Case Report

The use of functional and traditional mobilization interventions in a patient with chronic thoracic pain: a case report

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There is little information in the literature regarding the efficacy of spinal manual therapy (SMT) interventions for patients with chronic thoracic spinal pain. In addition, information regarding the clinical decision-making associated with the application of SMT for this patient population is deficient. The purpose of this case report is to present the rationale for and results of applying specific SMT interventions on a patient with chronic spinal pain. A 51-year-old female with 9 months of significant thoracic, chest, sternal, and left shoulder pain was managed with both mobilization with movement and spinal manipulative procedures. The report offers insight into the decisions that guided the selection of these SMT techniques in this case. The outcome provides preliminary support for using these specific SMT procedures in patients with chronic thoracic spinal pain.

Keywords: Mobilization with Movement, Thoracic spine, Manual therapy, Manipulation, Case report

In a systematic review, Briggs *et al.*¹ found that thoracic spinal pain (TSP) is a common condition, noting that its incidence varies by occupational subgroups. Its prevalence ranges from 3 to 55%. Most occupational groups have medians around 30%. Studies have also highlighted the extent to which TSP impacts the health status and physical capacities of a large segment of our population.^{2,3} These studies indicate that the prevalence of TSP is actually comparable to that of cervical and lumbar pain, which have received considerably more attention in the literature.¹

Thoracic zygapophyseal joints have been shown to be a cause of both local and referred pain in the mid and upper back.^{3,4} Mobilization with movement (MWM) involves the application of a joint glide parallel to the treatment plane of the thoracic zygapophyseal joints while the patient moves through the active range of motion (AROM) that the accompanying glide supports.⁵ The literature offers preliminary evidence to support this intervention in peripheral joints.⁶ However, there is less evidence for the use of MWMs, or any manual treatment, for cases of chronic, thoracic pain. The purpose of this case report is to address that shortfall by describing the clinical management and decision-making in a case of chronic thoracic pain where the primary interventions were functional mobilizations

(MWM) and more traditional, graded joint mobilizations and thrust manipulations.

Edmonston and Singer⁷ provided support for the use of sustained natural apophyseal glides, a manual technique first described by Mulligan,⁸ to facilitate restoration of pain-free mobility. Sustained natural apophyseal glides have been cited for their utility in acute and subacute thoracic spine cases.^{9,10} Other case reports have documented the benefit of managing patients with posterior thoracic, chest, or shoulder pain with manual therapy interventions to the thoracic spine and rib cage.^{9–16}

Red flags are a specific concern in any presentation of thoracic spine pain.¹⁷ On the other hand, thoracic mechanical disorders responding to manual therapy may mimic visceral pathology leading to unnecessary surgical investigations.¹⁷ Benhamou *et al.*¹⁸ described 28 cases of unexplained pseudovisceral pain referred from costovertebral arthropathies. Chest pain was the dominant referral pattern in 11 of the 28 cases.

Patient Characteristics

The patient was a 51-year-old, right-handed female who was referred to physical therapy with a diagnosis of left sided pectoral strain. She was employed at a toy store. Her chief complaint was left anterior shoulder, upper chest, and thoracic pain. She also reported a 'tightness' of her left pectoral and anterior cervical region, as well as aching in the left scapular region (Fig. 1). Her symptoms began 9 months

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Figure 1 Body chart of reported symptoms.

earlier. She described being in a forward bent, deep squat position in her bathroom and standing up quickly while twisting to her left. At the same time, she swung her left elbow out from her side, striking it hard on the underside of her marble countertop. She immediately noted transient loss of left medial hand and forearm sensation. Several hours later, while driving, she experienced an acute onset of severe chest pain necessitating an emergency room visit. A cardiac etiology or pulmonary embolus was ruled out. Later the same day she also developed left-sided thoracic and sternal pain, in addition to occasional left arm symptoms. The latter included axillary pain and 'tightness', along with a return of the paresthesia of the medial forearm and hand.

Prior interventions included massage from a licensed massage therapist, chiropractic care, acupuncture, herbal treatments, and treatment from a physical therapist (six sessions consisting of ultrasound, posterior–anterior/anterior–posterior mobilizations to the rib cage, and active range of motion for

the shoulder). The physical therapy interventions were given over a period of 4–8 weeks post-incident. None of these interventions provided lasting relief.

In light of her ongoing complaints of left sided chest pain and failure of all previous treatment strategies, she had been referred to a physiatrist. She had an extensive medical workup by the physiatrist. A summary of her medical diagnostics and interventions are given in Table 1. At the time of the initial physical therapy examination 9 months post-injury, the patient's thoracic and chest pain, on the 11-point (0–10) numeric pain rating scale (NPRS), was rated at 8/10. Her NPRS scores for least and most pain were 6/10 and 10/10, respectively. Her patient-specific functional score was 2/30. She identified left side lying, reaching overhead with the left upper extremity (UE), and riding in the car as her specific functional limitations. She was only taking an allergy medication, reporting that prior trials with prescription and over-the-counter medications for pain control and inflammation were ineffective. On her intake form, the patient noted that her symptoms had 'completely changed my life' and adversely affected her work, sleep, talking, singing, dressing, bathing, emotions, and leisure activities. She denied pain related to eating, coughing, or exertion. Her pain was relieved somewhat during standing or walking and especially by grasping her left lower ribs and manually lifting her rib cage. Her medical history was remarkable for breast augmentation performed approximately 25 years earlier. Otherwise, there were no medical or surgical concerns. There were also no associated signs or symptoms of visceral disease.

Examination

A posture assessment demonstrated a mild right lateral shift with left side-bending of her head and neck. Her shoulder girdles were protracted. The left lower costal margin of her anterior rib cage was also prominent. No other asymmetries of her shoulder girdle posture or alignment were evident.

The patient's active cervical range of motion was pain-free. Visual estimates of that motion revealed

Table 1 Summary of patient's medical workup by physiatrist prior to seeing the author

Medical diagnostic or intervention	Results
Chest and cervical spine radiographs (P–A and lateral)	1. Degenerative anterolisthesis and facet arthrosis at C4–5 2. Mild increase in cervical lordosis 3. Facet arthrosis at C2–3 and C7–T1 Temporary symptomatic relief
Costochondral injections (Lidocaine and Depo-medrol) at 6th costosternal jct	
Upper extremity NCV and EMG	Mild (L) ulnar nerve entrapment- cubital tunnel
Lidoderm patches for chest pain	No relief
Barium swallow for 'indigestion'	Normal
MRI of chest	Normal, including ACJ and SCJ
Examination of previous breast augmentation (25 years ago)	Normal

Note: P, posterior; A, anterior; NCV, nerve conduction velocity; EMG, electromyogram; MRI, magnetic resonance imaging; ACJ, acromioclavicular joint; SCJ, sternoclavicular joint.

full flexion and a 10% loss of extension and side-bending bilaterally. There was a 25% reduction in cervical rotation bilaterally with complaints of neck 'tightness' and mid-thoracic pain. Her left sided mid-thoracic pain was also reproduced with over-pressure of thoracic flexion and extension. Range of motion of these sagittal movements was judged to be normal. The patient's shoulder girdle AROM was normal except for a loss of left shoulder girdle flexion (150°) and abduction (130°) with complaints of concordant 'pulling' in the upper chest and axillary region.

Compression of the thorax in sitting^{19,20} produced an increase in upper thoracic pain while distraction relieved that pain. Compression was performed by pushing downward through the patient's upper thorax. Distraction was also applied with the patient seated. All relevant neurodynamic dural tests were unremarkable. Upper extremity sensation and reflexes were normal. Tinel's sign at the left elbow was negative. There were no long tract signs.

Passive physiological intervertebral movements and PA spring testing in prone demonstrated hypomobility of C7, T3, T4, and T7. These segments also demonstrated concordant pain provocation with the application of manual overpressures. To assess rib mobility, the author performed the cervical rotation lateral flexion test in sitting. This test has been used to identify first rib 'subluxations'.²¹ The test was unremarkable bilaterally. AP rib mobility testing using thumb pad pressures showed restricted mobility with stiff end feels at the left fifth to seventh costosternal junctions with pain production.²² P-A rib springing revealed limited mobility of ribs 3–8 at the costovertebral/costosternal (CV/CT) joints on the left side. A soft tissue assessment, as described by Ellis,²³ revealed a number of restrictions in the scapular and cervical regions, with point tenderness along the costal cartilage contour of the left lower rib cage. Left glenohumeral joint mobility²⁴ tests revealed restricted posterior and inferior glides. Sternoclavicular and acromioclavicular joint mobility were normal.

Cervical isometric testing was 5/5 in all planes and painless. Left shoulder testing in all planes was 4/5, with the exception of external rotation, which tested 4–/5. All tests were pain-free except internal rotation, which created a mild increase in her anterior shoulder symptoms. The right UE and the remainder of the left UE tested 5/5.

Special tests of the shoulder were performed to evaluate the possibility of hypermobility/laxity, labral pathology, or rotator cuff pathology. All of these tests were negative.

Clinical Impression

Following the examination, the author's (DA) impression was that the patient had chronic, thoracic,

chest wall, and left shoulder pain related to either discogenic and/or zygapophyseal/costovertebral/costosternal joint pathology of the thoracic spine. Arce and Dohrmann²⁵ reported that, while most thoracic disc herniations are insidious, they do occasionally begin with a traumatic incident. Meniscoid and fibroadipose structures have been demonstrated in the costovertebral articulations; inasmuch, it is conceivable that an entrapment scenario may have precipitated this patient's pain at the outset.^{26,27}

After nine months of symptoms, the patient also had a host of accompanying impairments including both soft tissue and articular findings. Hicks *et al.*²⁸ and others^{29–31} have shown that pain provocation with palpation or motion testing can be used to identify symptomatic tissues. In addition, those same authors suggest that pain provoked during these clinical tests should play a role in clinical decision-making.^{29–31} The patient's costosternal pain was thought to be related to her restricted CV/CT mobility posteriorly causing abnormal stresses into the costocartilage anteriorly, a relationship supported by Rabey.¹²

Finally, given the chronicity of the case, as well as the widespread symptoms, the presence of central sensitization was considered during the initial examination. Central sensitization has been defined as 'an augmentation of responsiveness of central pain-signaling neurons to input from low threshold mechanoreceptors'.³² Nijs and van Houdenhove³³ state that, 'central sensitization encompasses altered sensory processing in the brain and mal-functioning of pain-inhibitory mechanisms.' The patient had several items in her history that suggested the possibility of altered pain processing by the central nervous system. These included poor sleep patterns and high stress levels associated with the pain, as well as the constant and diffuse nature of the pain. This central nervous symptom phenomenon may have perpetuated her pain state.³⁴ Table 2 summarizes the author's differential diagnosis considerations and findings or factors that led to their inclusion or exclusion.

Interventions

The initial plan of care was to see the patient weekly for 3–4 months due to the chronicity of her symptoms. Treatment goals were to: (1) restore full ROM and strength of the left shoulder; (2) eliminate any sleep interruptions due to pain; (3) decrease pain to less than 4/10; (4) establish independence with self-management; and (5) improve overall level of function, as evidenced by a 20-point change in her patient-specific functional scale (PSFS) score. Her prognosis was rated as 'good' rather than 'excellent' and the plan of care extended in light of the chronic nature of her symptoms and the lack of progress to date.

The frequency of treatment was typically once-per-week, limited by the patient's schedule and distance from the clinic. Table 3 outlines the interventions and instruction provided to the patient, as well as her subjective responses to treatment. An MWM approach for the thoracic spine was emphasized initially due to the patient's failure to get relief when standard mobilization and thrust maneuvers were used in her previous chiropractic and physical therapy care.

Edmonston and Singer⁷ advocated this approach since it facilitates pain-free movement throughout the range, allows the patient to maintain control over the movement, and combines elements of AROM and physiological movement with accessory glides along

the joint plane. These techniques allow the therapist to isolate and mobilize specific restrictions while the patient, using AROM, facilitates ROM gains, improves tolerance to motion, and reduces fear-avoidance. The intention was not only to normalize end feels at specific soft tissue and joint restrictions, but also to allow the patient opportunities to experience larger, active movement patterns with greater ease and comfort.

The patient demonstrated moderate improvements in mobility and pain levels following the first two sessions of thoracic MWMs. Subsequent to that, two thrust techniques were added during session three (seated T5/6 distraction thrust and a supine T2/3 extension left thrust). The patient reported, on her

Table 2 Summary of differential diagnosis considerations

Hypothesis	Rationale for exclusion
Cervical/thoracic strain Pectoral strain	All spinal resisted tests strong and painless; duration since onset Full active/passive external rotation left shoulder with mild loss of flexion; internal rotation MMT strong with mild pain; resisted shoulder flexion painless; all shoulder resisted tests 4/5; duration since onset
Vertebral/rib fracture	All imaging (radiographs, CT scan, MRI) negative for fracture; no pain with ROM and compression of thorax; no local pain to rib pressures or during deep inspiration or coughing; duration since onset
Cervical radiculopathy	Negative Spurling's maneuver; normal neurological screening; negative for CPR; ³⁵ normal imaging
Ulnar neuropathy Cervical HNP T4 syndrome	Negative neurological examination, neurodynamic testing, Tinels, EMG/NCV Normal CT, MRI, and cervical active flexion ROM with compression loading No UE paraesthesias or pain; occasional c/o medial left forearm 'numbness' which was normal on light touch sensation exam
Intercostal neuralgia	No c/o burning pain or paraesthesias along chest wall; no local tenderness in intercostal spaces
Ankylosing spondylitis	Low incidence in females; no c/o spinal pain or stiffness that is worse in am or following periods of rest; normal hip and sacro-iliac mobility and chest expansion; spinal ROM only slightly limited
DISH Tietze's syndrome	Normal imaging; trunk flexion ROM normal Tenderness noted over several costosternal joints left but absence of associated swelling, heat, or erythema
Costochondritis 1st rib subluxation	Negative MR-chest Normal palpatory findings on 1st rib tubercle B — statically and with inspiration; negative CRLF test ²¹
Glenohumeral sprain/instability	No hypermobility noted with passive accessory motion testing or laxity with stress testing; negative for apprehension, load/shift, or relocation tests
AC/SC joint sprain	Normal visual exam except slightly enlarged left SC joint; no pain or laxity evident with stress testing; negative imaging
RTC strain/impingement	MMT 4/5 throughout left shoulder girdle with only mild c/o left anterior shoulder pain with internal rotation testing; negative for impingement testing including test cluster (Neer, Hawkins-Kennedy, drop arm, painful arc)
Upper limb neuro- dynamic dysfunction Viscerally referred pain	Negative for all upper limb neurodynamic tests and slump-sit test Negative exam from physician's cardiac and pulmonary work-up; negative esophagram; normal imaging; negative NSAID use; symptoms unrelated to meals or exertion; normal PMH; symptoms reproduced with movement
Hypothesis	Rationale for inclusion
Articular dysfunction (thoracic IV, CV/CT, CS and glenohumeral joints)	Hypomobility and pain reproduction with motion testing of: C7/T1-8 left, costosternal joints 1,2, 5-7 left, glenohumeral posterior and inferior glide left; rib cage caudal glides and A-P/P-A glides left side; limited active/passive ROM left shoulder flexion, abduction, and horizontal adduction
Myofascial dysfunction	Left shoulder pain reproduced with identification of soft tissue restrictions left axilla at pectoralis major and minor; restrictions with tenderness also left subscapularis, left cervical/thoracic paraspinals, left sternocleidomastoid, levator scapula, scalenes, and latissimus dorsi muscle groups

Note: MMT, manual muscle testing; CT, computed tomography; MRI, magnetic resonance imaging; ROM, range of motion; CPR, clinical prediction rule; HNP, herniated nucleus pulposus; EMG/NCV, electromyogram/nerve conduction velocity; UE, upper extremity; DISH, diffuse idiopathic skeletal hyperostosis; MR, magnetic resonance; B, bilateral; CRLF, cervical rotation lateral flexion; AC, acromioclavicular; SC, sternoclavicular; RTC, rotator cuff; NSAID, non-steroidal anti-inflammatory; PMH, past medical history; IV, intervertebral; CV/CT, costovertebral/costotransverse; CS, costosternal; A, anterior; P, posterior.

next visit, that she experienced an increase in her left chest, shoulder and cervicothoracic symptoms that had lasted several days. Based on this response and given her immediate, positive response to MWMs, the decision was made to utilize the MWMs exclusively during the early stages of her treatment. Joint mobilization techniques were also used to address abnormal end-feels, as determined by mobility testing at the intervertebral, costotransverse, costovertebral, or cost-osternal joints. Typically the joint techniques consisted

of Grade III or IV mobilizations²² into the restricted barrier with AROM performed simultaneously by the patient in various positions.⁸ These were the primary interventions used by the author through session 17.

Functional strengthening, related to her work activities, was added to the treatment program at session 11. Her job required frequent lifting, carrying, and wrapping of packages as well as occasional reaching overhead. Now that pain-free mobility had been largely restored, the treatment emphasis shifted

Table 3 Summary of manual therapy, exercise interventions, subjective responses and PSFS scores

Session no.	Manual intervention	Exercise/training	Subjective responses [PSFS score]
1	Active trunk rotations B with overpressure to ribs 4 and 5; costo-sternal PA mobilizations at 1st, 2nd, 6th, and 7th (Grade IV) in supine during lower trunk rotations	Supine lower trunk rotations with left shoulder girdle stabilized manually (1–2 minutes, 3/day)	[2/30]
2	STM to left scalenes, pectorals, subclavius, thoracic paraspinals, bony contours left clavicle; also done during trunk rotations, left arm flexion, and cervical rotations; T5/6 distraction thrust in sitting; T2/3 extension left thrust in supine; T4–6 PA mobilizations Grade IV in prone	SCM and scalene self-stretch with clavicle and 1st rib stabilized (15 second holds; 4+/day)	Decreased sternal and left UE pain, slept better
3	STM repeated; thrust techniques deferred; mobilizations to ribs 3–5 in supine (Grade IV) with breathing in various planes; AP/PA mobs to ribs 1 and 2 in supine; 'ring' 3 MWM during seated trunk rotation		Worse; increased tightness neck, back, chest and 'gassy' sensation
4	Rib MWM repeated; C2/3 extension right and OA side-bending right mobilizations Grade IV		Much better L neck; still with sternal, back, axilla tightness
5	STM to thoracic paraspinals; STM lower left rib cage with breathing in supine (inc lifting of costal border) and active trunk rotation in sitting; MWM to 'ring' 8 with seated rotation	Self-STM to diaphragm/lower rib cage with deep breathing and active trunk rotation (15-second holds; 4+/day)	Significantly better since PT began
6	C7/T1 extension left mobs and 1st rib caudal/ventral mobilizations grade IV supine added	Assisted cervical rotations with hand pull (3 repetitions each direction; 4+/day)	Sternum and left lower rib cage much better; still with 'achiness' L anterior shoulder
7	MWM repeated as described	Prone shoulder girdle AROM exercises: flexion, extension, IR/ER at 90° abduction (3 sets of 10–20 to fatigue; 1/day)	Last treatment helped a lot, especially rib cage
8	STM to left shoulder (subscapularis, pectorals, bony contours of clavicle) including with UE in flexion; joint mobilizations as described		Did great after PT but received DC treatment days later for 'old pelvic problem' which included TS manipulation — worse L shoulder, chest, C/T pain
9	Thoracic mobs repeated; added STM to intercostals at ribs 4–6; GH joint posterior glides with horizontal adduction assist; MWM for left UE flexion with thorax unloading, scapular upward rotation, clavicle rotation	Assisted UE flexion (6+/day); supine trunk rotations with LEs over physioball with various arm positions (2+ minutes, 2+/day)	Difficulty using L arm towards end of work day
10	Left shoulder flexion supine with STM to axilla as described; 1st rib and GH joint mobs repeated; trial with leukotape to re-posture shoulder girdle and unload mid thoracic region		Still flared from DC TS manipulation but improving L UE pain
11–17	Added STM to abdomen along midline with breathing, lower trunk rotations, and B UE flexion (fingers interlaced) in supine; left T3/4 flexion MWM in sitting with B UE reach to floor (fingers interlaced)	Progressed UE strengthening (i.e. RROM for flexion/scaption, ER) for shoulder girdle	'Best since starting PT' — at session 13 [20/30] — visit 14
18	Thrust techniques to T2/3, T6/7 and left 6th rib added		Able to sleep on left side now [23/30]
19–23	Manual techniques continued as appropriate	UQ strengthening progression	'Feels great' — at session 23; goals met [27/30]

Note: PSFS, patient-specific functional scale; B, bilateral; PA, posterior–anterior; STM, soft tissue mobilizations; SCM, sternocleidomastoid; UE, upper extremity; DC, Doctor of chiropractic; MWM, mobilization with movement; OA, occipito-atlantal joint; Ring, thoracic vertebral segment with both corresponding ribs; PT, physical therapy; AROM, active range of motion; IR/ER, internal/external rotation; TS, thoracic spinal; C/T, cervicothoracic; GH, glenohumeral; LE, lower extremity; RROM, resisted range of motion; UQ, upper quadrant.

toward improving upper quarter motor control and strength to allow for increased work tolerance.

A second flare-up occurred between sessions 7 and 8. The patient reported 'feeling great' following the previous PT session but decided to return to her chiropractor several days later because her pelvic girdle felt 'out of position'. Included in this session, while she was prone, was a thrust manipulation to her cervical and thoracic regions. She reported increased pain and tightness since. This led to a further delay in recovery but also demonstrated support for the treatment approach focusing on functional mobilizations.

Not until session 18, when the patient still described a constant, 'dull achiness' in her left upper back despite having full, pain-free cervical, thoracic, and shoulder AROM, were manipulative thrusts reinstated into the treatment program. Joint restrictions were identified through mobility testing at T2/3 and T6/7, as well as at the left sixth costotransverse joint.^{20,36} Given the extent of overall improvement in pain (8/10 to 4/10, at worst) and mobility and with the patient's verbal consent, manipulative thrust techniques³⁶ were performed to these restrictions. Further pain reduction (2/10 at worst) was reported by the patient during the remaining five physical therapy visits. As shown in Table 3, the emphasis of treatment during this terminal phase was strengthening and functional training.

Outcomes

The NPRS, PSFS, and global rating of change (GROC) scale were used to evaluate treatment outcome.

NPRS

From the initial evaluation to discharge her average pain rating was reduced from 8/10 to 1/10. The author monitored the patient's current, best, and worst levels of pain, over the previous 24-hour period, throughout the course of treatments. The 11-point scale ranges from 0 ('no pain') to 10 ('worst pain imaginable') with the average of the three ratings indicating the patient's pain level over the previous 24 hours. This scale has been shown to have adequate reliability, validity, and responsiveness in patients with low back pain.^{37,38} Childs *et al.*³⁹ reported a 2-point change on the NPRS as the minimal clinically important difference in patients with mechanical low back pain. The NPRS has not been specifically examined in patients with thoracic pain.

PSFS

The PSFS measures the patient's perceived level of disability through rating of three activities that have been affected by their pain. The rating of functional impairment involves a 10-point scale ('0' = not able to perform activity and '10' = able to perform activity as well as before onset of symptoms). The overall PSFS score is an average rating of the three activities. The

PSFS was utilized to allow for assessment of change related to the patient's chosen functional goals. Although not yet validated specifically for patients with thoracic pain, the tool has been shown to be valid and reliable for those with neck, low back, and knee pain.^{40,41}

The patient's initial score on the PSFS was 2/30, which improved at discharge to 27/30. A 6-point change overall has been cited as the minimal clinically important difference.⁴¹ Noted on the PSFS was the patient's continued inability to be comfortable in prolonged left side-lying. The patient scored 8/10 at the time of discharge from a 0/10 initially. Regarding all other previously reported functional limitations, the patient noted no difficulties.

GROC

The GROC is a 15-point scale ranging from -7 ('a very great deal worse') to zero ('about the same') to +7 ('a very great deal better'). Jaeschke *et al.*⁴² reported that scores of +4 and +5 were indicative of moderate changes in patient status and scores of +6 and +7 represented large changes in patient status. During the last several physical therapy visits, the patient rated her GROC as a +7. This was last reported at visit no. 19.

At the time of the twenty-third [last] session over a duration of 5 months, all of the patient's initial physical therapy goals were fully met. She was discharged to an independent home exercise program. Table 4 summarizes the patient's improvements from initial evaluation to final assessment.

Discussion

This case demonstrates the complexities of managing chronic musculoskeletal conditions of the thoracic region. A unique aspect of this case was the application of MWM as an alternative to passive mobilization or thrust techniques. As reported by Horton,⁹ the patient may have better tolerated the application of the MWMs, since it theoretically replicates the correct physiological motion, in contrast to perpendicular posterior-anterior procedures that may produce non-physiologic motion and compression. By enlisting the patient's active effort, it offers the treating therapist an alternate form of management when patients do not respond to passive mobilization. The author's selection of MWMs and the decision to extend the plan of care were influenced by concerns for the presence of centrally mediated pain. Although this patient did not demonstrate all of the symptoms characteristic of CS, such as hypersensitivity to light, touch, noise, or temperature, she did have some CS symptoms. Nijs *et al.*³⁴ stated that 'manual therapists may trigger symptom increases (indicative of central sensitization) when applying exercises too vigorously or aggressive hands-on therapy, such as high velocity

Table 4 Results of tests and measures at examination and final assessment

Tests and measures	Impairments at exam	Impairments at discharge
NPRS (current, worst)	8/10, 10/10 (average 8/10)	0/10, 3/10 (average 1/10)
PSFS	2/30	27/30
GROC	NA	+7 ('a very great deal better')
Posture/alignment	Head slightly side-bent and shifted right	Normal
Active motion testing	25% limitation cervical rotation; 25% thoracic rotation B with mid-thoracic pain; left UE flexion 150° with axilla pain and tightness and left upper thoracic pain	AROM with overpressure full, pain-free all planes cervical, thoracic spine and shoulder girdle
PROM/normal end feel	Limited left shoulder girdle flexion and abduction (150°) with soft tissue tightness end feel; limited horizontal adduction 50% with loss of 'folding' anteriorly (pain limited)	Full, pain-free all planes with normal end-feels
Passive motion testing	Restricted PIVM testing T1–7 left including costotransverse and costo-sternal joints; restricted mobility with caudal, AP, and PA pressures to 1st rib and rib cage in various planes; restricted posterior and inferior glide left glenohumeral joint (all hard end feels)	Normal throughout except for mild restrictions left 1st rib caudal glide, C7–T2 extension left, T3–4 flexion left and T8–9 extension left
Strength	Left shoulder MMT 4/5 (ER 4–/5)	5/5 all planes left shoulder
Special tests	Cervical and thoracic compression painful	Negative

Note: NPRS, numeric pain rating scale; PSFS, patient specific function scale; GROC, global rating of change scale; NA, not applicable; AROM, active range of motion; UE, upper extremity; PROM, passive range of motion; PIVM, passive intervertebral motion testing; AP, anterior–posterior; PA, posterior–anterior; MMT, manual muscle testing; ER, external rotation.

manipulation'. The functional mobilizations appeared to be an important factor in progressing the patient to where thrust techniques were tolerated and beneficial.

The authors recognize that the lack of long-term follow-up of this patient precludes a definitive conclusion that the current course of care was superior to her previous interventions. However, despite the physical therapy interventions, licensed massage therapist treatments, and chiropractic care, the patient was no better. The preceding treatments were given at approximately the same rate as described for the current interventions, i.e., weekly.

Lee^{19,43,44} and Pettman³⁶ described models of thoracic spine and rib motion where specifically applied manual assessment and treatments are essential. This case provides an example of how attention to specificity might be beneficial in some cases. In large part, the articular treatments utilized in this case were dependent on the presence of an abnormal joint end feel. A number of authors have questioned the validity and usefulness of end feel and/or intersegmental motion testing for determining appropriate treatment interventions for spinal pain.^{45–47} However, segmental hypomobility is part of a validated clinical prediction rule for predicting success with spinal manipulative therapy (SMT) in patients with low back pain.^{48,49} Moreover, Lakhani *et al.*,⁵⁰ in patients with neck pain, concluded that end feel assessment appears to be a useful post-manipulation tool for determining whether or not a perceived motion restriction improves follow-up SMT.

The treatment provided by an orthopaedic manual physical therapist emphasizes comprehensive management of all connective tissue structures, as well as prescriptive therapeutic exercises and patient education. It is likely that the comprehensive and specific nature of the interventions provided to this patient

were instrumental in the outcome of this patient's case. Highlighted in this instance, were the MWMs, which appeared to facilitate optimum gains in range of motion and symptom reduction, especially early in the treatment course. Unfortunately, thoracic MWMs have received little attention in the literature with limited exceptions.^{9,10}

Conclusion

This case report is an example of the successful use of a detailed and comprehensive assessment of movement restrictions and the application of soft tissue mobilizations, as well as joint non-thrust and thrust techniques, in managing a complex case of thoracic and shoulder girdle pain. One unique aspect of the treatment approach was the integration of MWM and traditional, passive joint mobilizations/manipulations. The benefit of this functional mobilization approach was highlighted by the fact that the patient failed to respond to either graded, passive mobilizations or manipulative thrust techniques during her previous care, as well as initially during this episode of care. The progress achieved utilizing the MWM techniques also appeared to facilitate an improved response to the thrust techniques applied in the latter phases of treatment. Physical therapists are encouraged to consider these interventions in managing chronic thoracic musculoskeletal pain and dysfunctions.

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