Use of First Rib Mobilization and Muscle Energy Techniques to Treat a Patient with Thoracic Outlet Syndrome: A Case Report

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Abstract

Title: Use of First Rib Mobilization and Muscle Energy Techniques to Treat a Patient with Thoracic Outlet Syndrome: A Case Report

Case Description: A 24 year old female arrived to therapy with a work related injury. During her job as a CNA she attempted to catch a falling resident resulting in a “jerking” injury in her neck and right shoulder. She presented to therapy with a primary complaint of right anterior shoulder pain associated with activity. She also had secondary complaints of burning and tingling running down her arm into her fingers and unusual fatigue with her arm overhead. The goal of therapy was manage her symptoms and return her to her prior level of function so she could return to work.

Outcomes: After 6 weeks of therapy the patient was discharged from therapy have met all of her functional goals and full resolution of her chief complaint of right anterior shoulder pain. She returned to work and independent exercise with little difficulty. Patient did have residual symptoms indicative of TOS upon discharge but were not significant enough to impair her ability to work. She had improved radial pulse and first rib height but still tested positive with the Adson and Roos special tests.

Discussion: The patient successfully completed therapy and was able to return to work even though she had residual symptoms. The research shows that it is difficult to make a definitive diagnosis of thoracic outlet syndrome (TOS) because of the weak specificity of the special tests. If the patient did actually have TOS, first rib mobilizations and METs were not an effective standalone treatment. Roos research does support a more comprehensive treatment with postural retraining as well as AC and SC mobilizations.

Keywords: Thoracic Outlet Syndrome, Muscle Energy Techniques, First Rib
Case Description

A 24 year old Caucasian female reported to physical therapy approximately one week after she sustained an injury to her left shoulder during her job as a CNA. The patient reported that she was helping a resident transfer, when the resident slipped and fell. In response the patient helped the resident finish the transfer as a max assist. During this activity she felt a sudden pain at the point when the resident slipped and fell; this persisted for the rest of the day and into the next morning. When the patient came to physical therapy her primary complaint was for pain in left anterior shoulder. The patient has secondary complaints of numbness and tingling running down her left arm into her fourth and fifth digits and unusual fatigue in the left shoulder when her arm is elevated over 90°. Rest was the only thing she reported as helping to relieve the pain in her shoulder bringing it down to a 3/10. While performing lifting activities, particularly those that are performed overhead made her pain worse raising it to an 8/10. While anything that had her arm above 90° caused numbness and the unusual fatigue after a short amount of time. The patient reported having no previous injuries to her shoulder and that she leads an active lifestyle. She states she exercises at the gym multiple times a week, running on a treadmill and performing various resistance exercises using machines and free weights. On the systems review she had no comorbidities or significant red flags. As this appeared to be a work related injury goals were functional to daily tasks at work. At her job she is primarily transferring residents and pushing them in wheel chairs, our two functional goals were push/pulling 50 lbs. of force and lifting from floor to waist 50 lbs. Goals related to impairments would also be considered post examination.

Clinical Impression #1

The patient came to physical therapy with a medical diagnosis of bicipital tenosynovitis, but her secondary complaints of numbness/tingling and unusual fatigue did not seem consistent with this diagnosis. Research noted that females in their 20's-30's with a slender build are the most likely at risk for thoracic outlet syndrome (T.O.S) than other demographics. One common cause of TOS is presence of a cervical rib which can be identified with an x-ray. The rib decreases the space in the thoracic outlet and compresses the subclavian vein/artery and brachial plexus. The presences of a cervical rib does not necessarily cause TOS, but rather leaves someone predisposed to the condition. A traumatic and or jerking injury that causes the cervical rib to subluxate is one of the causes of TOS. This patient did not have x-rays performed, so it is not known whether she had a cervical rib, however she does fall into the demographic that is most at risk from suffering from TOS. The injury she suffered could also be considered a "jerking" injury. Examination techniques to rule in/out TOS would be performed in addition to a typical shoulder examination. The Roos and Adson Test will be the tests used to rule in TOS and if more confirmation is needed checking the pulse on the affected wrist while performing the Allen Test can help to confirm the diagnosis with a stronger confidence. Research has shown though that both Roos and Adson have a significant chance of yielding a false positive, 47% and 20% respectively. The research has shown that TOS maneuvers have unreliable outcomes when using altered pulse and paresthesia but the rate of false positives dropped when pain was present with the tests. Even though these tests have a high false positive rate and low confidence interval, they will be used because they will assist in ruling out TOS. If TOS tests are positive treatments will address the impairments found during the objective examination. If TOS is ruled in, first rib joint play will be performed to determine if
the rib is elevated and hypomobile. If the rib is hypomobile then this patient will be a candidate for Muscle Energy Technique's (METs) that target the first rib for TOS. Other medical diagnosis will also be addressed during the examination including palpation of the biceps long head tendon, strength tests and tests for rotator cuff and labrum pathology.

Examination

During the examination multiple tests were used in an attempt to rule in TOS as a possible diagnosis. The first was the Roos, which has the patient seated with their arms abducted and elbows flexed to 90° and maximally externally rotated. The patient holds this position while opening and closing their hand for duration of 3 minutes. If the patient begins to become symptomatic at any point during this test they are to stop and the test should be considered positive. The next test performed was Adson's Test which has the therapist check the patients pulse while moving their arm into extension and external rotation while rotating the head to the ipsilateral side. If the pulse is absent but returns after 15 seconds the test is negative, while if it stays absent for the longer the test is considered positive. Both of the tests were positive for this patient.

To further rule in TOS, radial pulses were compared right to left to see if there was a discrepancy between the two pulses. This was done because the patient's description of pain seemed ischemic and compression of the subclavian artery is one of the types of TOS she could have had and a resting discrepancy in the pulse could help make a stronger case for that particular type of TOS. First rib joint play is also used to rule in a diagnosis of TOS, during the joint play if the rib on the affected side appears elevated and hypomobile. This was done because a common cause of TOS is first rib subluxation and assessing the joint play and height between the two ribs could reveal a difference which strengthens the diagnosis of TOS. During the examination for this patient, she became symptomatic during the Roos in one minute and her pulse did not reappear during Adson's for 35 seconds. Her right pulse was strong and bounding while her left was weak and thready, during joint play her left first rib appeared both hypomobile and elevated. These tests all helped to rule in TOS as a diagnosis for this patient but did not rule out the medical diagnosis of bicipital tenosynovitis. The other tests performed during this examination are all presented in the table below.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Results</th>
<th>Validity &amp; Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palpation</td>
<td>Tenderness Biceps long head tendon, increase tone in left scalene muscles</td>
<td>n/a</td>
</tr>
<tr>
<td>A/PROM (Shoulder Flexion, Abduction; Elbow Flexion, Extension)</td>
<td>WNL, end range pain</td>
<td>High intra/interobserver reliability (ICC = 0.89) Reliability acceptable for clinical practice (4)</td>
</tr>
<tr>
<td>Strength (Shoulder Flexion, Abduction, IR, ER; Elbow Flexion, Extension)</td>
<td>WNL, pain with shoulder flexion, bicep curl</td>
<td>High intra/interobserver reliability (ICC = 0.89) Reliability acceptable for clinical practice (4)</td>
</tr>
</tbody>
</table>
### Table

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed’s &amp; Yergerson</td>
<td>+&amp; -</td>
<td>43 &amp; 32</td>
<td>79 &amp; 75</td>
</tr>
<tr>
<td>Impingement Tests</td>
<td>Negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labral Stability Tests</td>
<td>Negative</td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>Adson’s</td>
<td>Positive</td>
<td></td>
<td>32-87</td>
</tr>
<tr>
<td>Roo’s</td>
<td>Positive</td>
<td></td>
<td>94</td>
</tr>
</tbody>
</table>

### Clinical Impression #2

The results of the examination show that this patient appears to have subluxed her left first rib during her accident at work. A cervical rib which has gone undiagnosed is one explanation for her possible diagnosis of TOS, but also a subluxed first rib due to trauma could be the cause based off of the findings. All of the tests used to rule in TOS were positive which further reinforces the diagnosis and the cause being the elevated rib. These tests will be used again on the 6th visit to determine if the treatment had been effective. The treatment used for this patient to treat her subluxed first rib is muscle energy techniques to help reduce tone in the scalene muscles, increase mobility in the first rib and place the first rib in proper alignment with the thoracic spine. With her shoulder pathology special tests all being negative it is reasonably certain that impingement and labral pathologies can be ruled out. The only other special test that was positive was Speed’s that with the pain in the biceps long head tendon it is reasonable to also rule in a tendonitis of the biceps tendon.

### Intervention

The focus of this case report is first rib mobilization and muscle energy techniques (METs) as a therapeutic treatment for TOS. Other interventions were used in conjunction to give a full comprehensive treatment. Because the patient also presented with tendonitis of the biceps long head, some of the adjunct interventions were focused on that. The objective measures for upper extremity strength and range of motion were within normal limits but painful so the focus of the interventions were not to increase range or correct a muscular imbalance but to promote tissue healing. The stretches used were a bicep stretch, 90-90 pectoral stretch in a door way and a scalene stretch in standing; these stretches were held for a duration of 30 seconds two separate times with the intent of applying a low load force across the collagen fibers a promoting proper alignment. For resistance training, low load high repetitions were used because it supports tissue healing. Movements targeted for resistance training were; shoulder flexion/abduction, internal & external rotation, and elbow flexion. These exercises were implemented in three sets of 15 repetitions. As treatment progressed and the patient
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improved her functional status the amount of therapeutic exercise performed during treatment sessions decreased. Giving more time to focus on the TOS

The TOS treatment could be broken up into two components, first rib mobilizations and the METs. The mobilizations were performed with the patient lying on a hi-low table in supine with the patient rotating her head slightly to the right and laterally flexing to the left to put the scalene musculature on slack. The thumb was placed on the superior portion of the first rib and mobilized in a superior to inferior motion at approximately 100 oscillations a minute. Because the focus of the mobilizations was to help correct a subluxation of the first rib on the left side, the mobilizations were done as grade III and IV to get the rib to end range in an inferior direction. Muscle energy techniques were performed with the patient sitting on the edge of a mat table with the therapist behind them. The patient rests their unaffected arm over the therapist leg. From this position the therapist finds the affected first rib and depressed it. With the free hand the therapist puts the patients head into ipsilateral lateral flexion and contralateral rotation. From here the patient is told to use submaximal force to try and return to normal cervical alignment. This contraction is resisted by the therapist and held for a count of five. This is performed between 3 and 5 times. The contraction targets the opposing scalene musculature utilizing reciprocal inhibition to get the scalene’s on the affected side to decrease in tone, relieving pressure on the first rib. The first rib is depressed during this as to keep it from subluxing. These interventions were performed at the beginning of each treatment session after the patient warmed up for 7 minutes on an arm bike ergometer. A total of approximately 20 minutes was spent on manual therapy to the first rib/shoulder girdle region. Neural glides of the radial and median nerve in supine and joint mobilizations to the acromioclavicular and sternoclavicular joints done with the same parameters as the first rib.

Outcomes

No standardized outcome measure were used with this patient instead the outcomes were determined by the special tests used. The special test used in determining the diagnosis of TOS were the Adson’s, Roos, first rib joint play and pulse. The first two are special tests which have specific research evaluating their validity/reliability as objective measures to rule in/out TOS while the other two tests have limited evidence related to T.O.S but were used to help corroborate the information gained from the special tests. In terms of the Adson’s test, current evidence does not support it as an accurate test for TOS, Stallworth et el. has shown that head direction is irrelevant during the test and you will get similar results regardless of head position. It is also primarily a measure for arterial TOS which is the rarest form of TOS and thus only a small percentage of people who do have a diagnosis of TOS will test positive on this test. Nord et el. shows the reliability of Roos is better than that of Adson’s however compared to the gold standard of imaging it is still a very poor diagnostic measure for TOS. The current evidence demonstrates that the outcomes of this assessment may not be accurate because the diagnostic measures used to establish the treatment are not supported in the literature as being reliable measures for TOS.

At the 6th visit the patient was reassessed and discharged from therapy having met all of her functional goals in a timeframe supported in the literature for conservative management of TOS. The Adson test
was a negative upon the retest with the patient’s pulse returning within 10 seconds. With the Roos the test is negative if she stayed symptom free for three minutes, however her symptoms began after one minute. First rib level and mobility were equal and pulses were equal. Compared to baseline, the patient improved by having a negative Adson’s and symmetrical radial pulse and first rib joint play; however the Roos test which was the most reliable indicator of TOS stayed positive. At discharge the patient had full function, had returned to work and resumed exercising independently at the gym. Her pain had significantly decreased though she continued to have complaints of a burning sensations and numbness running down her arm. It appears that the patient’s long head bicep tendonitis resolved which is why she was able to return to full function with minimal complaints. Even though the patient did not have any outcome measures done, her return to prior her level of function is indicative of a positive outcome. Her residual symptoms could be attributed to TOS which treatment may not have been able to correct. It is difficult to discern whether this is the cause of her residual pain because of the poor reliability and validity for tests to rule in/out TOS.

**Discussion**

TOS is not a definitive diagnosis, but instead an overarching label for multiple contributing factors that lead to similar symptoms. The best way to diagnose TOS in a patient is if they have a cervical rib found through imaging as per Keshishian et al. As the special tests used by therapists to determine whether or not a patient has TOS have low validity and are not strongly supported in the literature, a combination of signs and symptoms are used to make this diagnosis. As there is no definitive means for making this diagnosis the foundation of our intervention choice may have been flawed. The intervention used to correct for TOS secondary to first rib subluxation have been ineffective as this may have not been a significant contributing factor. The special tests have not shown to be reliable and treatment could have been based off of a false positive. Further research should be done on the special tests that diagnose TOS and their reliability/validity or it there is a combination of tests and/or subjective factors that could be combined to give a more definitive diagnosis.

During this patients treatment the focus was the resolution of inflammation in the biceps tendon and return to prior level of function so she could return to work. Treatments targeting her TOS were kept to first rib mobilizations and METs because that is what the research this intervention case report was based on. Roos research though, shows that treatments targeting the first rib are not the only potentially beneficial treatments for TOS. Other treatments that have shown to work well in conjunction are mobilizations that target the AC and SC joints to promote improved shoulder girdle mobility and decrease impingement in the thoracic outlet. Another intervention is soft tissue mobilization of the pectoralis minor and postural re-education to correct for rounded shoulders which also can close off on the thoracic outlet. These were not used during course of treatment for this patient. Further research into the treatment of TOS should look into more comprehensive treatment plans that incorporate more than just one of these strategies.

With this patient another thing to consider is how her functional training could have affected her outcomes. Her treatment plan had a lot of functional activities involved in it such as lifting, pushing and pulling. These activities could have negatively impacted the resolution of her TOS and the resulting
symptoms. So this could be the reason why she had residual symptoms at discharge. If she had continued therapy focusing on the first rib mobilization and METs without any strenuous lifting exercises it is possible that her lingering symptoms could have abated. Unfortunately she came to therapy on a workman’s compensation claim and was discharged once she was able to return to work.

References