    | **Thoracic Outlet Testing**                    |
| Elevated Arm Stress Test: positive for pain/paresthesia ulnar nerve distribution right | Elevated Arm Stress Test: positive for pain/paresthesia ulnar nerve distribution right |
| Cyriax release test: positive for pain/paresthesia ulnar nerve distribution right | Cyriax release test: positive for pain/paresthesia ulnar nerve distribution right |
| **Mobility Testing Acromioclavicular, Sternoclavicular, Glenohumeral Joints** | **Mobility Testing Acromioclavicular, Sternoclavicular, Glenohumeral Joints** |
| Acromioclavicular joint: restricted right       | Acromioclavicular joint: restricted right       |
| Sternoclavicular joint: restricted right         | Sternoclavicular joint: restricted right         |
| Glenohumeral joint: positive relocation test provoking familiar shoulder pain, mild anterior translation laxity right | Glenohumeral joint: positive relocation test provoking familiar shoulder pain, mild anterior translation laxity right |
| **Mobility Testing First Rib**                  | **Mobility Testing First Rib**                  |
| Cervical Rotation Lateral Flexion test: restricted bilateral | Cervical Rotation Lateral Flexion test: restricted bilateral |
| First rib spring test: hard end feel with reproduction of familiar symptoms right | First rib spring test: hard end feel with reproduction of familiar symptoms right |
| **Scapulothoracic Stability Testing**           | **Scapulothoracic Stability Testing**           |
| Winging, tipping in static and dynamic testing right | Winging, tipping in static and dynamic testing right |
| **Neural Tension Testing**                      | **Neural Tension Testing**                      |
| Median nerve: positive for symptom reproduction right | Median nerve: positive for symptom reproduction right |
| Ulnar nerve: positive for symptom reproduction right | Ulnar nerve: positive for symptom reproduction right |
| **Wrist Testing**                               | **Wrist Testing**                               |
| Ballottement test: positive for hypermobility right | Ballottement test: positive for hypermobility right |
| Grip strength Right: 81 pounds with 5/10 pain dorsal ulnar aspect of the wrist | Grip strength Right: 81 pounds with 5/10 pain dorsal ulnar aspect of the wrist |
| Resisted wrist flexion Right: 5/5 and mildly painful ulnar wrist | Resisted wrist flexion Right: 5/5 and mildly painful ulnar wrist |
| Resisted wrist flexion with ulnar deviation Right: 5/5 and moderately painful in the ulnar wrist | Resisted wrist flexion with ulnar deviation Right: 5/5 and moderately painful in the ulnar wrist |
| **Ulnar Neuropathy Triad Testing**              | **Ulnar Neuropathy Triad Testing**              |
| Elbow flexion pressure provocation test: provoked moderate pain in the ulnar forearm and wrist right | Elbow flexion pressure provocation test: provoked moderate pain in the ulnar forearm and wrist right |
| Semmes Weinstein Monofilament testing 2.83 g/f: normal sensory threshold C4-T1 dermatomes bilateral | Semmes Weinstein Monofilament testing 2.83 g/f: normal sensory threshold C4-T1 dermatomes bilateral |
| Fifth digit abduction resisted testing: 3/5 mild pain in ulnar wrist right | Fifth digit abduction resisted testing: 3/5 mild pain in ulnar wrist right |
Interpretation of Clinical Examination Findings and Diagnosis

Based on the clinical examination findings, this patient presented with signs and symptoms consistent with true neurogenic TOS and double crush phenomenon involving the ulnar nerve at the right elbow with sensory and motor deficits. He displayed dysfunctions in the upper extremity kinetic chain known to be associated with TOS, such as scapulothoracic instability, sternoclavicular hypomobility and glenohumeral instability. Additionally, imaging revealed rudimentary CRs (Figure 1) and nerve conduction velocity testing of the ulnar and median nerves was positive for prolonged distal onset latency sensory at the wrist.

Prognosis and Plan of Care

The prognosis was favorable; the patient was a young healthy adolescent with optimal family support and motivation to return to his musical interest and daily life without pain. Because he had true neurological deficits in both the median and ulnar nerves on the right side and bilateral cervical rudimentary ribs, surgery could not be ruled out should motor and sensory dysfunctions persist. The primary goals for this patient were to resume unlimited French horn playing and to be able to handwrite his school-work without pain or paresthesia.

Interventions

The patient was initially treated twice per week for three months, then one time per week for three months, and finally one time per month for six months. At first, treatment focused on normalizing rib and shoulder mobility that included techniques of right sternoclavicular joint traction manipulation, posterior and inferior glenohumeral joint glides in prepositioned flexion, posterior capsule mobilization in prepositioned extension and internal rotation, and soft tissue mobilization to the upper trapezius, middle trapezius, pectoralis major and minor, anterior and middle scalenes and the thoracic paravertebral musculature. This was performed in order to open space at the gates of the thoracic outlet and restore increased blood flow to the vasa nervorum. Simultaneous sympathetic nervous system treatment was performed by means of soft tissue mobilization to thoracic paravertebral musculature, normalizing mobility of ribs 1 to 9 bilaterally, and giving the patient a transcutaneous electric nerve stimulation (TENS) unit for a home program (to be applied for several hours daily along the paraspinal muscles at T2 to T9). Focus on the sympathetic nervous system was performed to reduce vasomotor constriction of the vasa nervorum to the brachial plexus and upper extremity peripheral nerves. Gentle non-symptom-provoking ulnar nerve mobilization was also initiated in the home program. Nerve mobilization was performed without tension or reproduction of familiar pain in order to prevent venous stasis and tethering of the nerve to its sheath. Neural mobilization position involved neutral abduction, 20° elbow flexion, neutral forearm position, and wrist extension with simultaneous finger flexion alternating to wrist flexion with finger extension.

At the same time, management focused on improving posture and optimizing positioning of the upper extremity during activities of daily living. The patient was fitted for a posture shirt to wear during band practice and school work. (Figure 2) The postural shirt allowed feedback for scapular positioning into relative neutral while preventing thoracic kyphosis and forward head positioning. To begin with, the amount of French horn practice time was limited specifically to thirty-minute increments, four times per week. Elbow flexion was restricted to 20° and forearm rotation to neutral by placing a strip of kinesiotape on the posterior aspect of the elbow. The patient was instructed to avoid sleeping, writing or performing any activity in greater than 20° elbow flexion.
Pain and positive ballottement testing at the distal radial ulnar joint (DRUJ) indicated a fibrocartilaginous complex lesion and DRUJ instability, respectively. Subluxation of the distal radial ulnar joint can be caused by hyperpronation or repetitive pronation movements resulting in marked loss of strength in the wrist and hand; thus the patient was instructed to also avoid reaching or grasping with a pronated forearm. He was fitted with a WRIST-Widget® brace and instructed to wear it during all right upper extremity activities. Transverse friction was performed to the locally tender right flexor carpi radialis and long finger flexor training was initiated in neutral rotation of forearm to further stabilize the carpus.

As the patient’s symptoms of pain and paresthesia diminished, treatment progressed to include scapular neuromuscular re-education. Training focused on centralizing the humeral head prior to elevating the right arm. Additionally, maintaining a relative neutral scapular position with early upward scapular elevation was emphasized during flexion and abduction elevation. (Figure 3) As ulnar nerve paresthesia and pain dissipated, medial glide of the humeroulnar joint was performed in order to lengthen the retinacular fibers at the cubital tunnel, thereby promoting increased space in this narrow passageway.

Figure 2: Donning posture shirt. Straps pulled superior and slightly lateral to facilitate upward rotation, adduction and posterior tilt of scapula.

Figure 3: Neuromuscular re-education of the scapula during abduction elevation. Circumferential band to facilitate centralization of humerus in glenoid with superimposed resisted abduction with kinesthetic facilitation of upward rotation (serratus anterior) and posterior tilt (inferior trapezius) of the scapula.

OUTCOMES
Treatment took place over a total of twelve-months’ time; this duration was needed in order to address the various contributing components of limitation of joint mobility, joint laxity, weakness, and sensory loss. Furthermore, time is required for neurogenic pain disorders to improve once the compressive/tension or injury to the nerve has been alleviated. In cases of neuropraxia where there is temporary axonal conduction loss with demyelination of sensory and motor fibers, minimum healing time is twelve weeks once compressive/tension event on the nerve had stopped. In this case, once the postural component was corrected, combined with sympathetic dampening activities, the right wrist instability became a more prominent feature and continued to contribute to the multiple crush phenomenon in the right upper extremity (TOS, ulnar neuropathy at the elbow and median neuropathy at the wrist). TOS symptoms were most likely due to narrowing of the costoclavicular space with compression primarily affecting the C8/T1 nerve roots, elbow symptoms were due to ulnar nerve compression in the cubital tunnel, and the wrist DRUJ instability with volar subluxation of the ulna reduced both ulnar tunnel and carpal tunnel volume leading to ulnar and median nerve compromise, respectively.

On final clinical examination, the Cyriax release maneuver and the elevated arm stress test, for symptom provocation in TOS, were negative for right upper extremity pain. Cervical rotation lateral flexion testing for hypomobility of the first rib was no longer symptom
provoking nor hypomobile. Flexion pressure provocation testing was negative for the ulnar nerve at the right elbow, and sensation was normal to light touch in the ulnar distribution of the forearm and hand. Ulnar nerve tension testing was negative for provocation of symptoms on the right side. The ballottement test remained positive for laxity of the right DRUJ. Grip strength improved from 81 pounds and 5/10 pain (tested in a position of elbow extension and forearm pronation) to 105 pounds and 0/10 pain with application of the Wrist Widget®. The patient was encouraged to continue to wear a wrist stabilizing device until he was able to grip without pain.

Motor function at C8/T1 fifth digit abduction was normalized 5/5 strength. DASH scores were 2.0 for disability and 0.0 for sports/performance. Follow up was performed at three months after physical therapy cessation. The patient reported experiencing only transient recurrence of right hand paresthesia in the ulnar nerve distribution with prolonged elbow flexion positioning, which abated within one hour after performing his home exercise program of neural mobilization. Improvements in DASH scores for disability and sports/performance remained unchanged. The patient was able to achieve his goals of playing the French horn and writing school-work without limitation or pain.

DISCUSSION:

True neurogenic TOS is uncommon in all age groups with the adolescent age group being most rare. Although true neurogenic TOS in adolescents is less frequent than in adults, signs and symptoms are typically unequivocal and are accompanied by axonal conduction loss. This is the first case study to report on successful management of true axonal conduction loss of an adolescent musician with TOS and CR. Although the cervical rotation lateral flexion test is not a test designed to evaluate TOS, an elevated first rib is thirteen times more likely to occur in the upper limb of subjects with ulnar neuropathy and/or double crush syndrome. Literature has emphasized the association of CTS with impairment of the ulnar sensory nerve fibers at the wrist with prolonged fifth digit sensory latency and increased vibration threshold at the fifth digit. There is a strong correlation between CTS and damage to the ulnar sensory fibers at the wrist. In addition, subtle volar dislocation of the ulna at the distal radial ulnar joint can reduce the carpal tunnel volume, contributing to signs and symptoms of median and ulnar neuropathies at the wrist. Subtle volar ulnar subluxations are frequently unrecognized by radiographs, which can lead to long-term pain and disability at the wrist and hand. Nerve conduction velocity testing of this subject confirmed prolonged distal onset latency of the median and ulnar sensory fibers at the wrist. At no point in the physical therapy intervention did this patient report any pain, paresthesia and/or weakness in the median nerve distribution of the affected arm. Surgical carpal tunnel release had been recommended after the positive findings with electrodiagnostic testing of the median nerve. Nerve conduction velocity testing was not concordant with clinical testing, however, in which pain, paresthesia and weakness were present only in the ulnar nerve distribution of the right upper extremity. Ulnar neuropathy can occur in instances of DRUJ instability with intermittent symptoms related to rotation of the forearm. The treatment of choice is to stabilize the DRUJ with bracing and strengthening and/or surgical stabilization. This patient did not undergo surgical carpal tunnel release as symptoms were clearly the result of DRUJ laxity and ulnar neuropathy, and resolved with treatment that specifically addressed those pathologies.
References:


References (con’t):


The Thoracic Four Syndrome: A Case Report and New Insights in Pathophysiology, Diagnosis and Treatment

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ABSTRACT
Thoracic-four (T4) syndrome is a clinical condition that involves upper extremities, trunk and neck symptoms. It is postulated that the sympathetic nervous system is mainly responsible for the manifestations of this clinical entity. Only a few articles address the main features of the pathophysiology, diagnosis and treatment of this condition. The aim of this report is to present the evaluation and treatment of a patient who demonstrated clinical signs and symptoms consistent with T4 syndrome. Specific exercise therapy is integrated into the rehabilitation program as a new option for pain modulation. An update on the theory to explain the possible pathophysiological mechanism of T4 syndrome is proposed, with implications on the clinical decision-making process.

BACKGROUND
The Thoracic Four Syndrome (T4 syndrome) comprises a set of signs and symptoms that are related to a dysfunction in the upper thoracic spine. It manifests as glove-like paresthesia and temperature changes in one or both hands, sensation of heaviness, swelling and pain in one or both upper extremities, usually associated with thoracic and/or chest wall stiffness, and often presents with generalized headaches.⁸,¹⁰ It has been accepted that the T4 vertebra is the most frequently affected segment (that is T3-T4 and/or T4-T5) when this constellation of symptoms occurs. However, it is not limited to this vertebra and may include other segments in the upper thoracic spine.⁸,¹⁰

There are only a few articles that describe this clinical entity. However, it has been well accepted that thoracic mobilization techniques are the treatment of choice for this condition.⁷,⁸,⁹,¹⁵,¹⁹ Exercise therapy has only been mentioned as a secondary component in the rehabilitation process.

Recently, a set of symptoms similar to that of T4 syndrome was described in a case report, however in this case the lower extremities were affected. Interestingly, thoracic mobilization techniques for the thoracolumbar junction, which was assessed as hypomobile, relieved symptoms. This clinical entity was termed “T10 syndrome” due to the reduction of bilateral leg symptoms using thoracic mobilizations (analogous to the bilateral arm symptoms in T4 syndrome).¹³ These findings highlight the possible role of the autonomic nervous system (ANS) as a plausible source of musculoskeletal symptoms.

The purpose of this case report is to describe the evaluation and treatment of a patient suffering from T4 syndrome, incorporating manual therapy techniques and a novel exercise treatment approach oriented to pain modulation and postural control. Additionally, an updated theory for the pathogenesis of T4 syndrome is proposed.
EXAMINATION

History

A 34-year-old female was referred to physical therapy for treatment of fibromyalgia. She had 4 children, all delivered naturally. The patient worked as a receptionist in a chiropractic office. She had undergone multiple testing procedures, including blood tests, CT scan of her brain and spinal X-rays without evidence of any serious pathology or signs of a condition that would explain her symptoms.

She received treatment at her workplace, which consisted of myofascial release and chiropractic adjustments, with temporary relief.

Past trauma history included a motor vehicle accident in 2004 and a fall in the bathtub when pregnant with her fourth child in 2000 (landing on her buttocks). She experienced minor pain following these two episodes, but states symptoms resolved shortly thereafter.

Medical background included allergies to certain foods (e.g. chicken) and medications (Milnacipran, Cyclobenzaprine), and she had been diagnosed with depression (no medication). Surgical history included clavicle cyst removal and tubal ligation in 2000. She was not taking any medication, except for vitamin D3 supplement and probiotics.

The patient described a 1-year history of pain, gradual in onset and without specific precipitating event. She had experienced brief episodes of low-intensity low back and neck pain in the past, but these were self-limited and were not related to her current complaints.

Pain distribution involved both upper extremities (equally affected), neck and head. Although these areas were the most significantly affected, other parts of her body were also painful, including mid back, chest, low back and lower extremities (she reported feeling pain “from head to toes”). (Figure 1) She described her symptoms as “aching” and “throbbing”. She noted that her skin sometimes felt “warm” and “sweaty”, especially in the upper and lower extremities, and stated that her hands and feet felt “swollen”, “tingly” and were “red” in appearance. When asked to rate the pain on a scale from 0 to 10, with 0 being “no pain” and 10 being “emergency room pain”, she reported her symptoms ranged from 6/10 at the least and 10/10 at the worst.

The patient reported being unable to perform daily activities in the same capacity as prior to the onset of symptoms. This increased her anxiety level since she was unable to keep her house clean (with significant difficulty performing activities like mopping and vacuuming). She had difficulty sleeping at night as she was unable to get comfortable in bed; she slept between 2 and 4 hours, awakening several times due to pain. She had persistent constipation and bloating, which further impaired her daily performance.

Aggravation of symptoms occurred with mild exertion and sustained positioning (as short as 2-3 minutes), especially sitting. Headaches increased when upper extremity symptoms were exacerbated. Flare up of symptoms after exertion could last up to 1-2 weeks, having gradual and/or spontaneous reduction. Heat increased symptoms and cold did not change them. Only temporary reduction of symptoms could be obtained by gentle massage that she usually received at her workplace.

CLINICAL FINDINGS

The Fear Avoidance Belief Questionnaire (FABQ) and the Fibromyalgia Impact Questionnaire (FIQ) were completed. The patient scored 24 on the FABQ Physical Activity subscale (where maximum score is 24) and 17 on the FABQ Work subscale (where maximum score is 42). A high score on the FABQ predicts high pain avoidance behavior. In regard to the FIQ, patient scored 90.2 points using the 10-item method (maximum score is 100 and a higher score indicates a greater impact of the syndrome on the person).

A summary of the clinical examination findings is listed in Table 1.
CLINICAL IMPRESSION
Examination of the patient was limited due to intensity and high irritability of symptoms at the time of the evaluation. However, a predominant pattern of upper extremities and back pain was revealed that was associated with paresthesia in both hands and symptoms consistent with a possible sympathetic up-regulation (sweating, redness, swelling, tingling, etc.).

Fibromyalgia was the referral diagnosis. Overview of patient symptoms revealed consistency with most symptoms of fibromyalgia: pain in the four quadrants of the body, digestive system symptoms, sleep disturbances and headaches. However, the prevalence of hand symptoms in a glove-like distribution raised the possibility to additionally clinically diagnose T4 syndrome; this was further supported by hypomobilities found at the mid and lower thoracic segments, specifically T2-3 to T6-7 and T9-10. The latter level reproduced lower extremity symptoms upon testing, leading to suspicion of T10 syndrome as well.

INTERVENTIONS
After completion of the clinical examination, the patient was educated on the clinical diagnosis and treatment plan. Two distinctive rehabilitation phases were established. Phase one was oriented to reduce irritability and intensity of symptoms, thus providing relief and increasing tolerance to therapy. Phase two aimed to further reduce her symptoms, and also improve functional capacity by means of inclusion of exercise therapy into the management plan. All treatment phases consisted of one-hour sessions that included soft tissue and joint mobilization for the mid thoracic spine based on initial evaluation and session-by-session assessment. Diaphragmatic breathing was taught at the first session in an attempt to reduce anxiety and provide the patient with an active behavior tool to control her symptoms. Exercise therapy was emphasized in phase two (but was first initiated at session 5).

<table>
<thead>
<tr>
<th>Test</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>Head positioned in right rotation.</td>
</tr>
<tr>
<td>Trunk positioned in right rotation and right sidebending. Very mild scoliotic curve (upper thoracic right, mid-lower thoracic left and lumbar right convexity).</td>
<td></td>
</tr>
<tr>
<td>Trunk Motions</td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td>20% limited, mild band-formed pain across lumbar area</td>
</tr>
<tr>
<td>Trunk Sidebending</td>
<td>20% limited, mild ipsilateral lumbar pain in each direction</td>
</tr>
<tr>
<td>Trunk Flexion</td>
<td>10% limited, mild pain and tightness across low back and both posterior thighs. No change with the addition of cervical flexion</td>
</tr>
<tr>
<td>Cervical Motions</td>
<td>Right rotation was normal in range of motion but provoked right superior shoulder pain; all other motions were WNL in range and painfree</td>
</tr>
<tr>
<td>Reflexes</td>
<td>Biceps, brachialis, triceps, patellar and Achilles were 2+ bilaterally. Babinski was negative</td>
</tr>
<tr>
<td>Myofascial mobility testing</td>
<td>Significant fascial restrictions in mid-thoracic spine in a medial-lateral more than cranial-caudal direction</td>
</tr>
<tr>
<td>Muscle palpation testing</td>
<td>Local pain and tenderness were provoked with palpation of the rhomboids, mid-thoracic paraspinals, serratus posterior superior and levator costarum ribs 3-7 bilaterally</td>
</tr>
<tr>
<td>Thoracic DorsoVentral mobility</td>
<td>Significant hypomobility was noted in the segments from T2-3 to T6-7, and at T9-10. With testing of each hypomobile segment, the patient’s symptoms were reproduced</td>
</tr>
</tbody>
</table>

Table 1: Clinical examination findings.
### Treatment Session Description

**Phase 1 Goals:** Reduce the irritability of patient’s symptoms; gentle improvement of myofascial and joint integrity; sympathetic down-regulation.

<table>
<thead>
<tr>
<th>Treatment Session</th>
<th>Description</th>
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| **1**              | • Evaluation  
                      • Treatment trial of grade 1 oscillations performed on T3-4 segment |
| **2**              | • Soft tissue mobilization included gentle effleurage and skin rolling applied in the mid thoracic spine (30 minutes)  
                      • Thoracic dorsoventral (DV) mobilization performed at T1-2, T2-3, T3-4, T4-5, T5-6 and T9-10 segments (for 2-3 minutes on each segment for a total of 15 minutes)  
                      • Diaphragmatic breathing taught and performed (15 minutes) |
| **3 & 4**          | Repeated treatment 2, except for T3-4 segment: DV mobilization was performed until symptom-provocation resolved |
| **5 to 8**         | • Soft tissue mobilization as described above for 15 minutes  
                      • Thoracic DV mobilization performed in T2-3, T3-4, T4-5, T5-6, T6-7 and T9-10 segments (2-3 minutes on each segment)  
                      • Costovertebral and costotransverse joint mobilization performed on 2nd to 5th ribs bilaterally  
                      • Instructed in bimanual exercise and performed for 10 minutes |
| **9**              | • Same as sessions 5 to 8  
                      • In addition, patient was instructed in first rib self-mobilization technique and this was added to the home exercise program |
| **Phase 2 Goals:** Pain reduction and improvement of myofascial and joint integrity. Treatment became more localized to the T4 area since symptoms from distal segments had resolved. Intensity of manual therapy increased in order to reset the sympathetic system. |
| **10 -12**         | • Soft tissue mobilization was progressed to deeper transverse friction technique to the serratus posterior superior and upper rib levator costarum muscles, bilaterally (15 minutes)  
                      • Rotation mobilization was performed on T1-2 and T3-4 segments to improve left rotation and on T2-3 and T4-5 segments to improve right rotation  
                      • Costovertebral mobilization performed on second to fifth ribs bilaterally  
                      • Bimanual exercise performed for 10 minutes after manual therapy |
| **13 -20**         | • Manual therapy became more specific at each subsequent session, focusing on the fibrous painful bands of myofascial structures in the upper thoracic spine, mobilizing the hypomobile and painful thoracic segments in rotation, and performing rib mobilizations where indicated.  
                      • Each session ended with 10 to 15 minutes of the bimanual exercise |
| **Phase 3 Goals:** Resolution of local restrictions, both in soft tissue and joint structures. Tolerance to exercise was excellent, and emphasis shifted to increasing intensity and duration of bimanual exercise, especially at home. Patient was also able to incorporate elliptical exercise and resume normal daily activities. |
| **21-26**          | • Manual therapy became localized to the T3 to T5 segments, focusing on the fibrous painful bands of myofascial structures, mobilizing the hypomobile and painful thoracic segments in rotation, and performing rib mobilizations where indicated  
                      • Each session ended with 10 to 15 minutes of the bimanual exercise that increased in vigorousness. Home program was progressed to include elliptical work outs |
| **27**             | Treatment performed as noted above, to resolve localized residual myofascial and joint dysfunction  
                      Patient was discharged from physical therapy as goals had been met |
Soft tissue techniques included moderate-intensity, slow stroke movement over the thoracic spine, followed by very gentle skin rolling technique in the direction of myofascial restrictions according to initial evaluation and session-by-session assessment (Figures 2 and 3, respectively). It would usually take about 15 minutes to complete this part of the treatment, and the patient often reported moderate to significant relief and relaxation after these techniques. Attention was given not to exacerbate symptoms and to continuously assess soft tissue changes associated with the application of these techniques.

After soft tissue mobilization was completed, joint mobilization of the restricted, hypomobile segments was implemented, including thoracic posterior-anterior and rotational mobilization, costotransverse and costovertebral joint mobilization. (Figures 4 through 9)

Joint specific technique application would usually last 30 minutes. Thoracic posterior-anterior mobilizations were performed in an oscillatory fashion, at an estimated frequency of 0.5 Hz. Attention was placed on reproduction of patient’s symptoms while performing techniques; thoracic posterior-anterior mobilization would normally reproduce her local and referred symptoms, and the technique was maintained until symptoms resolved. This would usually take 1-3 minutes, depending on the technique, segments and phase of the treatment; in phase one, three to four minutes were necessary to relieve symptoms, while only 30-60 seconds were required toward the end of the phase. Rotatory joint mobilization of the thoracic spine, costotransverse and costovertebral joint mobilization were performed in a sustained, non-oscillatory fashion of 4-5 sets of 45 seconds hold, or until hypomobility was resolved.

![Figure 2a and b: Slow-stroke massage. Patient is prone. Gentle movement of the therapist’s flat hands over the skin at the thoracic level is performed. Strokes are performed in a circular fashion; the aim of this technique is to prepare patient for the rest of the manual therapy techniques.](image)

![Figure 3: Skin rolling is used to assess and treat myofascial restrictions. Patient is prone. Therapist grasps the patient’s skin with pincer grip. To progress with the technique, gentle pressure is exerted with thumb tips towards the fingers. At the same time, the fingertips slightly release pressure to allow hands movement over the skin. Treatment was performed in the direction of the restrictions found on examination.](image)
Figure 4: Posterior anterior (PA) mobilization for thoracic segments. Patient is positioned prone with a towel roll under sternum to protect the cervical spine (keeps the neck from hyperextending during PA pressure of the thoracic spine). Hands are placed parallel over the transverse processes of the caudal vertebra of the segment being mobilized. Pressure (with oscillation) is performed in a direction of 60° anterior-caudal to respect facet joint orientation.

Figure 5: Rotation mobilization. To treat T4-5 right rotation (as pictured). Patient is prone with a towel roll under the sternum. The therapist stands on the side of rotation to be improved (eg., on the right side to improve right rotation). Right hand is placed on right transverse process of the fifth vertebra (stabilizing hand). Hypothenar eminence of left (mobilization) hand is placed on left transverse process of the fourth vertebra, and exerts a cranial, lateral and ventral pressure.

Figure 6: Costotransverse mobilization for ribs 2-5. To treat left 4th rib (as pictured): Patient is in prone with pillow placed diagonally from right shoulder to left abdomen to allow left ribs to be free from the table. Head is positioned in left rotation to lock the thoracic spine. Therapist’s left hand stabilizes the transverse processes on the right side; right hand is placed just lateral to the costotransverse joint. Pressure is exerted in a ventral and slightly lateral direction.

Figure 7: Costotransverse mobilization for ribs 6-10. To treat left 7th rib (as pictured): Patient is in prone with pillow placed diagonally from right shoulder to left abdomen to free left ribs from the table. The trunk is prepositioned in left sidebending to lock the thoracic spine. Therapist’s right hand stabilizes transverse processes on the right side; left hand is placed just lateral to the costotransverse joint. Pressure is exerted in a ventral, lateral and slightly cranial direction.

Figure 8: Costovertebral joint mobilization for ribs 2-5. To treat left 2nd rib (as pictured): Patient is in supine. The therapist’s right hand is placed on the rib to be mobilized while the left hand positions the patient’s left arm into elevation until movement on the 2nd rib is perceived, thus stabilizing the 1st rib. Pressure is then exerted with the right hand in a caudal and slightly dorsal direction. The rib can be prepositioned in an expired position by asking the patient to exhale.

Figure 9: Costovertebral joint mobilization ribs 6-10. To treat left 7th rib (as pictured): Patient is lying on her right side. The therapist’s right hand is placed on the rib to be mobilized while the left hand positions the patient’s left arm into elevation until movement of the 7th rib is perceived, thus stabilizing the 6th rib. Pressure is then exerted with the right hand in a caudal direction. The rib can be prepositioned in an expired position by asking the patient to exhale.
Exercise therapy consisted of an ‘in-phase’ movement sequence, which by definition implies the activation of homologous muscle groups on both sides of the body. The sequence selected for this patient included internal and external rotation of shoulders and hips. (Figure 10) She performed this exercise for 15 minutes after manual therapy procedures during the second phase in her plan of care. She was also instructed to perform this exercise at home daily for 15 minutes.

Clinical examination performed at the last session revealed no pain provocation with active trunk and neck movements, normal reflex testing, and absence of pain with palpation. Very minimal fascial restrictions were noted in the mid thoracic spine, however significant improvement was noticed compared to baseline. Final assessment revealed normal segmental mobility in the thoracic spine and there was no reproduction of upper extremity paresthesia when performing thoracic posterior-anterior mobilization.

Figure 10: In-phase coordination pattern. Patient lies comfortably supine; if desired, a small pillow can be placed under knees to reduce stress in the lumbar spine. Bilateral, symmetric, rhythmic rotation of upper and lower extremities is performed in a simultaneous fashion (rotation occurs at hips and shoulder levels, respectively). The elbows are flexed to 90° to improve awareness of how rotation occurs in the shoulders. Gentle scapular retraction is performed during the shoulder external rotation and then maintained while returning to internal rotation. A short rest of scapular retraction is solicited before beginning a new sequence.

OUTCOME
The patient was treated 27 sessions over a period of 5.5 months. During the first two months she was seen an average of 2 times per week, and then 1 time per week for the remaining period. By the end of the treatment program, the patient reported complete resolution of symptoms with a fully restored capacity to perform daily activities. (Figure 11) Additionally, she was able to resume light physical activity without flare-up (elliptical machine).

FABQ and FIQ questionnaires were administered 2, 4 and 6 six months (at discharge) after the initial evaluation. Results of these tests were compared with scores obtained at baseline, demonstrating a substantial improvement of functional capacity. (Table 3)
Table 3: Results of the Fear Avoidance Belief Questionnaire (FABQ) for Physical Activity (PA) and Work (W), and the Fibromyalgia Impact Questionnaire (FIQ) at initial evaluation and every 2 months after initial evaluation.

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<th>FABQ W</th>
<th>FIQ</th>
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Figure 11: Evolution of pain score during treatment program. Pain was measured using Visual Analog Scale (VAS).

DISCUSSION:
T4 Syndrome encompasses a variety of symptoms ranging from pain to paresthesia, vasomotor and sudomotor changes, headaches and stiffness. Symptoms are felt in the upper extremities (often bilaterally, non-dermatomal, and in a glove-like distribution), upper thoracic region and neck. It has been reported to affect females 4 times more than males, usually between the ages of 30 and 50. Patients often deny a history of trauma; however, the syndrome has been associated with postural strain (repetitive or sustained forward stooping or bending). On clinical examination, findings are suggestive of T4 syndrome when, in the absence of other pathology (such as discogenic), manual techniques in the area of the T4 vertebrae elicit symptoms as just noted.7,8,19

In this case, application of posterior-anterior mobilization on T4 in relation to T3 provoked the patient’s symptoms in the upper extremities and back. After application of 3 minutes of a posterior-anterior oscillatory technique at T3-4 the patient demonstrated reduction of swelling and redness in both hands, and a significant improvement of pain and paresthesia in her back, upper and lower extremities, which further supported the clinical diagnosis of T4 syndrome.

Soft tissue mobilization has been suggested to improve patient tolerance to pressure, and help reduce stress.9 In a case report by Mellick et al, T4-level paraspinals injection of a mixture of 2 mL 0.5% bupivacaine HCl and 1/4 mL of methylprednisolone acetate (20 mg/mL) caused significant reduction of pain and reduction of symptoms in patients with T4 syndrome.19 This may suggests that reducing soft tissue irritation at the thoracic spine allows reduction of local and referred symptoms in patients with T4 syndrome. Furthermore, it has been suggested that moderate intensity massage elicits a parasympathetic nervous system response,
which may contribute to regulate ANS disturbances.2,12 Gentle skin rolling technique was added to restore normal fascial mobility, especially in the mid-thoracic spine where myofascial restrictions were found. In this sense, myofascial release techniques have been linked to improvements in fascial mobility, sleep quality, physical function, postural stability and reduction of anxiety.2,3,11

Thoracic posterior-anterior mobilization has been effectively used in prior case reports on patients with T4 syndrome.8,19,34 Joint mobilization effects on sympathetic system and pain modulation has been widely studied, and evidence supports an analgesic mechanism mediated by activation of the dorsal portion of the periaqueductal grey (dPAG) in the midbrain, and an excitatory effect on the sympathetic system.4,5,18,20-24,28,30,33,35 This has been described as a non-opioid, noradrenergic pain control system, using norepinephrine as a neurotransmitter.35 Consequently, in a study of Jousey et al, a grade III posterior-anterior mobilization technique applied to the T4 vertebrae at a frequency of 0.5 Hz caused a sympathoexcitatory response consisting of an increase in skin conductance in the hands.15 It was suggested this was a “rebound phenomenon” as an explanation for the sympathetic-mediated analgesia induced by this technique; joint mobilization increases sympathetic activity, which may return to levels below their pre-technique values. This fact supports the use of an oscillatory technique at the aforementioned frequency to achieve the analgesic effects. Additionally, holding the application of the technique until the patient’s symptoms resolve seems to be necessary to down-regulate sympathetic activity. In this patient’s case, technique application took from a few seconds to several minutes before she experienced resolution of symptoms. For the patient in this case report, mobilization was applied at several thoracic segments adjacent to T4. During the evaluation, symptoms were elicited not only when the T4 vertebra was mobilized, but also in other thoracic segments (from T1 to T8). Interestingly, the patient’s lower extremity symptoms were reproduced with mid thoracic segmental mobilization (especially from T6 to T10). Mobilization of these segments was essential for resolution of her lower extremity symptoms, as in the case study documented by Geerse.13

It has been proposed that low-to-moderate intensity exercise induces hypoalgesia in patients with chronic pain conditions.22 In this regard, the most accepted mechanism responsible for this pain modulation is associated with the activation of endogenous opioid and/or non-opioid systems.22 Furthermore, cortical activation of the M1 area may lead to activation of neural systems responsible for the reduction of thalamic activity. The balanced activation of M1 and the thalamus is associated with improvement in motor control, an important factor to reduce maintenance of pain.34 In fact, motor learning may be involved in pain threshold modulation, therefore adding cognitive effort into motor training which may allow further pain reduction.34 Taking this information into account, the appropriate exercise selection may contribute to enhanced pain modulation processes, thus complementing manual therapy effects.

Bimanual exercises have been extensively studied, and their neurobehavioral characteristics are well known. Among these, bimanual patterns have been associated with increased M1 activity compared to unimanual activity.27,29,31 There are two bimanual coordination patterns that can be performed in a stable, reliable fashion without training; in-phase (simultaneous activation of homologous muscles) and anti-phase (alternating activation of homologous muscles) coordination. Of these two patterns, bimanual in-phase coordination is easier and more stable compared to the antiphase sequence.25,26

It was decided to incorporate a bimanual in-phase exercise pattern to promote cortical activity associated with pain modulation, in a stable simple way without the need for prior practice. This seems to be appropriate for this case considering the significant irritability and functional impairment of the patient. In order to add a cognitive component to the in-phase coordination, gentle scapular retraction hold while performing in-phase shoulder external-internal rotation was incorporated, thus stimulating motor learning processes involved in further pain modulation and improvement of motor control strategies.

Considerations of T4 syndrome
It’s been proposed that T4 syndrome is associated with increased sympathetic activity, which in turn explains the referred symptoms to both upper extremities. Evans proposed a model in which sustained postures may provoke ischemia in thoracic spine structures thereby causing referred symptoms.10 In a study by Keating et al, posterior-anterior mobilization elicited a subjective report of discomfort in 37% of the asymptomatic
study group, which was more frequent in segments involving T4, T5, and T6. It was theorized that the proximity of the thoracic nerves to contractile structures was the cause of these results, since the medial branch of the dorsal rami from T1 to T5 lies over the apex of their corresponding spinous process, close to the tendinous insertion of the splenius cervicis (T3, T4 and T5). In this way, increased forward bending or slumped positioning may not only cause an ischemic injury, but also increase tension on the dorsal structures in the thoracic spine and cause mechanical irritation of the neural structures. Nerve damage has been linked to sympathetic fiber sprouting into the dorsal root ganglia (a structure that usually has poor sympathetic innervation), perhaps explaining a connection between sympathetic and nociceptive systems due to neural tissue dysfunction. In this way, neural irritation of thoracic dorsal ramus could cause sympathetically mediated pain in the corresponding referred pain pattern; head and neck are supplied by T1-4, and the upper trunk and upper extremity by T1-9. In support of this theory, Gonzalez-Darder reported complete resolution of a patient’s interscapular, neck and arm symptoms by decompression surgery of the T3, T4 and T5 nerves due to presence of osteophites causing neural entrapment. This may also explain why paraspinal injection with local anesthetic at the T4 level results in significant relief of symptoms in patients with T4 syndrome. In this same study, patients reported relief of symptoms by the administration of gabapentin, a medication used for neuropathic pain conditions, perhaps further supporting the relationship between nerve damage/irritation and sympathetic mediated pain.

In summary, T4 syndrome has been linked to increased sympathetic activity due to dysfunction in the upper thoracic spine. However, findings in this case report suggest involvement of several other segments besides T4, which exposes a more complex scenario: as complex as ANS function. Important components of the treatment of a patient suffering from T4 syndrome may include soft tissue mobilization and stress-anxiety management techniques, which have demonstrated beneficial effects at a sympathetic level. Thoracic joint mobilization techniques remain the center of treatment in patients with T4 syndrome. Exercise therapy should be incorporated into the treatment plan to take advantage of its analgesic effects and improve patient’s function. This information is valid not only for patients suffering from T4 syndrome but for any condition that presents with symptoms associated with sympathetic mediated pain, as it has been suggested in fibromyalgia and other chronic pain conditions. Future research should focus on further insights into the pathophysiology of T4 syndrome and the specific effects of treatment techniques in these patients. Increased understanding of T4 syndrome may help improve knowledge about the possible role of the ANS in common musculoskeletal conditions.
References:


References (con’t):


References (con’t):


**QUESTION #1:**
Does a dysfunction of the costotransverse joint induce a positional (biomechanical) disturbance that can be identified in clinical examination?

**ANSWER #1:**
It is unlikely that a stiffness purely at the costotransverse joint will manifest with an observable aberration in observation of trunk mobility. In clinical examination the spring test is used to provoke pain in the costotransverse joints and access end feel of the joints with dysfunction/pain in comparison to those ribs with normal mobility. This is primarily an end-feel and pain provocation test; it is likely that this is the best way to determine a dysfunction at the costotransverse joint.

**QUESTION #2:**
Is the costovertebral joint dysfunction solely responsible for rib malpositioning?

**ANSWER #2:**
1. We should be cautious in using the phrase that a rib is “out of place” or for that matter malpositioned. In conservative care clinics, most – if not all – the time, the rib will be positioned within the realm of its movement excursion; however, the soft tissue and joint capsule(s) can have restrictions that keep it from moving through its full excursion or that keep it from achieving (or returning to) its resting position. For example, in an ankle sprain; the ankle is not malpositioned if it has a plantar flexion limit and the person cannot push off effectively; we don’t say ‘your ankle is out of place’ – we simply make note of the stiffness and restore mobility for optimal function.

2. One joint being the sole cause of a movement dysfunction may be thinking too simply. There are so many structures from myofascial to joint that are within the immediate and adjacent environment that can be involved: cranial, caudal, dorsal and ventral. All tissues have to be involved to a certain degree; therefore, there is a need to think and treat in 3-dimensions. For example, an elevated rib will affect change in the intercostal muscles, costovertebral, costotransverse joints and the thoracic segment and all of the fascial and inert connections between these structures. The rib bone doesn’t “twist on itself” (certainly within the short expanse between vertebral body and the transverse process); the radiate ligament may be shortened at the costovertebral connection and the superior capsule of the costotransverse joint would be relatively shortened as well. Research shows us that in immobilization, the myofascial structures are the first to adapt and tighten; so you can imagine that if there is a loss of mobility at the rib joints, that there is also loss of mobility of the surrounding myofascial structures. Do you ever notice in the clinical setting that you have to repeatedly mobilize a joint on an individual? The ribs are famous for that. In this instance, it is likely that the soft tissue structures, meaning all of the myofascial connections (and that’s a lot!) are not being mobilized sufficiently. If the various muscles that attach to any particular rib are not additionally ‘stretched’ (with any of a number of myofascial techniques), the ribs will likely ‘not stay in place.’ In other words, the rib stiffness will return between treatment sessions because only a part of the ‘stiffness’ was optimally treated.
QUESTION #3:
Does treatment to the costotransverse joint only induce pain relief?

ANSWER #3:
1. No, this can be performed to break fatty bridges that can develop in states of immobility (when this is the goal, manipulation works well), and to stretch the joint capsule along with other connections between the rib and the transverse process. By mobilizing the costotransverse joint, a stretch will occur to the joint capsule, extra-capsular ligaments and all of the myofascial structures that are influenced during that particular maneuver.

2. Current literature validates that one of the primary effects of mobilization is neurophysiological, and this in turn is an important mechanism behind reduction in acute pain and inhibition of reflex muscle contractions. The achievement of neurophysiological effects requires movement at the joint, resulting in a hysteresis effect. Hysteresis involves inhibition of low threshold mechanoreceptors and inhibition of high threshold nociceptors, both of which result in a reduction of intra-articular pressure and peripheral afferent discharge.

QUESTION #4:
Is there differential testing for the costotransverse and costovertabral joint and a distinctive dysfunctional pattern that appears with testing?

ANSWER #4:
1. It can get rather theoretical to try to isolate one joint from the other when one wonders whether one really can affect change on one without the other…

2. One cannot differentiate which of the 2 joints (CV or CT) is problematic with any kind of specificity on manual testing; however, the need to do so could be purely academic, as clinically it seems to matter very little.¹

There are several clinical tests discussed in the two IAOM courses, 1) Thoracic Spine and Ribs and 2) Thoracic Outlet Syndrome and Cervicothoracic Junction, that emphasize one joint over the other, theoretically.

To test general rib dysfunction, the examiner can simply place the hands on the ventral aspect of the upper ribs and the lateral aspect of the lower ribs and ask the patient to breathe in and out deeply. Ribs 1 to 5 should move ventrally and ribs 6 to 10 laterally during a deep breath in; the examiner should also register a return to the resting position and beyond with deep exhalation. The spring test is applied to test the costotransverse (the more lateral) joints, and the position test is utilized to test the costovertebral joints.
QUESTION #5:
Is there a specific sequence to treat costotransverse or costovertabral joints?

ANSWER #5:
1. There are no specific research results that have evaluated the effect of costotransverse or costovertbral mobilization and the sequence of those on patient’s improvements in mobility and pain.

2. The decision to mobilize costotransverse before costovertabral joint is more empirical; it seems to work better and be better tolerated by the patient. The IAOM proposes starting with the more lateral or peripheral joint, the costotransverse, before trying to influence the costovertbral (a deeply medial) joint.

References


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COURSES JULY THROUGH DECEMBER 2017

<table>
<thead>
<tr>
<th>Date</th>
<th>Course Description</th>
<th>City, State</th>
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<tr>
<td>July 13</td>
<td>Certification</td>
<td>Lubbock, TX</td>
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<tr>
<td>July 22 - 23</td>
<td>Wrist I</td>
<td>Denver, CO</td>
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<tr>
<td>August 19 - 20</td>
<td>Knee</td>
<td>Houston, TX</td>
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<tr>
<td>August 26 - 27</td>
<td>Upper CS</td>
<td>Oakland, CA</td>
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<tr>
<td>Sept 16 - 17</td>
<td>Shoulder</td>
<td>Denver, CO</td>
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<tr>
<td>Sept 16 - 17</td>
<td>UE Shoulder</td>
<td>Houston, TX</td>
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<td>Sept 23 - 24</td>
<td>Lower CS</td>
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<td>Sept 30 - Oct 1</td>
<td>Wrist I</td>
<td>Atlanta, GA</td>
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<tr>
<td>Oct 6 - 8</td>
<td>Dry Needling Level II (WITH CADAVER ANATOMY)</td>
<td>Athens, OH</td>
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<td>Oct 7 - 8</td>
<td>Knee</td>
<td>Springfield, MO</td>
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<td>Oct 14 - 15</td>
<td>TOS CTJ</td>
<td>Sioux Falls, SD</td>
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<td>Oct 21 - 22</td>
<td>Foot/Ankle</td>
<td>Cleburne, TX</td>
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<td>UE TOS</td>
<td>Manitowoc, WI</td>
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<td>Oct 28 - 29</td>
<td>Upper CS</td>
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<td>Nov 4 - 5</td>
<td>TOS/CTJ</td>
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<td>Nov 4 - 5</td>
<td>Wrist I</td>
<td>Nashville, TN</td>
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<td>Nov 11 - 12</td>
<td>UE Elbow</td>
<td>Houston, TX</td>
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