



**Rehabilitation
& Performance**
INSTITUTE

***The
Thoracic Spine
& Ribs***



The Thoracic Spine & Ribs

ASSESS

Initial observation

- Posture of spine-how does patient carry chest/thoracic spine?
- Breathing patterns: apical or diaphragmatic?
- Gait pattern
- Posterior: medial arches, calcaneal deviation, popliteal folds, PSIS, iliac crest, trochanters, waist angles, scapular elevation, shoulder level, head position
- Lateral: knee angle, hip angle, pelvic angle, spinal curves, position of head
- Anterior: patellar direction and level, Q-angle, ASIS, iliac crests, navel, rib protrusion, nipple level, clavicles

SFMA- will catch this in the other patterns involving upper extremities and spine.

Active movements-pt is seated in abducted position

- Flexion, Extension, Sidebending, Rotation
- Flexion with SB and rotation to same side
- Extension with SB and rotation to opposite side

Passive movements-sitting-same movements as above

Resisted (isometric testing)-perform in 3 positions-neutral, flexion and extension

- Flexion, Extension, Side bending, Rotation

Rib Function tests

Active Movements

- Palpate quick breathing-hands just below breasts-fingers on sternum
- Forced respiration with arms over head-places spine in extension with inspiration
- Arms at side and depress shoulder with expiration

Passive movements- perform in supine

- Push on lower ribs bilaterally with expiration

- Push down on sternum with expiration

Resisted movements

- Resistance lateral for lower and middle ribs
- Resistance anterior over upper ribs

Palpation

- Temperature, pain or paresthesia, tone, crepitation, defector malposition.
- Posterior aspect:
 - All portions of the trapezius
 - Rhomboids
 - Teres major/minor
 - Latissimus
 - Intercostals musculature
 - Erector spinae
 - Spinous processes
 - Transverse processes
 - Rib angles
- Anterior aspect
 - SCM
 - Pec major/minor
 - Serratus anterior
 - Intercostals
 - Rib cartilages
 - Spring test of ribs

Neurology

- Dermatomes: T1-12-tested at corresponding thoracic vertebra level posteriorly

Special Tests

- Thoracic compression test-indicates decreased disk height or decreased foraminal space compressing the nerve.
- Forward bend test-tests for scoliosis Sn=.92 Sp=.60
- Passive neck flexion test-assesses neural tension
- Thoracic foraminal closure test-tests for IVF involvement
- CRLF Test for First Rib Mobility

Specific Joint Mobility

- Mid thoracic T5-12 in weight bearing and non-weightbearing
 - Flexion, Extension, Side bending, Rotation
 - Combined movements: flexion, SB, rotation and extension, SB, rotation
- Rib Mobility
 - Springing of costovertebral and costotransverse joints

Do not forget to R/O cervical, lumbar, kidney and gallbladder if testing is inconclusive.

RESET THE SYSTEM

Mid Thoracic Spine Mobilization

(Cranial to Caudal)

- Rotational components- can perform in sidelying or seated
- Sidelying components- can perform in sidelying or seated
- PA Glides



There are various hand placements. Most importantly, do not compromise your body or position AND follow the correct orientation of the spine.

- Cervicothoracic Facet Distraction



*Facet distraction relative to segment cranially.
Make sure force is 45 degrees in anterior and inferior direction.*

- Seated Extension Mobs



Make sure low back is supported; Use patient's arms as leverage.

- Thoracic Spine Manipulations



Prone- there are multiple hand placements; Make sure scapulae are out of the way.



Seated J-Stroke for Mid-Thoracic Spine



Seated C-T Junction Manipulation; Can place towel along spine for additional leverage

****USING A SPLIT STANCE HERE WILL BE MORE EFFICIENT FOR THE PRACTITIONER****

Costovertebral & Costotransverse Joints (Ribs)

- Springing for assessment



Follow patient's respiratory pattern. Apply pressure anterior, caudal, and lateral as applies counter pressure with opposite hand.

- Seated First Rib Mobilization



Considerations:

- Scapulae out of the way with mobilization
- Orientation of spinous processes throughout spine- 60 degrees in thoracic spine

REINFORCE THE CORRECTION

Patient Education:

- Activity modification- ADLs/ ANLs
- Driving
- Sleeping positions/ hygiene
- Postural education
- Lifting mechanics
- **Breathing**
 - Teach diaphragmatic breathing to patients and why this is important

Basic Reinforcement Interventions:

- Foam Roller- Reinforces any soft tissue work and helps remove additional TEDs
 - Along lumbar and thoracic spine paraspinals, rhomboids, latissimus dorsi
- Stretches- assisting with various TEDs
 - Quadratus lumborum, pretzel stretches, quadruped rock backs

Functional Taping:

For Example:

- Postural taping with Leukotape or Kinesiotape

RELOAD THE SOFTWARE

Once mobility is established at the dysfunctional joint, treat as a SMCD and reload the system so that the patient can utilize their new mobility in a functional manner.

<i>Corrective Matrix TO INCREASE THORACIC EXTENSION/ROTATION</i>				
<i>Posture</i>	Standing	Standing lift with Theraband assist	Standing lift without assist	Standing lift with KB or theraband resistance
	Stacked Spine (Kneeling)	Tall or ½ kneeling rotation with theraband around knees/knee-ankle for stability assist	Tall or ½ kneeling rotation without assist	Tall or ½ kneeling rotation against resistance band
	Suspended Spine (Quadruped)	LL rotation in IR or ER using band around shoulder girdle to assist motion	LL rotation in IR or ER without assist	LL rotation in IR or ER with theraband around shoulder girdle providing resistance
	Supported Spine (Supine/Prone)	PNF stretching with curling/flexion of shoulder and hip	Sidelying rotation with top hip flexed to 90 degrees and ability to contact top shoulder to mat table behind them	Resisted sidelying rotation with theraband
		Facilitate (Expresses Mobility)	Demonstrates (Expresses Competency)	Challenges (Expresses Motor Control)

[CASE REPORT]

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Use of Thoracic Spine Thrust Manipulation for Neck Pain and Headache in a Patient Following Multiple-Level Anterior Cervical Discectomy and Fusion: A Case Report

Neck pain is one of the most common musculoskeletal complaints, with up to 70% of the population experiencing symptoms at some point in their lifetime.¹² Previous studies indicate that the incidence of neck pain



is increasing, with women reporting symptoms more frequently than men.^{20,55} Considering the high prevalence of this condition, the associated economic burden

on society is significant.⁵⁵ Approximately 25% of patients who experience an initial episode of neck pain report continued health care utilization for their persistent symptoms 5 years later.⁵⁵

One potential source of neck pain is the intervertebral disc.^{2,58} The natural history of symptomatic cervical degenerative disc disease is debatable, because longitudinal follow-up is frequently minimal and some patients eventually undergo surgical intervention.⁴⁴ Wilder et al^{62,63} reported a 21.7% baseline prevalence of cervical disc degeneration, with 47.9% demonstrating evidence of progression during a mean follow-up period of approximately 6 years, with higher rates reported for patients who had received surgical fusion intervention. This is potentially relevant information for physical therapists because (1) cervical degenerative disc disease has been suggested to be one of the most common indications for anterior cervical discectomy and fusion

STUDY DESIGN: Case report.

BACKGROUND: Thoracic spine thrust manipulation has been shown to be an effective intervention for individuals experiencing mechanical neck pain.

CASE DESCRIPTION: The patient was a 46-year-old woman referred to outpatient physical therapy 2 months following multiple-level anterior cervical discectomy and fusion. At initial evaluation, primary symptoms consisted of frequent headaches, neck pain, intermittent referred right elbow pain, and muscle fatigue localized to the right cervical and upper thoracic spine regions. Initial examination findings included decreased passive joint mobility of the thoracic spine, limited cervical range of motion, and limited right shoulder strength. Outcome measures consisted of the numeric pain rating scale, the Neck Disability Index, and the global rating of change scale. Treatment consisted of a combination of manual therapy techniques aimed at the thoracic spine, therapeutic exercises for the upper quarter, and patient education, including a home exercise program, over a 6-week episode of care.

OUTCOMES: Immediate reductions in cervical-region pain (mean \pm SD, 2.0 ± 1.1) and headache (2.0 ± 1.3) intensity were reported every treatment session immediately following thoracic spine thrust manipulation. At discharge, the patient reported 0/10 cervical pain and headache symptoms during all work-related activities. From initial assessment to discharge, Neck Disability Index scores improved from 46% to 16%, with an associated global rating of change scale score of +7 ("a very great deal better").

DISCUSSION: This case report describes the immediate and short-term clinical outcomes for a patient presenting with symptoms of neck pain and headache following anterior cervical discectomy and fusion surgical intervention. Clinical rationale and patient preference aided the decision to incorporate thoracic spine thrust manipulation as a treatment for this patient.

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KEY WORDS: ACDF, cervical spine, manual therapy, mobilization

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(ACDF) surgical intervention⁴⁷ and (2) national trends between 1990 and 2004 indicated an approximate 8-fold increase in ACDF procedures, with a similar increase in subsequent health care utilization.⁴⁷ Furthermore, a significant number of patients still have persistent symptoms following surgery,^{40,66} with up to 70% of patients frequently experiencing neck pain 1 year following ACDF procedures.⁵³

Introduced in the 1950s,^{21,59} ACDF is the surgical standard of care for cervical radiculopathy and myelopathy, with the primary goal of surgery being the preservation and restoration of neurological function.¹³ Commonly, the procedure consists of a transverse incision of approximately 4 cm in the anterior cervical region, extending from midline to the medial border of the sternocleidomastoid muscle.⁹ The longus colli muscle is retracted to grant access to the intervertebral disc and adjacent vertebral bodies. Thereafter, hardware is surgically secured to provide stability to the targeted vertebral bodies. One potential long-term risk of ACDF surgical intervention includes adjacent segment cervical disease, which has been reported to occur in approximately 25% of patients within the first 10 years following cervical fusion.¹³ Moreover, 2-year reoperation rates following ACDF procedures have been reported to range from 6.2% to 14.5%.^{1,23,24,28,50}

Two recent systematic reviews^{49,51} have provided preliminary support for physical therapy as a form of conservative care for individuals presenting with cervical radiculopathy or myelopathy, prior to considering ACDF surgical intervention. First, an updated Cochrane review⁵¹ indicated that surgery for cervical radiculopathy or myelopathy may provide more rapid (ie, short-term) pain relief when compared to physical therapy or hard-collar immobilization, primarily based on low-quality evidence, with virtually no difference in the long-term outcomes. Second, Matz et al⁴⁹ indicated similar clinical improvements in certain outcomes when comparing anterior surgical nerve root decompression with

TABLE 1 INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH CERVICAL DIAGNOSIS ¹²	
Neck Pain and Headache	Patient Clinical Findings
Unilateral headache associated with neck/suboccipital-area symptoms aggravated by neck movements or positions	Present
Restricted cervical range of motion	Present
Headache produced or aggravated with provocation of the ipsilateral posterior cervical myofascia and joints	Present
Restricted cervical segmental mobility	Present
Abnormal or substandard performance on the cranial cervical flexion test	Not assessed

or without fusion to physical therapy or cervical immobilization at 12 months. Recently, 2 separate studies^{31,54} reported on findings from a randomized clinical trial comparing clinical outcomes in patients who received either ACDF followed by physical therapy or physical therapy alone. Collectively, the results of those studies indicated that over a 2-year follow-up period, both groups improved and there were no significant differences in clinical outcomes (ie, neck disability, neck and arm pain intensity, neck active range of motion [ROM], neck muscle endurance, and hand-related function).^{31,54} As a result of these findings, the authors suggested that to reduce the need for surgery, adequate conservative care in the form of a structured physical therapy program should precede a decision to prescribe ACDF surgical intervention for patients with radiculopathy.^{31,54}

Headache is a common comorbidity in patients presenting to physical therapy with symptoms associated with neck pain. According to the clinical practice guidelines for neck pain developed by the Orthopaedic Section of the American Physical Therapy Association,¹² establishing a diagnosis of neck pain with headache is improved when 5 clinical findings are present (TABLE 1). There are a variety of interventions that physical therapists can implement for the management of patients experiencing neck pain with headache, including cervical spine manipulation and mobilization procedures combined with exercise.¹² Findings from previous clinical trials suggest that in-

corporating thoracic spine thrust manipulation as a treatment is beneficial in reducing pain intensity and improving function for patients with primary symptoms related to neck pain.^{12,19,20,32,36} Despite these promising findings, the use of thoracic spine thrust manipulation as a treatment for patients who have undergone ACDF surgical intervention presenting with neck pain (or headache) has, to our knowledge, not been reported.

A high percentage of patients may experience neck pain 1 year following ACDF surgical intervention.⁵³ Previous studies evaluating the effectiveness of thoracic spine thrust manipulation have not included individuals post-ACDF, primarily due to study exclusion criteria.^{16,19,20,35,36,43,65} Consequently, utilization of this manual therapy technique may not be considered as routine physical therapy care, based on either postoperative protocols or lack of empirical studies to support its clinical effectiveness in this specific patient population. Therefore, the purpose of this case report was to describe the physical therapy management, which included thoracic spine thrust manipulation, and outcomes in a patient referred to physical therapy with neck pain and headache following an ACDF surgical procedure.

CASE DESCRIPTION

THE PATIENT WAS A 46-YEAR-OLD woman referred to outpatient physical therapy 8 weeks after undergoing a 2-level ACDF at the C5-6 and C6-7 lev-

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els. Following surgery, her cervical spine was immobilized with an Aspen neck collar (Aspen Medical Products, Irvine, CA), as prescribed by her surgeon, for 6 weeks, and she was restricted to lifting up to 2.3 kg. Diagnostic imaging reports at 6 weeks following surgery indicated that the surgical hardware was intact, with no evidence of instability.

Prior to surgery, the patient reported having symptoms of neck pain, headaches, frequent fatigue of the upper quarter, and intermittent referred pain to her left arm. She denied any sensory deficits, tingling, or numbness, and her symptoms were present for approximately 1 year prior to surgery. During that 1-year period, surgery was not an option due to insurance restrictions, and attempts to self-manage her symptoms were not successful. She also did not receive physical therapy intervention prior to surgery. Following surgery and before physical therapy management, the patient reported (1) an improvement in intensity of referred pain to the left arm; (2) no improvement in headache frequency and intensity, cervical pain, and fatigue of the upper quarter; and (3) new onset of limited cervical ROM in the directions of flexion and extension, cervical muscle tightness and fatigue, and intermittent referred pain in the right elbow.

At the time of her initial physical therapy evaluation, the patient reported primary symptoms of frequent headaches (4–5 times per week), neck pain, tightness, and fatigue localized to the right cervical and upper thoracic spine regions, with intermittent referred pain in the right elbow. Aggravating factors were identified as cervical flexion, which was required for work-related activities, rotating her head to scan the environment or while driving, and periods of prolonged standing, with onset of neck pain and fatigue occurring after approximately 30 minutes and maximal tolerance being approximately 60 minutes. Specific occupational requirements as a dental assistant included long durations of standing and looking in a downward direction, which exacerbated

TABLE 2

PHYSICAL EXAMINATION KEY FINDINGS

Test or Measure	Initial Examination	Discharge (6 wk)
Cervical spine active ROM, deg		
Flexion	18	65
Extension	30	62
Left rotation	25	70
Right rotation	10	75
Left sidebend	10	35
Right sidebend	15	33
Grip strength, kg*		
Left	22.7	29.5
Right	22.2	35.4
Palpation	Upper trapezius tenderness elicited	No tenderness elicited
DNF endurance test, s	3	Greater than 90
Passive joint mobility testing	Thoracic spine (hypomobile T1 through T10)	AO and AA: normal
	Cervical spine (deferred)	C3-4 level: normal
		C4-5 level: hypermobile
		C5-6 and C6-7 levels: fused
		T1 through T10: normal

Abbreviations: AA, atlantoaxial joint; AO, atlanto-occipital joint; DNF, deep neck flexor; ROM, range of motion.
**Average of 3 repetitions.*

her symptoms. The patient also indicated discomfort and anxiety when in a supine position, with or without a pillow, and during prolonged sitting. These positions caused her symptoms to increase and were recognized by the patient as positions that she avoided throughout her daily activities. She also reported that sleeping was difficult secondary to neck pain exacerbations. Alleviating factors included the use of pain medication, rest, and heat, as per patient self-report. The patient denied any previous episodes of cervical-related symptoms prior to 1 year before surgery, and she did not receive physical therapy prior to this current episode of care.

Comorbidities included possible osteoarthritis, hypertension controlled by medication, and history of low back pain, as reported by the patient. In addition, she had a significant surgical history to resolve residual stress incontinence following the birth of 3 children. The patient's primary goal for physical therapy was to be able to resume her previous functional activities, which specifically

included working as a dental assistant, reading, and exercising in the gym.

Tests and Measures

Differential Diagnosis Screening Consistent with clinical practice guidelines,¹² a thorough screening process of the neurological, cardiopulmonary, and integumentary systems was performed to identify any differential diagnoses associated with nonmusculoskeletal origins (eg, systemic disease), to ensure that the patient was appropriate for physical therapy management. The results of the screening process were unremarkable.

Observation The physical examination was initiated with an observation of the patient's posture, which revealed an excessive forward head position. This was operationally defined as the external auditory meatus being anteriorly located when compared to the lumbar spine, and the shoulders were identified as protracted, as the acromion was noted to be anteriorly located in relationship to the lumbar spine.⁴²

Neurological Testing Bilateral muscle

TABLE 3

CLINICAL OUTCOME MEASURES

Clinical Outcome Measure	Initial	Follow-up (Visit 6)	Discharge (Visit 12)
NPRS neck pain (0-10)	10	2	0
NPRS headache (0-10)	3	0	0
NDI (0-100), %	46	26	16
GROC (-7 to +7)	NA	+5 ("quite a bit better")	+7 ("very great deal better")
DNF endurance test, s	3	33	Greater than 90

Abbreviations: DNF, deep neck flexors; GROC, global rating of change; NA, not applicable; NDI, Neck Disability Index; NPRS, numeric pain rating scale.

stretch reflexes of the biceps and triceps were each tested with 10 trials and recorded using a 0-to-4 scale, with all muscle stretch reflexes rated as 2+ (normal).⁴⁵ Sensory function was tested using light touch over the dermatomal distribution of the upper extremity and found to be intact. Myotomal testing was deferred for spinal levels C1 through C3 due to the patient's elevated pain intensity and apprehension regarding her neck. Manual muscle testing was used to identify gross muscle strength of the upper extremity using the 0-to-5 rating scale,⁴² with symptom response being recorded. Key findings included 4+/5 grades for the shoulder flexors, shoulder abductors, and elbow flexors on the right side when compared to the left.

Cervical Spine Active ROM All cervical ROM measures were performed in the upright sitting position using a bubble inclinometer, as described elsewhere.¹² Cervical ROM measurements for flexion, extension, and sidebending using a bubble inclinometer have exhibited moderate to substantial reliability coefficients ranging from 0.66 to 0.84.^{14,61} For all ROM measures, the patient was asked to move as far as possible and describe any changes in symptoms. Initial and follow-up ROM findings are provided in **TABLE 2**. **Deep Neck Flexor Endurance** Deep neck flexor endurance was tested as described by Harris et al.³⁸ The test was performed in a supine, hook-lying position. With the chin maximally retracted and maintained isometrically, the patient lifted the head and neck until the head was approxi-

mately 2.5 cm above the examination table. The patient was able to initially maintain this position without deviation for 3 seconds (**TABLE 2**). A previous study has indicated moderate interrater reliability (intraclass correlation coefficient model 2,1 [$ICC_{2,1}$] = 0.67) and a mean \pm SD endurance hold time of 24.1 ± 12.8 seconds for this test when performed with individuals experiencing cervical pain.³⁸ Findings from a similar study also indicated moderate interrater reliability ($ICC_{2,1}$ = 0.66), with mean \pm SD endurance hold times of 38.9 ± 20.1 seconds for men and 29.4 ± 13.7 seconds for women, when performed with healthy individuals.³⁰

Grip Strength Testing A handgrip dynamometer was used to assess bilateral grip strength, following procedures described elsewhere.³³ Briefly, the patient was tested in the sitting position with the shoulder adducted, the elbow at 90° of flexion, and the wrist at approximately 20° of extension. The mean value of 3 trials was reported in kilograms for each hand (**TABLE 2**).

Palpation Hypertonicity was observed in the upper trapezius and the anterior and middle scalene muscles bilaterally, and the right levator scapulae. Tenderness was elicited upon palpation of the right levator scapulae and upper trapezius bilaterally, with symptoms on the right being greater when compared to those on the left.

Passive Joint Mobility Testing Passive joint mobility testing in the posterior-to-anterior direction was performed for

the thoracic spine in the prone position⁴⁶ during the initial evaluation, and testing of the cervical spine was deferred secondary to the patient's increased apprehension (**TABLE 2**). A 3-level ordinal scale (ie, hypomobile, normal, or hypermobile) was used to assess the amount of spinal segmental motion, with symptom response also being recorded. Varied ranges of interrater reliability estimates have been reported for cervical (-0.26 to 0.74) and thoracic (0.13 to 0.82) passive joint mobility testing in individuals experiencing mechanical neck pain.¹⁴ The decision to perform passive joint mobility testing in the prone position is consistent with physical therapy-based clinical practice guidelines.¹² The posterior-to-anterior-directed force used to assess passive joint mobility was modified as needed, following the anatomical orientation of each spinal segment (a slightly superior-to-inferior direction was added to the upper thoracic spine assessment).

Self-Reported Measures

Numeric Pain Rating Scale Current pain intensity for neck pain symptoms and headache was measured using an 11-point numeric pain rating scale (NPRS) ranging from 0 (no pain) to 10 (worst pain imaginable). Initial and follow-up pain intensity scores for neck pain symptoms (initial, 10/10) and headache (initial, 3/10) are provided in **TABLE 3**. The NPRS is frequently used as a measure of clinical pain intensity and has demonstrated sound psychometric properties in patients experiencing cervical pain.^{41,56,64} The NPRS has been reported to have a minimal detectable change of 2.1 points and a minimal clinically important difference of 1.3 points in a sample of patients with mechanical neck pain.¹⁷

Neck Disability Index The Neck Disability Index (NDI)⁶⁰ is a 10-item, region-specific, self-report disability outcome questionnaire used to establish how cervical pain affects common daily activities. The total score of the NDI is expressed as a percentage that ranges from 0% (no disability due to cervical pain) to

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100% (completely disabled due to cervical pain), with higher scores indicating greater levels of disability.⁶⁰ Initial (46%) and follow-up NDI scores are provided in **TABLE 3**. A minimal detectable change of 18 percentage points has been reported for the NDI in an ACDF population,⁵² and a 10-point decrease in NDI scores has been reported to indicate substantial clinical benefit following cervical spine fusion.¹⁰

Global Rating of Change At follow-up (visit 6) and discharge (visit 12), the global rating of change scale (GROC) was administered as an indication of patient perception of overall improvement since the beginning of physical therapy treatment (**TABLE 3**). The GROC is a 15-point scale ranging from -7 (“a very great deal worse”) to +7 (“a very great deal better”), with 0 indicating “about the same.”³⁹ Previous studies have indicated that scores on the GROC of between ± 3 and ± 1 represent small changes, scores of ± 4 and ± 5 represent moderate changes, and scores of ± 6 and ± 7 represent large changes.³⁹

Clinical Impression

Based on findings from the initial examination, the patient in this case report presented with 4 out of 5 criteria for the diagnosis of “neck pain with headache,” as indicated by the neck pain clinical practice guidelines (**TABLE 1**).¹² Recommendations for patients fitting this diagnosis include (1) cervical mobilization/manipulation and (2) coordination, strengthening, and endurance exercises, but do not indicate the use of thoracic mobilization/manipulation.¹² Unfortunately, there is no clear direction for the management of patients following ACDF surgical intervention, particularly in outpatient physical therapy settings. Therefore, clinical reasoning involved with physical therapy management of this patient also incorporated research findings primarily conducted with nonsurgical patients and clinical reasoning, which ultimately led to the decision to incorporate thoracic spine thrust manipulation. In addition, patient



FIGURE 1. Midthoracic spine self-mobilization exercise.

reports of discomfort, anxiety, and fear with supine and sitting positions were considered when determining an appropriate position to apply interventions.

Intervention

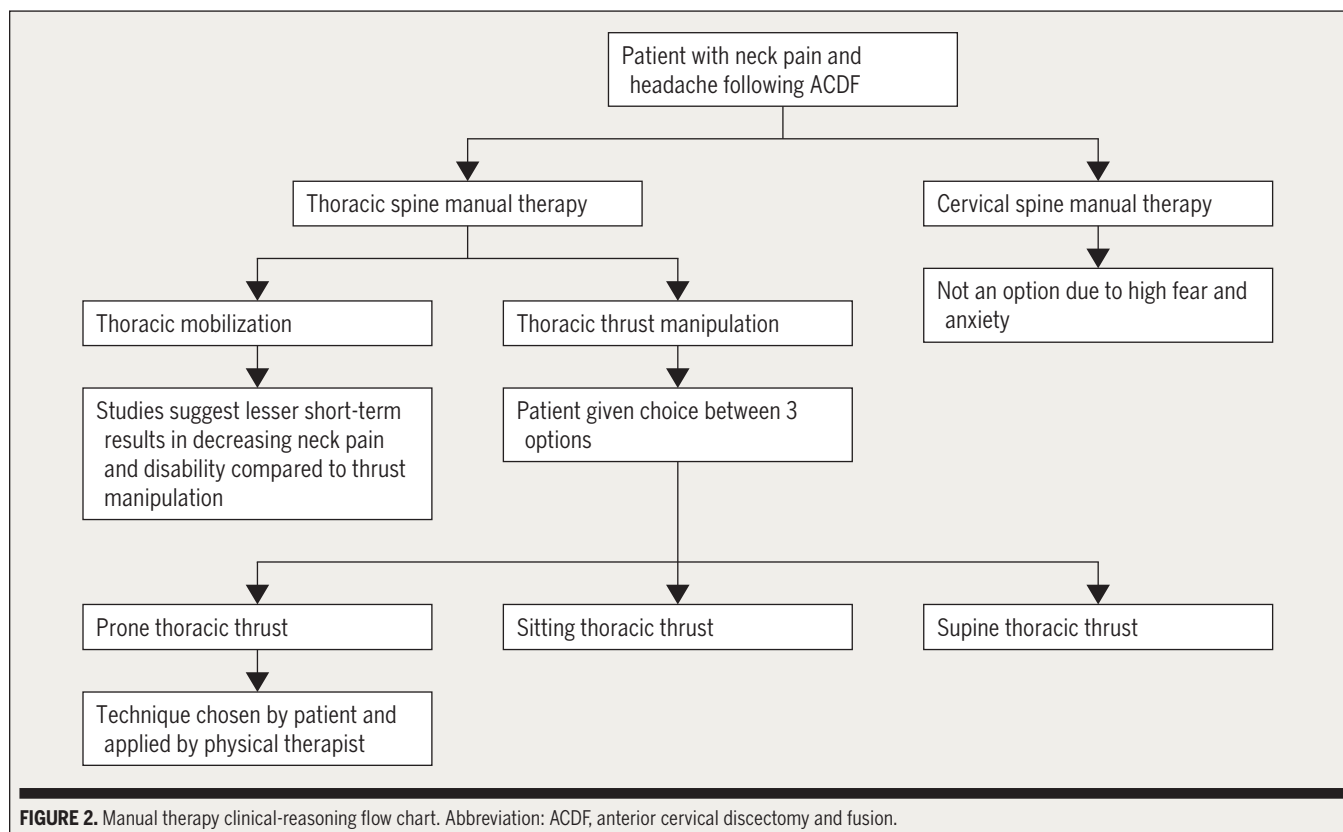
Subsequent treatment sessions focused on 2 intervention components targeting (1) cervical muscle weakness and decreased ROM and (2) the reduction of neck pain and headache intensity.

To address ROM deficits, therapeutic exercise interventions consisted of active cervical rotation, flexion, and extension, as well as self-mobilization techniques for the thoracic spine (**FIGURE 1**). Strength impairments were addressed with a progression from cervical isometric exercises, supine deep neck flexor exercises, and isolated postural exercises to isotonic cervical exercises and a combination of cervical and thoracic spine postural strengthening during functional positions. Therapeutic exercises were progressed from an emphasis on increasing mobility, followed by exercises dosed for endurance (3 sets of 25 repetitions at approximately 60% of 1-repetition maximum) and, eventually, strength (3 sets of 8 to 10 repetitions at approximately 80%

of 1-repetition maximum).³⁷ During the initial evaluation and subsequent treatment, the patient received education on proper sleeping position, joint-protection techniques, and the importance of compliance with her home exercise program. The home exercise program was initially focused on reducing muscle guarding through 50 to 60 repetitions of light-resistance exercises, with the intent to promote revascularization, which was subsequently progressed to promote muscle endurance and strength as she progressed through her plan of care.

At visit 2, thoracic spine thrust manipulation was initiated, with the rationale of decreasing cervical pain intensity and the potential for a reduction in headache-related symptoms (**FIGURE 2**). A high-velocity, end-range, posterior-to-anterior-directed force was separately applied to the upper thoracic spine (on the lower cervical spine region), to the midthoracic spine (on the upper thoracic spine region) (**FIGURE 3, ONLINE VIDEO**), and to the lower thoracic spine (on the midthoracic spine region) in the prone position. The anatomical orientation of each spinal segment was considered in regard to angulation of the posterior-to-anterior-directed force (a slightly superior-to-inferior angle was added to the posterior-to-anterior force direction at the upper thoracic spine). The techniques were aimed at the upper, middle, and lower thoracic spine regions, in that order, without attempts to target specific thoracic spinal segments. Three repeated applications of the thoracic spine thrust manipulation were chosen based on a previous study³² that indicated that this dosage would not lead to tolerance, as suggested by the effect size or magnitude of the intervention over time. These techniques were implemented at subsequent sessions, when the patient reported cervical or headache-associated NPRS scores greater than 0/10.

Thoracic spine thrust manipulation was chosen for 2 primary reasons. First, as a result of recent surgery, the patient reported very elevated pain intensity rat-

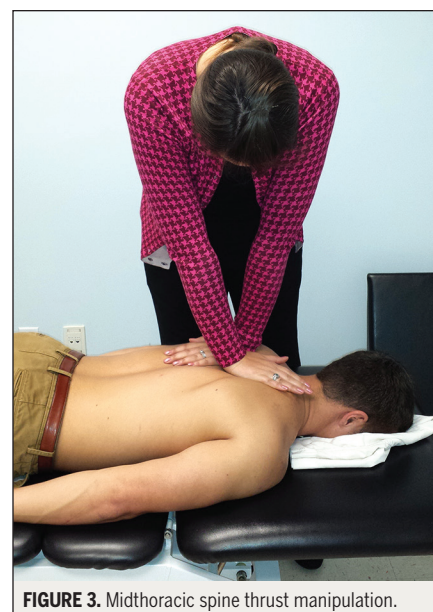


ings (10/10) and had significant muscle guarding, which did not allow her to tolerate other manual therapy interventions targeting the cervical spine region (eg, soft tissue and joint mobilization techniques) that were initially attempted. Second, thoracic spine thrust manipulation has been shown to be beneficial for reducing pain intensity and improving function for patients with primary symptoms related to neck pain.^{12,19,20,32,36} Therefore, the decision to incorporate thoracic spine thrust manipulation for this specific patient was primarily based on incorporating findings from previous research performed on nonsurgical patients and translating that evidence to the physical therapy management of a patient who had undergone ACDF surgical intervention.

Thoracic spine thrust manipulation techniques can be performed in various positions (supine, prone, or seated). As a result of early communication and feedback from the patient, the prone po-

sition was used, primarily based on patient preference after other alternative positions were described. Prior to implementing thoracic spine thrust manipulation techniques, the patient rated her current neck and headache pain intensity using the NPRS. This was an integral assessment component in the decision to provide additional thoracic spine thrust manipulation during subsequent treatment sessions and was primarily based on the prognostic value of within- and between-session changes for clinical outcomes involving the application of manual therapy interventions for low back pain.²²

Previous review^{4,25} and experimental^{5,6,34} studies suggest that the application of spinal manipulation techniques and subsequent hypoalgesic effects are associated with neurophysiological changes within the central nervous system. Therefore, the rationale for implementing these techniques was primarily based on short-term hypoalgesic respons-



es, as indicated by subsequent patient self-report improvements in pain intensity. Moreover, previous research has shown that thoracic spine thrust manipulations similar to those implemented in

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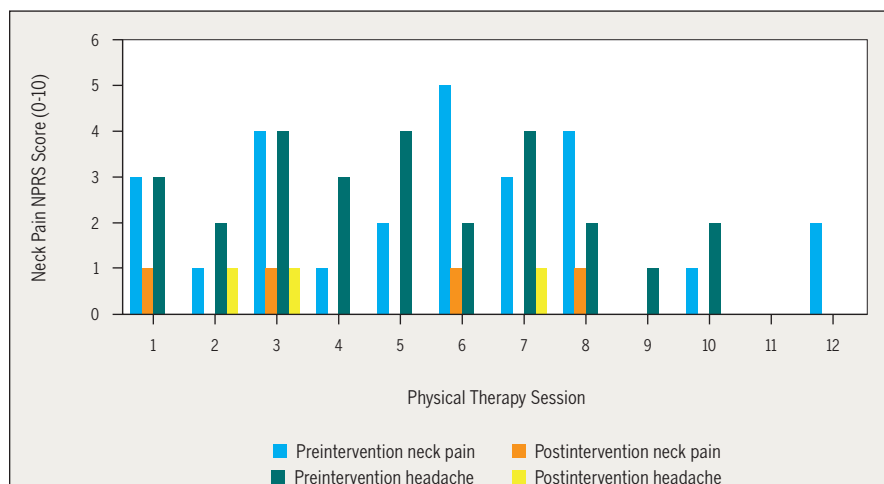


FIGURE 4. Neck pain and headache intensity pre- and post-thoracic spine thrust manipulation at each physical therapy session as assessed with an 11-point NPRS, where 0 is no pain and 10 is the worst pain imaginable. The mean \pm SD within-session improvements were 2.0 ± 1.1 for neck pain and 2.0 ± 1.3 for HA intensity. The absence of bars in the figure indicates an NPRS score of 0. Abbreviation: NPRS, numeric pain rating scale.

this case report are associated with positive outcomes in individuals with neck pain,^{15,16,19,36} suggesting that the regional specificity of these interventions may not be important to achieving the desired clinical outcomes (eg, improved pain intensity ratings). Immediately following the 3 thoracic regional thrust-type techniques (upper, middle, and lower thoracic regions), neck pain and headache intensity were reassessed using the NPRS.

OUTCOMES

THE PATIENT ATTENDED 12 PHYSICAL therapy sessions over the course of 6 weeks. Clinical outcomes were recorded at baseline, during the episode of care, and at discharge (TABLE 3). Within-session improvements in neck pain and headache intensity were measured with the NPRS following the application of thoracic spine thrust manipulation techniques (FIGURE 4). At discharge, the patient reported 0/10 neck pain intensity and decreased frequency of headache (from 4 to 5 times per week to 1 to 2 times per month). Deep cervical flexor muscle endurance improved from a 3-second hold to a hold of greater than 90 seconds. Tenderness was not elicited during palpa-

tion of the upper trapezius, levator scapulae, or scalene muscles. Over the episode of care, NDI scores improved from 46% to 16% (30-percentage-point improvement), which exceeds previously reported minimal detectable change estimates for post-ACDF⁵² and minimal clinically important difference estimates for patients experiencing mechanical neck disorders¹⁷ or cervical radiculopathy.¹⁸ GROC scores were collected at visit 6 (+5, “quite a bit better”) and discharge (+7, “a very great deal better”), with both ratings having been associated with beneficial short-term clinical outcomes in a previous clinical trial involving individuals with mechanical neck pain.⁴⁸

DISCUSSION

CERVICAL DEGENERATIVE DISC disease, particularly with associated signs and symptoms of radiculopathy and myelopathy, is one of the most common indications for ACDF surgical intervention, which is an increasingly common procedure in the United States.⁴⁷ The patient in this case report did not report deterioration in neurological status in the 1-year period prior to surgery, nor did she receive conserva-

tive care prior to the surgical intervention, which might have been beneficial based on preliminary evidence supporting conservative-care approaches in this patient population.^{31,49,51,54} Following surgery and prior to the initiation of physical therapy intervention, there was a lack of improvement in the patient’s neck pain and headache symptoms and significant limitations in cervical ROM that potentially could have been related to 6 weeks of cervical immobilization after surgery. Therefore, the purpose of this case report was to describe the physical therapy management, which included thoracic spine thrust manipulation, and outcomes of a patient referred to physical therapy with neck pain and headache following an ACDF surgical procedure. A novel element of this case report is the utilization of thoracic spine thrust manipulation, which, to our knowledge, has not previously been reported in this population postsurgery and therefore has not been considered a component of routine care.

Current clinical practice guidelines¹² provide physical therapists with research-supported evidence for the conservative physical therapy management of patients who experience common neck pain-related conditions; however, these guidelines do not provide suggestions for the management of patients after surgical procedures. A common challenge for physical therapists is that guidelines for the utilization of spinal manipulation in patients postsurgery are lacking, because this population is typically excluded from manual therapy clinical trials. As a result, clinicians may be reluctant to implement manual therapy techniques in postsurgical populations and patients may not receive interventions that could positively impact clinical outcomes.

The primary emphasis of this case report was to describe how the decision to incorporate thoracic spine thrust manipulation into this specific patient’s treatment plan was primarily based on findings from previous research conducted on patients without surgical procedures,^{12,19,20,32,36} and how that evidence

was translated to the physical therapy management of a patient who had undergone an ACDF surgical intervention. For example, a recent review has indicated that incorporating thoracic spine thrust manipulation as an intervention for patients with acute or subacute mechanical neck pain may provide short-term improvement in cervical ROM and self-reported functional scores.²⁷ The outcomes of this patient's treatment after neck surgery, which included improvements in cervical ROM (TABLE 2), NDI scores (TABLE 3), and neck pain and headache (TABLE 3) over a 6-week episode of physical therapy, are consistent with those of patients with mechanical neck pain.²⁷

Patient preference and values were integrated into clinical reasoning during the physical therapy management of this patient. Specifically, patient preference for treatment was considered when deciding to use thoracic spine thrust manipulation techniques. Initially, more traditional techniques targeting the cervical spine region were attempted (joint and soft tissue mobilization) in supine and prone positions; however, patient subjective responses (discomfort and anxiety) suggested an inability to tolerate those interventions and positions. The content and manner in which information was shared with patients, as well as the patient's experience of being involved in the clinical decision-making process, can directly alter clinical outcomes via nonspecific responses.⁸ A previous study²⁹ has indicated that shared decision making is not being applied in physical therapy settings, despite suggestions that many patients prefer to be involved in clinical decision-making processes.¹¹ A thorough description of individual expectation is beyond the scope of this case report but is provided elsewhere.³ It is plausible that high patient expectations associated with receiving a potentially beneficial intervention (as described by the clinician) might have influenced the outcomes reported in this case report. Previous studies have indicated that positive patient expectations for receiving spinal

manipulation for the treatment of neck pain are associated with improved clinical outcomes.^{7,57}

We fully acknowledge that other potential explanations can be attributed to the observed outcomes during the physical therapy management of this patient. For example, some clinical features (cervical muscle tightness and fatigue, and intermittent pain referral to the right elbow) were only present following surgery, which was followed by 6 weeks of immobilization with a cervical collar. Considering the brief 2-week period between the use of the cervical collar and initiating physical therapy, the outcomes reported in this case report could have been the result of natural history. Therefore, many of the clinical improvements reported during the management of this patient might also have been observed with time or other treatment strategies. Yet, the immediate within-day improvements specifically following thoracic spine thrust manipulation suggest that at least some aspects of the interventions provided were helpful.

There are several limitations when interpreting the findings of this case report. First, despite the favorable outcomes presented in this case report, a cause-and-effect relationship between treatment and clinical outcomes cannot be established, as changes could have been related to the natural history or a placebo effect. Second, a lack of previous research involving this specific post-surgical population and thoracic thrust manipulation techniques prohibits our ability to compare these findings to those of other studies. Future studies should consider evaluating the clinical implications of incorporating thrust-type manual therapy techniques that target the thoracic spine in individuals who have had ACDF surgical intervention, where alternative manual therapy techniques are either contraindicated or not aligned with patient preferences. Third, recall bias²⁶ might have been associated with patient self-reporting of symptoms prior to and immediately following surgery; therefore, we were not able to confirm the

patient's status prior to the initial physical therapy encounter. Finally, symptoms of anxiety and fear were only identified through communication with the patient and not assessed with validated screening measures that could have provided an earlier indication of how these or other psychological factors might have influenced this patient's initial presentation and whether psychologically informed practice principles should have been integrated into the physical therapy management of this patient.

CONCLUSION

A SIGNIFICANT NUMBER OF PATIENTS continue to experience neck pain following ACDF procedures; however, this patient population is frequently excluded from studies investigating the treatment effects of thoracic spine thrust manipulation. As a result, incorporating these manual therapy techniques is not considered routine clinical practice for these patients postsurgery. Clinical reasoning based on evidence-based practice principles consisting of (1) prior research involving nonsurgical patient populations, (2) patient values involving preference for intervention, and (3) clinical rationale involving communication to positively influence patient expectations for treatment was an integral component in the physical therapy management of this patient. ●

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