

# Evidence-Based Approach to the Physical Therapy Diagnosis and Management of Neck and Upper Extremity Pain using Cervical and Thoracic Spine Thrust Manipulation: A Case Report

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**Abstract:** Neck and upper extremity pain are common medical diagnoses for patients seeking physical therapy care. The purpose of this case report is to describe an evidence-based approach to the physical therapy diagnosis and management of a 46-year-old female reporting insidious onset neck pain and bilateral upper extremity paraesthesiae of two years duration. Evaluation of examination data, based on research data with regard to diagnostic accuracy of the tests and measures used, indicated a diagnosis of cervical radiculopathy. Management was based on a treatment-based classification approach and focused on restoring mobility by way of thrust manipulations directed at the thoracic and cervical spine. At the completion of the physical therapy plan of care (8 visits), the patient rated her perceived improvement on the Global Rating of Change Scale as “a very great deal better.” The Numerical Pain Rating Score improved from 6/10 to 0/10. Patient-perceived disability, as measured by the Neck Disability Index, improved from 26% to 0%, and the patient’s score on the modified Oswestry Disability Index improved from 30% to 0%. Bilateral upper extremity paraesthesiae also had completely resolved. These clinically meaningful improvements in pain and perceived disability were maintained six weeks after discharge. While a cause-and-effect relationship cannot be inferred from a case report, it is plausible that an orthopaedic manual physical therapy approach in the management of patients with both neck and upper extremity pain may result in decreased pain and improved function. Further clinical trials are needed to test this hypothesis.

**Key Words:** Evidence-Based, Diagnosis, Management, Cervical Radiculopathy, Treatment-Based Classification Approach, Thrust Manipulation

A reported 6-month prevalence of 54% makes neck pain a common disorder among the adult population<sup>1</sup>. In fact, in any given month 10% of the population will experience pain in the cervical area<sup>1</sup>. Patients with neck pain are regularly encountered in outpatient orthopaedic physical therapy (PT) clinics<sup>2</sup>. In some cases, cervical radiculopathy, which has been defined as motor and/or sensory changes in the neck and upper extremities resulting from extrinsic pressure on a cervical nerve root<sup>1</sup>, accompanies neck pain. In the presence of cervical

radiculopathy, the level of nerve root involvement will determine the patient’s clinical presentation. Regardless of the specific diagnosis, it is common for patients with neck and upper extremity symptoms to have difficulty performing activities of daily living. Recent literature<sup>3,4</sup> has addressed the evidence-based diagnosis and management of cervical radiculopathy, but the most effective, conservative treatment strategy has yet to be elucidated. The purpose of this case report is to describe an evidence-based approach to the PT diagnosis and management of an individual presenting to physical therapy with neck and upper extremity symptoms.

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## Case Description

### History

A 46-year-old female research physician and mother of 2 children (ages 12 and 16) presented to the outpa-

tient PT department of Newton-Wellesley Hospital with a 2-year history of intermittent bilateral neck pain and upper extremity paraesthesiae<sup>5</sup>. These symptoms were reported to occur during bilateral ipsilateral cervical sidebending and overhead motions. Paraesthesiae were isolated to the radial forearm and digits 1-3 bilaterally. The patient also reported the onset of central low back pain (LBP), which had occurred within two weeks of the development of neck pain. Additionally, she stated that both the neck pain and LBP always presented simultaneously. Wainner et al<sup>5</sup> established moderate to excellent interrater reliability for a patient report of intermittent neck pain ( $\kappa=0.57$ ), upper extremity paraesthesiae ( $\kappa=0.74$ ), and for symptoms below the elbow and in the hand in patients with cervical radiculopathy ( $\kappa=0.83$ ).

Magnetic resonance imaging (MRI) of the cervical spine was performed one month prior to her initial examination and revealed a minimal C5-C6 left-sided disc bulge without foraminal obstruction. MRI has demonstrated a sensitivity of 88.9% and a specificity of 99.1% to detect cervical spondylotic radiculopathy<sup>6</sup>.

Functional limitations at the time of the initial evaluation included an inability to cradle the phone for more than five minutes due to ipsilateral neck pain. The patient also reported difficulty backing her car out of the driveway and washing her hair due to the onset of symptoms associated with cervical rotation/extension and overhead activities. These limitations were dichotomized into “present or not present” and documented as asterisk signs, i.e., signs to be assessed again after treatment to help guide the evaluation of treatment effectiveness<sup>7</sup>.

Following the history, the patient was asked to complete the Numerical Pain Rating Scale (NPRS)<sup>8</sup>, the modified Oswestry Disability Index (ODI)<sup>9</sup>, and the Neck Disability Index (NDI)<sup>10</sup>. Baseline scores for these self-report measures can be found in Table 1. The patient completed a medical status questionnaire (Table 2), which was reviewed prior to the physical examination to identify any red flags that might be indicative of systemic pathology. The 11-point NPRS ranges from 0 (“no pain”) to 10 (“worst pain imaginable”) and was used to indicate the average intensity of current pain over the

last 24 hours<sup>11</sup>. The scale has adequate test-retest reliability (ICC=0.63)<sup>12</sup> and validity<sup>13</sup>. A 2-point change on the NPRS has been identified as the minimal clinically important difference (MCID) for this scale<sup>13</sup>. The modified ODI consists of 10 questions and was used to measure disability. Each question is scored from 0 to 5, with higher scores indicating greater disability. The scores are then converted to a percentage out of 100. The modified ODI has demonstrated good test-retest reliability (ICC=0.90)<sup>14,15</sup>. Fritz et al<sup>14</sup> have demonstrated a change of 4-6 points (8-12%) on the modified ODI as its MCID. The NDI is the most widely used condition-specific disability scale for patients with neck pain, and it consists of 10 items addressing different aspects of function, each scored from 0-5, with a maximum score of 50 points<sup>16,17</sup>. The score is then doubled, and interpreted as a percentage of the patient’s perceived disability. Higher scores represent increased levels of disability. The NDI has demonstrated moderate test-retest reliability (ICC=0.68)<sup>18</sup> and validity as an outcome measure for patients with neck pain<sup>16,19-21</sup>. Cleland et al<sup>18</sup> have identified a 7-point difference (14%) as the MCID for the NDI. No data is available on the diagnostic accuracy of the medical status questionnaire as it is unique to our facility.

### Examination

The initial focus of the examination was to exclude contra-indications to PT management, more specifically vertebrobasilar insufficiency (VBI); this problem is a contra-indication to manual therapy interventions to the cervical spine and its consequences can be significant<sup>22</sup>. Our screening for VBI started during the history-taking described above; the patient did not report the relevant symptoms to direct questioning as reported by Kuether et al<sup>23</sup>: dysarthria, dysphagia, visual field defects, diplopia, nausea, and headaches. The history-taking included questions regarding speech, swallowing, or visual problems; episodes of nausea; and a new onset of headaches. Relevant signs or symptoms were also not reported on the medical status questionnaire. The patient was then screened to determine the appropriateness of supine VBI testing via a series of sitting active end-range cervical

**Table 1: Cervical and lumbar self-reported measures of pain and functioning.**

Outcome	Baseline	Week 2	Week 4-Discharge	Week 10 Follow-up
NPRS	6/10	3/10	0/10	0/10
NDI	30%	14%	0%	0%
ODI	26%	12%	0%	2%
GROC		“Quite a bit better” +5	“A great deal better” +6	Cervical “A very great deal better” +7; lumbar +6

Note: NPRS = Numeric Pain Rating Scale; NDI = Neck Disability Index; ODI = Oswestry Disability Index; GROC = Global Rating of Change Scale.

Table 2: Medical Status Questionnaire



**NEWTON-WELLESLEY  
HOSPITAL**  
2014 Washington Street  
Newton, MA 02462

Name: \_\_\_\_\_

Date of Birth: \_\_\_\_\_

Unit Number: \_\_\_\_\_

Today's date: \_\_\_\_\_

**REHABILITATION SERVICES  
MEDICAL STATUS QUESTIONNAIRE**

The purpose of this questionnaire is to assist us in understanding your current and past medical history. Please answer all questions during your exam. This form is considered part of your medical record.

Age: \_\_\_\_\_ Height: \_\_\_\_\_ Weight: \_\_\_\_\_

What is your primary language? English Other (Specify) \_\_\_\_\_

Why were you referred to therapy? \_\_\_\_\_

Are there any cultural/religious practices which should be considered in treatment plan? \_\_\_\_\_

Have you fallen in the last 3 months? \_\_\_\_\_

1. Have you ever been informed that you have:		Comments/Update
High Blood Pressure?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Heart Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Lung Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Kidney Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Head Injury?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Multiple Sclerosis/ Parkinson's Disease?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Stroke/Neurological Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Liver Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Thyroid Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Blood Disorder?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Diabetes (High Blood Sugar)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Low Blood Sugar?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Seizures?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Cancer?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Arthritis?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Tuberculosis?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Repeated Infections?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Osteoporosis?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Circulation or Vascular Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Broken Bones (Fracture)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Ulcer/Stomach Problems?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>For Men Only:</b>		
Prostate Disease?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>For Women Only:</b>		
Pelvic Inflammatory Disease?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Endometriosis?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Have you had a complicated pregnancy/delivery?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>2. Have you recently had:</b>		
Weight loss or gain?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Loss of Appetite?	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Table 2: Continued

Name:		DOB:	Unit Number:
<b>3. Have you recently had (Continued):</b>			<b>Comments/Update</b>
Difficulty Sleeping?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Joint pain and/or Swelling?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Urinary or Bowel Problems?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Nausea and Vomiting?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Numbness or Tingling?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Weakness in your Arms or Legs?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Coordination Problems?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Difficulty Walking?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Dizziness or Loss of Consciousness?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Loss of Balance?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Chest Pain?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Heart Palpitations?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Shortness of Breath?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Difficulty Swallowing?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
New Onset of Headaches?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Visual Problems?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Hearing Problems?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Hoarseness?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Cough?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Sexual Dysfunction?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>4. Do you?</b>			
Smoke? If yes how much? _____ packs/day		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Have a significant family history of cardiopulmonary illness or disease?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Have any other medical problems? If so, what?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Do you receive other services here or elsewhere?		<input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>5. Current medications/Drugs (Please list all, including herbals and over the counter)</b>			
A.	B.	Known allergies or reactions	
C.	D.		
E.	F.		
G.	H.		
<b>6. Previous Surgeries/Hospitalizations</b>		Date:	Reason:
A.			
B.			
C.			
<b>7. Have you recently had the following tests?</b>		<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, please circle all
A. X-Rays	B. CT Scan	C. MRI	
D. Bone-Scan	E. Myelogram	F. Blood Tests	
G. EKG	H. Electrocardiogram	I. EMG	
J. Stress Test	K. Pulmonary Function Test		
L. Other:			
<b>8. Have you seen anyone else for the problem for which you have been referred?</b>		<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, please circle all
A. Physician	B. Dentist	C. Podiatrist	D. Osteopath
E. Physical Therapist	F. Chiropractor	G. Other	
<b>9. Have you recently received other treatments? If yes, please circle all that apply.</b>		<input type="checkbox"/> Yes <input type="checkbox"/> No	When was your last get
A. Chemotherapy	B. Injection	C. Other	Are your immunizations
<b>10. Who is the physician you see most often?</b>		NWH <input type="checkbox"/>	Address:

motions, including sidebending, rotation, and extension. After negative testing in sitting, the patient was placed in the supine position with the head supported on the table, and the cervical spine was sustained in extension-rotation for 30 seconds while testing of the cranial nerves was performed<sup>24</sup>. Testing was performed bilaterally with a 30-second hold in between in the neutral position, to monitor for latent signs and symptoms. Mitchell et al<sup>25</sup> demonstrated a statistically significant reduction in neutral position blood flow after cervical rotation testing, indicating the need to monitor in this position. All cranial nerve testing performed in the sustained positions were negative, and we therefore concluded that further examination and interventions could be initiated.

The results of further neuroconductive testing included negative bilateral Hoffman signs, normal deep tendon reflexes throughout the upper and lower extremities, 5/5 strength testing in the upper extremities, and intact sensation in the dermatomes of C5-T1 as measured by pin prick<sup>5</sup>. During straight leg raise (SLR) testing, the patient complained of LBP with the addition of cervical flexion but lower extremity symptoms did not occur. LBP was not reproduced with slump testing<sup>24</sup>. Sung and Wang<sup>26</sup> prospectively studied 16 asymptomatic individuals with a positive Hoffman sign noting a sensitivity of 94% for MRI-confirmed central cord compression. Wainner et al<sup>5</sup> have found upper extremity reflex testing and strength testing to possess low sensitivity with values ranging from 3-24% and 12-29%, respectively, but excellent specificity with values of 93-95% and 66-86%, respectively, when compared to a reference standard of radiculopathy established by way of needle electromyography and nerve conduction studies. The same study<sup>5</sup> also documented substantial interrater reliability for upper extremity reflex testing ( $\kappa=0.73$ ) and poor to substantial interrater reliability for upper extremity strength ( $\kappa=0.23-0.69$ ) and dermatomal sensation testing ( $\kappa=0.16-0.67$ ). Philip et al<sup>27</sup> found that positive slump testing, defined as symptom reproduction and reduction with cervical flexion, possessed excellent interrater reliability (mean  $\kappa=0.89$ ).

Integrity of the upper cervical ligaments was assessed via the alar ligament and Sharp-Purser tests<sup>28,29</sup>.

Both tests were negative. Using a dichotomous rating scale, Cattrysse et al<sup>28</sup> reported poor to substantial intra- ( $\kappa=0.29-0.67$ ) and interrater reliability ( $\kappa=0.09-0.67$ ) for the Sharp-Purser test in patients with Down's syndrome. Uitvlugt and Indenbaum<sup>29</sup> compared Sharp-Purser testing to plain film radiographs in a patient population with rheumatoid arthritis and demonstrated a sensitivity of 69% and a specificity of 96%.

Supine side-gliding segmental motion tests were performed to identify symptomatic cervical motion segments<sup>30</sup>. The test was used to yield information both on pain and on mobility. For pain, the test was rated on a dichotomous rating scale of "painful" or "not painful." Pain provocation during segmental motion tests has demonstrated poor to good interrater reliability even when using an 11-point pain rating scale (ICC=0.22-0.80)<sup>31</sup>. Mobility was documented on a 3-point grading scale: hypermobile, normal, hypomobile (Table 3). To date, no studies have examined the reliability of this mobility grading scale in the cervical spine. However, Vicenzino et al<sup>32</sup> have demonstrated relative linear displacements of 2.7-3.9 cm using the lateral glide technique at levels C5-T1; these findings may provide preliminary indications as to the validity of this technique.

Postural observation revealed lower-cervical extension, upper-thoracic flexion, and mid-thoracic extension. Fedorak et al<sup>33</sup> reported fair mean intrarater reliability ( $k = 0.50$ ) and poor mean interrater reliability ( $k= 0.16$ ) for visual assessment of posture using a 3-point rating scale (normal, increased, decreased).

Active range of motion was performed for the cervical, thoracic, and lumbar spine. These tests were used to yield information both on symptom reproduction at end-range (increased pain, decreased pain, status quo) and on mobility (Tables 3 and 4). Mobility was measured using an inclinometer, a technique that has demonstrated good interrater reliability in patients with neck pain (ICC=0.81-0.84)<sup>34-37</sup>. Piva et al<sup>38</sup> also reported substantial to excellent interrater reliability for the use of an inclinometer in patients with neck pain ( $\kappa=0.78-0.91$ ) and a minimal detectable change (MDC) of 12° for left lateral sidebending, 10° for right lateral sidebending, 11° for left rotation, 13° for right rotation, and 16° for both flexion and extension; the authors noted these values as

**Table 3: Passive mobility testing and provocation.**

Location	Mobility Assessment	Provocation
Mid-cervical spine	Hypomobile	Status quo
Lower cervical spine	Hypomobile	Increased pain proximal & distal
Mid/Upper thoracic spine	Hypomobile	Status quo
Lower thoracic/Lumbar spine	WNL	Status quo

adequate for clinical use. Wainner et al<sup>5</sup> have reported 89% sensitivity and 41% specificity for cervical flexion AROM < 55° in patients with cervical radiculopathy. They have also found cervical rotation < 60° towards the involved side to possess 89% sensitivity with 49% specificity.

Shoulder involvement due to glenohumeral instability was examined through the use of multiple diagnostic tests for labral lesions, as these lesions have been associated with anterior and inferior instability<sup>39</sup>. This glenohumeral instability was considered as a possible causative or contributory impairment leading to excessive tension of neural structures and subsequent symptoms in the upper extremity as described by this patient. Testing included the Kim and Jerk, active compression, and biceps load II tests. The Kim and Jerk tests have a combined sensitivity of 97% to detect postero-inferior labral lesions<sup>40</sup>, the active compression test has a sensitivity of 54%-100% to detect superior labral lesions, and the biceps load test II has a sensitivity of 90% and a specificity of 97% to detect superior labral lesions<sup>41-44</sup>. All tests directed at the shoulder were found to be negative.

The patient was evaluated for thoracic outlet syndrome (TOS) through a combination of the Adson, costoclavicular, and hyperabduction tests<sup>23,45</sup>. All tests were negative for pain. However, hyperabduction testing elicited reproduction of upper extremity paraesthesiae<sup>46,47</sup>. Gilard et al<sup>45</sup> evaluated the diagnostic utility of these tests with competing diagnoses eliminated by way of electrophysiological studies, ultrasonography, helical computed tomography, and plain films. They reported a sensitivity of 79% and a specificity of 76% for the Adson test. They also reported 84% sensitivity and 40% specificity for the hyperabduction test with symptom provocation as a positive finding; pulse abolition as a positive finding

resulted in 70% sensitivity and 53% specificity.

The examining clinician screened for the presence of cervical radiculopathy through the use of a diagnostic test item cluster<sup>5</sup>. The four variables identified as accurate predictors of cervical radiculopathy included:

- Positive upper limb tension test A (ULTT A; median nerve bias)
- Ipsilateral cervical rotation <60°
- Positive Spurling test A: Patient seated with ipsilateral sidebending of the neck and 7 kg of overpressure applied
- Positive supine cervical distraction test as measured by a reduction/resolution of symptoms

The patient in this case report scored positive for three of four tests in the test cluster: cervical distraction did not decrease upper extremity symptoms. Data on the positive likelihood ratio associated with the number of positive tests are located in Table 5.

The examining clinician (PG) considered carpal tunnel syndrome (CTS) a competing diagnosis. The examination combined single diagnostic tests with components of a test cluster as part of a clinical prediction rule (CPR) for the diagnosis of CTS<sup>48</sup>. Single diagnostic tests included the Phalen, carpal compression, and Tinel tests; all were negative. These tests have all shown substantial to excellent interrater reliability in a CTS patient population with κ-values ranging from 0.77-0.88<sup>48,49</sup>. The CPR includes a symptom severity scale, report of hand-shaking relieving the symptoms, age > 45, a wrist-ratio index > 0.67, and decreased median nerve sensation in the thumb. The symptoms severity scale was not available at the time of this initial evaluation. The patient was over 45 but hand-shaking did not relieve the symptoms, the wrist ratio index was < 0.67, and the median nerve sensation in the thumb tested normal. Therefore, the patient in

**Table 4: Impairment-based measures (all range-of-motion measurements in degrees).**

Motion	Baseline	Week 2	Week 3	Week 4 Discharge	Week 10 Follow-up
Cervical flexion	50	66	68	68	66
Cervical extension	70	70	70	70	70
Cervical sidebending right	30	36	36	36	32
Cervical sidebending left	32	34	36	36	34
Cervical rotation right	56	64	70	72	68
Cervical rotation left	40	60	70	74	70
Thoracic flexion	20	26	34	34	34
Lumbar flexion	50	54	54	54	54

this case report at most satisfied two criteria in this CPR. Data on the positive likelihood ratio associated with the number of positive tests are located in Table 6.

### Evaluation and Diagnosis

A diagnosis is established during the differential diagnostic process by acknowledging the greater likelihood of one diagnosis while excluding competing diagnoses. In the past, this process occurred by interpreting tests based on a pathophysiologic rationale but under the currently predominant evidence-based practice paradigm, the intent is to use, to the maximum extent possible, research data on reliability and diagnostic accuracy in our interpretation of test results and in the formulation of the most likely diagnosis. In this case, we began with a history that showed a reliable patient report of neck pain, paraesthesiae, and sensory symptoms below the elbow into the hand in patients with cervical radiculopathy<sup>5</sup>. MRI findings, both sensitive and specific, were used to exclude the presence of morphological foraminal obstruction, which may not have been amenable to conservative treatment<sup>6</sup>.

Examination findings included negative findings on tests for VBI, but due to the poor established values for diagnostic accuracy, we were unable to fully exclude the possibility of vertebral artery compromise or exclude possible future adverse effects should we choose to use thrust manipulation. Due to the absence of clear data on the value of the VBI tests as a diagnostic or screening tool, the treating clinician proceeded by using the most current practice guidelines available with regard to suggested tests for the vertebrobasilar system<sup>50</sup>.

Neuroconductive testing showed, with confidence, that there was no myelopathy present<sup>24</sup>, but the sensitivity and reliability of the other tests were insufficient to exclude potential nerve root compromise at that time, despite negative testing. Limited reliability and low sensitivity values also did not allow for a confident ruling out of upper cervical ligament instability.

Segmental motion testing for pain has demonstrated moderate reliability and there is preliminary evidence indicating a level of validity. However, once again the

data was limited, not allowing for confident research-based decision-making. Despite noted postural deviations, the reliability of the visual posture assessment used is insufficient to add confidence to our diagnostic decision-making. The reliability of AROM testing is good indicating its relevance as an outcome measure; however, reasonable sensitivity but low specificity values limit the use of these measurements as either inclusion or exclusion criteria in patients with suspected cervical radiculopathy.

Although the production of upper extremity symptoms as a result of shoulder dysfunction was considered unlikely due to the bilateral nature of the complaints, the examining clinician performed testing to exclude potential shoulder problems with greater confidence. Due to symptoms reported distal to the elbow, adverse neural tension created by glenohumeral instability was ruled out. The exclusion of a labral lesion was done with confidence as a result of the combination of good test sensitivity and negative results (Table 7).

With the exacerbation of upper extremity paraesthesiae during overhead activity, TOS became a competing diagnosis. Three examination procedures were chosen based on their moderate diagnostic utility. All tests were negative except for hyperabduction, which produced paraesthesiae only (Table 7). TOS could not be confidently excluded due to the moderate sensitivity of the hyperabduction test, which was positive here (Table 7). Also, it has been recognized that a positive test as defined by pain production, vascular responses, and paraesthesiae is unreliable, and a high percentage of false positives have been found in healthy, asymptomatic individuals<sup>46,47</sup>. The interpretation of the test cluster for cervical radiculopathy was clearer as the patient possessed three of four variables indicating a positive likelihood ratio of 6.1. This likelihood ratio produced a moderate shift in post-test probability that the patient possessed cervical radiculopathy<sup>5</sup>.

The bilateral presence of symptoms in a median nerve distribution prompted the examining clinician to investigate the possible presence of carpal tunnel syndrome (CTS). The traditional tests chosen possessed

**Table 5:** Clinical utility of the cervical radiculopathy test item cluster<sup>5</sup>.

Number of Positive Tests	Positive Likelihood Ratio
2	0.88
3	6.10
4	30.30

**Table 6:** Clinical utility of the carpal tunnel syndrome clinical prediction rule<sup>48</sup>.

Number of Positive Tests	Positive Likelihood Ratio
2	1.1
3	2.1
4	4.6
5	18.3

excellent reliability in the CTS population and they were combined with a recent CPR by Wainner et al<sup>48</sup>. With two variables satisfied in this CPR, a +LR of 1.1 was produced (Table 6); this result did not produce a shift in post-test probability<sup>49</sup> for CTS. In combination with the clear test findings indicating cervical radiculopathy as responsible for the upper extremity symptoms, this suggested to the examining clinician that CTS could be ruled out (Table 7)<sup>51</sup>.

As noted above, the clinical utility of many of our examination procedures does not allow for confident inclusion or exclusion of competing diagnoses (Table 7). We therefore must cluster the best available evidence and proceed. In this case report, the utilization of a CPR produced a moderate shift in post-test probability that the definitive diagnosis was cervical radiculopathy. Despite our confidence in the diagnosis, this pathoanatomical label did not assist in treatment planning for the patient. Therefore, using a treatment-based classification system suggested by Childs et al<sup>52</sup>, the patient was classified into the mobility subgroup (hypomobile findings) to assist in intervention selection (Table 8). It should be noted that as of yet no research has been done to establish reliability and predictive validity of this classification system.

### Prognosis

According to the *Guide to Physical Therapist Practice*, 80% of patients with cervical radiculopathy should achieve expected outcomes within 8 to 24 visits over a 1 to 6 month time frame but research has not yet validated this diagnostic classification system<sup>53</sup>. As reported in a literature review on cervical radiculopathy<sup>3</sup>, up to 90% of individuals will improve with conservative treatment. Radhakrishnan et al<sup>54</sup> identified muscle weakness and

dermatomal sensory deficits as indicators of potential progression to surgical intervention in patients with cervical radiculopathy. The patient in this case report possessed neither of these variables possibly improving the prognosis for symptom resolution with physical therapy. The reported negative MRI findings also confidently excluded a morphological lesion resulting in radiculopathy, which would again indicate a lack of rehabilitation potential with conservative intervention<sup>6</sup>. A confounding comorbidity of mention was the presence of LBP, which has been shown to be a predictor of persistent neck pain<sup>55,56</sup> and might, therefore, be expected to impact the final outcomes.

### Intervention

The clinician chose to use a treatment-based classification approach<sup>52</sup> in the management of this patient's condition. Effective classification of patients has been shown to improve decision-making and outcomes in patients with LBP<sup>12,57</sup>. It should be noted that as of yet, similar evidence is not available for patients with neck pain and related upper extremity symptoms. However, this patient did not clearly fit into any of the neck pain subgroups (Table 8) identified by Childs et al<sup>52</sup>. Hypomobility was detected throughout the cervical and thoracic spine indicating classification in the mobility category. However, signs and symptoms of nerve root compression including peripheralization were also noted during ipsilateral cervical sidebending indicating possible classification in the centralization category. Despite the presence of peripheralization, the patient's symptoms did not centralize with manual cervical traction but rather returned to status quo with neutral head positioning. Therefore, the initial treatment strategy included interventions commonly used in the mobility subgroup and

Table 7: Competing diagnoses for neck and arm pain.

Shoulder Labral Lesion	Thoracic Outlet Syndrome	Cervical Radiculopathy	Carpal Tunnel Syndrome
Kim test (-)	Adson's test (-)	ULTT A (+)	Symptom severity scale (?)
Jerk test (-)	Costoclavicular maneuver (-)	Ipsilateral cervical rot. (+)	Hand-shaking relieves symptoms (-)
Active compression test (-)	Hyperabduction maneuver parasthesias (+) Pulse abolition (-)	Spurling's test A (+)	Age > 45 (+)
Biceps load test II (-)		Cervical distraction (-)	Wrist ratio Index >.67 (-)
			Decreased median nerve sensation in the thumb (-)

ULTT = upper limb tension test

**Table 8: Proposed classification system for patients with neck pain**

Classification	Examination Findings	Interventions
Mobility	<ul style="list-style-type: none"> <li>Recent onset of symptoms</li> <li>No radicular/referred symptoms</li> <li>Restricted ROM</li> <li>No signs of nerve root compression</li> </ul>	<ul style="list-style-type: none"> <li>Cervical/thoracic mobilization/manipulation</li> <li>AROM</li> </ul>
Centralization	<ul style="list-style-type: none"> <li>Radicular/referred symptoms</li> <li>Centralizes/peripheralizes with ROM</li> <li>Signs of nerve root compression</li> <li>May have diagnosis of cervical radiculopathy</li> </ul>	<ul style="list-style-type: none"> <li>Mechanical/manual cervical traction</li> <li>Repeated movements to centralize symptoms</li> </ul>
Conditioning and increase exercise tolerance	<ul style="list-style-type: none"> <li>Lower pain and disability scores</li> <li>Longer duration of symptoms</li> <li>No signs of nerve root compression</li> <li>ROM does not centralize/peripheralize symptoms</li> </ul>	<ul style="list-style-type: none"> <li>Strengthening/endurance exercises for neck and upper quarter</li> <li>Aerobic conditioning exercises</li> </ul>
Pain control	<ul style="list-style-type: none"> <li>High pain and disability scores</li> <li>Very recent onset of symptoms</li> <li>Symptoms precipitated by trauma</li> <li>Radiating/referred symptoms into upper quarter</li> <li>Poor tolerance for examination or interventions</li> </ul>	<ul style="list-style-type: none"> <li>Gentle AROM within pain free-range</li> <li>ROM to adjacent regions</li> <li>Physical modalities</li> <li>Activity modification</li> </ul>
Reduce headache	<ul style="list-style-type: none"> <li>Unilateral headache with onset precipitated by neck pain</li> <li>Headache pain produced by neck movement or positions</li> <li>Headache pain produced by pressure on the posterior neck</li> </ul>	<ul style="list-style-type: none"> <li>Cervical spine mobilization/manipulation</li> <li>Strengthening neck and upper quarter muscles</li> <li>Postural education</li> </ul>

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not the centralization subgroup.

Thoracic thrust manipulation techniques were performed following the initial examination. Unilateral, upper thoracic (T1-T4) extension techniques were performed on both sides (Figures 1 and 2), as well as middle thoracic (T5-T9) flexion techniques (Figures 3 and 4). Two manipulations were performed in each area, with each technique executed approximately 2 segments caudal from the first.

Following the initial examination and the thoracic thrust manipulation techniques, the patient was instructed in a home exercise program (HEP), which consisted of AROM exercises including quadruped spinal flexion/extension with the patient emphasizing thoracic motion (Figures 5 and 6), and cervical flexion in sitting. Ten repetitions of each were to be performed 3-4 times per

day with the intent of maintaining the ROM achieved during the treatment session. Compliance was confirmed through subjective reporting.

The patient was scheduled for follow-up sessions, 2 times per week for 4 weeks, for a total of 8 treatments. This schedule allowed the treating therapist to utilize thrust techniques to facilitate return of ROM early and to adjust the patient's home exercise program with a progression to self-management. A return follow-up visit was also scheduled 6 weeks after the final treatment session to determine if the positive effects of treatment had been maintained with the independent HEP.

Treatment during the second session included the identical manipulation techniques used on the first session as the patient related improvement in neck pain. However, despite the patient's improvement, segmental



*Fig. 1 & 2: Supine upper thoracic unilateral thrust manipulation. Place the thenar eminence of your open hand on the area of the facet joint, just to the side of the spinous process. Roll the patient into supine. Flex the patient's cervical spine to isolate motion to the upper thoracic spine. Push downward through the patient's arms onto your hand until the soft tissue slack is removed. Apply a high-velocity, low-amplitude thrust in an AP direction.*



*Fig. 3 & 4: Supine middle thoracic central thrust manipulation. Position your hand in a fist/pistol-grip position. Place your thenar eminence and third digit on the inferior vertebrae of the motion segment. Flex the patient up until you feel the above segment begin to move. Push downward through the patient's arms until the soft tissue slack is removed. Apply a high-velocity, low-amplitude thrust.*

motion assessment of the cervical spine revealed continued hypomobility in the lower segments. Unilateral lower cervical upglide (flexion) rotary thrust manipulations (Figure 7) were introduced on both sides to address the remaining cervical hypomobility. Deep neck flexor strengthening as well as AROM rotation bilaterally was added to the HEP during the second session (Figures 8 and 9).

The treatment approach outlined above was performed for 4 consecutive sessions as all outcome measures continued to improve (Tables 1 and 4). At the 6<sup>th</sup> visit, the patient's AROM had not improved from measurements taken at the prior session, and the treating clinician

identified the need to modify the treatment plan. The patient then received 2 sessions that focused on advancing her HEP to include maintenance of a neutral cervical spine posture while performing functional tasks including reaching, lifting, pushing, and pulling. Ergonomic workstation adjustments were also discussed as the patient was employed as a research physician and spent extended periods of time at a computer terminal. Modification included relocating all frequently used items (i.e., calculator, log book, etc) within arm's reach, and relocation of the computer monitor to decrease cervical extension and rotation. Finally, sleeping posture was discussed to avoid prolonged provocative positions.



*Fig. 5 & 6: Quadrupedal spinal flexion/extension. The patient arches the back upward concentrating on the thoracic spine. The thoracic spine is then relaxed downward and moved into the extended position.*



*Fig. 7: Lower cervical upglide/flexion rotary thrust manipulation. Sidebend the targeted segment towards the affected side. Rotate the targeted segment to the contralateral side. Assure end-range motion is not attained. Assure patient's comfort verbally. Perform a high-velocity, low-amplitude thrust further into rotation with the force directed diagonally in the plane of the facet.*

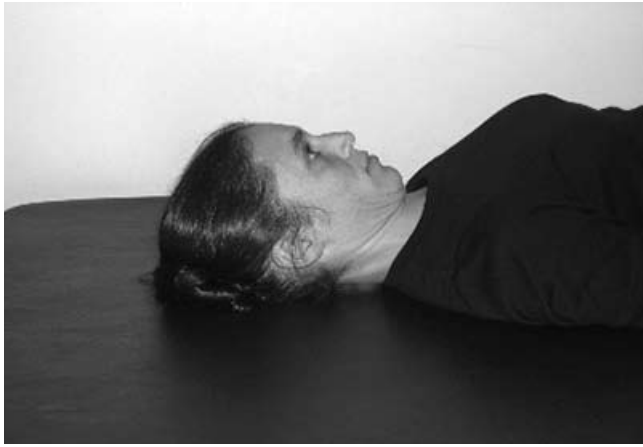
The treating clinician chose not to address the lumbar spine during the intervention phase due to a lack of identifiable impairments, most specifically symptom reproduction, during the examination. The patient's LBP occurred only with the addition of cervical spine flexion to the SLR test. The patient was discharged at the comple-

tion of 8 treatment sessions. All functional limitations were eliminated and she was independent with her HEP as demonstrated in the clinic. The patient was scheduled for a follow-up visit in 6-weeks to assess progress with only the home program and advice provided.

### **Outcomes**

Outcome measures used in this case report included a combination of impairment- and function-based measures. Impairment-based measures included AROM (Table 4) of the cervical, thoracic, and lumbar spine measured with an inclinometer. We discussed above an MDC of 9-16° for this measure in neck patients<sup>38</sup>. Based on these MDC values reported by Piva et al<sup>38</sup>, a true difference in AROM occurred for cervical flexion and left rotation, with right rotation approaching MDC. Bilateral cervical sidebending and extension did not surpass the MDC and, therefore, the change in AROM was considered insignificant<sup>38</sup>.

Functional measures utilized included the NDI, modified ODI, NPRS, and the global rating of change scale (GROC). As noted above, the MCID for the NDI has been established as 14% and the MCID for the modified ODI and NPRS are 8-12% and 2 points, respectively<sup>13,14,18</sup>. The GROC scale was utilized to measure between-session changes<sup>58</sup>. The GROC is a 15-point rating scale ranging from 0 ("about the same") to +7 ("a very great deal better") or -7 ("a very great deal worse")<sup>58</sup>. It has been recommended that scores on the GROC between +/- 3 and +/- 1 be considered small changes. Scores between +/- 4 and +/- 5 represent moderate changes, and scores of +/- 6 or +/- 7 large changes<sup>58</sup>. The MCID for the GROC was established as a change of +/- 3 in patients with chronic heart and lung disease<sup>58</sup>. This scale has not been validated in the neck pain population at this time.



*Fig. 8: Deep neck flexor re-education. The patient is instructed to rotate the head on the neck by looking down towards the chest. The chin tuck position is avoided. The treating clinician minimizes sternocleidomastoid activation via palpation and verbal instruction.*

As seen in Table 1, the MCIDs of all function-based outcome measures were surpassed by the 4<sup>th</sup> treatment session with further gains occurring by the 8<sup>th</sup> treatment session. The improvements were maintained at the 10-week follow-up with slight reductions in the ODI and lumbar GROG; however, these reductions were minimal and did not surpass the MCID. Hence clinically significant change was maintained.

## Discussion

The purpose of this case report was to describe the clinical decision-making process used in the diagnosis and management of a patient with neck and upper extremity symptomatology. Through the use of the best available evidence, the patient was diagnosed, classified, and treated in a seemingly efficient and effective manner. Four valid, reliable, and responsive function-based outcome measures for patients with neck and back pain were chosen, and all indicated clinically significant change by exceeding the MCID established for these measures. All functional limitations (asterisk signs) documented during the initial examination were eliminated as well as neck and low back pain and upper extremity paraesthesiae.

This patient presented with signs and symptoms indicative of bilateral cervical radiculopathy, as identified by the test item cluster with established diagnostic accuracy<sup>5</sup>. Cervical sidebending with overpressure reproduced ipsilateral upper extremity paraesthesiae as well as neck pain. Supine cervical flexion in conjunction with SLR testing reproduced her low back pain. However, provocative and segmental motion assessment of the lumbar spine was negative; therefore, the clinician did



*Fig. 9: Cervical AROM. Four fingers are placed between the chin and the sternum. The patient rotates the cervical spine in both directions while maintaining contact with the fingers. Fingers are sequentially flexed out of the way to allow for greater degrees of cervical flexion.*

not directly treat this area but rather monitored the patient's low back symptoms. As a result of all symptoms being reproduced by examination of the cervical spine, the treating clinician initially targeted this area for treatment.

Research has identified a biomechanical link between the cervical and thoracic spine<sup>59</sup>. Passive segmental mobility testing identified limitations throughout the lower cervical and middle/upper thoracic spine in this patient. Immediate cervical AROM gains and decreased pain have been achieved in patients with neck pain through treatment of the thoracic spine with thrust manipulation<sup>60,61</sup>. Additionally, it has been shown that a multi-modal treatment program, including thoracic spine thrust manipulation, is beneficial in the management of cervical radiculopathy<sup>4,62</sup>. Therefore, the treating clinician decided to first address the middle/upper thoracic region.

Central and unilateral thoracic thrust manipulations were directed at the middle and upper thoracic spine following the initial examination (Figures 1-4). The locations of the techniques were determined based upon postural presentation and hypomobility identified during the examination. However, recent evidence suggests that the particular direction of the technique used may not alter the patient outcome<sup>63,64</sup>. Rather, it may simply be the introduction of motion that produces the results. Data also indicates that segmental specificity of techniques in the thoracic spine is likely nothing but a hypothesis; Cavitation has been shown to occur on average 3.5 cm from the targeted segment<sup>65</sup>. Hence, rather than attempting a segment-specific thrust intervention, two manipulations were performed in each area, with each

technique executed approximately 2 segments caudal from the first. Positive results were achieved with the techniques demonstrated by a 2-point reduction in cervical pain, which met the MCID of the NPRS scale used to measure the patient report of pain<sup>13</sup>. This indicated that a true and meaningful change in the patient's status had occurred<sup>58</sup>.

Evidence indicates that within-session changes are predictive of between-session changes in patients with cervical pain: The odds ratio for between-session changes based on changes occurring within a preceding session has been reported as 4.5<sup>66</sup>. Therefore and also to maximize patient outcomes<sup>59,60</sup>, the treating clinician continued to use the same thrust manipulation techniques at the follow-up visits. By the completion of 4 treatment sessions, the patient exceeded the MCID on the NPRS (3/10 score), the NDI (16% improvement), the modified ODI (14% improvement), and the GROC (+5 change), indicating true and meaningful change in patient status<sup>13,14,18,58</sup>.

The decision to incorporate thrust manipulations to the cervical spine on the patient's second visit was based upon the continued presence of hypomobility and pain provocation during segmental assessment of the lower cervical spine. VBI and cranial nerve testing as well as a comprehensive neuroconductive exam were all negative: No red flags or contraindications to manipulation were noted. In light of the absence of relevant findings with examination and the extremely low reported incidence rates of adverse events<sup>67</sup>, the clinician decided to target the hypomobile segments of the lower cervical spine with thrust procedures (Figure 7). Haas et al<sup>68</sup> reported that determining a cervical segmental level to manipulate using a thrust technique based on examination findings has not been shown to produce superior results over randomly selecting a targeted segment. However, the treating clinician felt that the combination of postural deviation (lower cervical extension, upper thoracic flexion, and mid-thoracic extension), and positive findings on segmental provocation and mobility testing were an adequate indicator of the area to treat. Evidence has demonstrated that thrust manipulation of the cervical spine is most beneficial for patients with mechanical neck disorders when combined with exercise<sup>69</sup>; therefore, cervical AROM and deep neck flexor strengthening were added to the HEP at that point (Figures 8 and 9).

The outcome measures used continued to demonstrate clinical improvement with the addition of these cervical thrust techniques (Table 1 and 4). Inclinometric AROM measurements supported the interventions chosen. By the 4<sup>th</sup> treatment session, cervical flexion and left rotation surpassed the MDC for this tool while right rotation approached clinical significance (Table 4)<sup>38</sup>. However, between treatments 5 and 6, AROM did not improve (Table 4, week 3). Once this plateau was noted with regard to progress in AROM, the manual therapy

interventions ceased and the treatment was modified to include ergonomic and sleeping posture adjustments. At the completion of 8 treatment sessions, the patient scored a 0 on the NPRS, with 0% disability as measured by both the ODI and NDI (Tables 1 and 4). The patient's AROM was fully restored and she no longer reported any functional limitations as indicated by questions with regard to the asterisk signs established at the initial evaluation.

Provocative and segmental motion assessment of the lumbar spine was negative during the initial examination. Coupled with the fact that the patient did not report any functional limitations during the history-taking due to LBP, the clinician did not directly treat this area. We hypothesized that the gravity-eliminated supine position in which the SLR was performed may have allowed for a more provocative assessment of the dural system in the absence of the protective reactions that may have been present during the seated test and that perhaps resulted in the negative slump test. The addition of cervical flexion may simply have indicated a dural restriction at some point in the system; the examination findings led the treating clinician to believe that this restriction may have been in the cervical or thoracic spine rather than the lumbar spine. Despite the lack of direct treatment, the patient's low back symptoms were monitored by way of the modified ODI to determine if the above-mentioned hypothesis was true. LBP has been shown to be a predictor of persistent neck pain, and failure to improve would, therefore, have indicated a need for the clinician to again assess and perhaps address the lumbar spine. Results indicated notable gains in both cervical and thoracic ROM with small gains in the lumbar spine (Table 4). Although the patient did not report functional limitations due to the low back, the modified ODI noted limitations, and by the end of treatment, there was a complete resolution of disability. Although lumbar ROM gains may not always correlate with functional improvement<sup>70</sup>, in this case both clinical improvement and functional gains were noted.

Despite reported inconsistencies with regard to HEP compliance at the 6-week follow-up, the patient continued to maintain the improvements in pain, ROM, function, and disability. A slight reduction in the scores on the GROC and the ODI measures was noted (Table 1). However, the negligible regressions in status did not surpass the MCID of the scales that would have indicated a worsening of status, and they were attributed by the patient to her lack of compliance with the HEP as instructed. The patient was discharged from therapy and verbally reported complete satisfaction with the results.

Current best evidence was utilized to guide decision-making with regard to PT diagnosis and management throughout this patient's course of treatment. We achieved excellent outcomes as demonstrated by a change in all 4

functional outcome measurements (NPRS, GROC, NDI, ODI), which all surpassed the MCID, thus indicating a true and clinically meaningful difference in functional status. One inherent limitation of a case report is the inability to determine a cause-and-effect relationship. Future studies should investigate the most effective diagnosis and management strategies for patients presenting with concurrent neck and upper extremity symptoms.

## Conclusion

Individuals presenting with both neck and upper extremity pain are commonly seen in outpatient orthopaedic PT clinics. This case report demonstrated the use of the current best available evidence to establish a diagnosis and subsequently classify a patient with persistent neck pain, bilateral upper extremity paraesthesiae, and concurrent LBP in a proposed but as of yet not validated treatment-based classification system for patients with neck

pain. Thrust manipulations to the cervical and thoracic spine combined with an AROM home exercise program as suggested for patients in the mobility category of this treatment-based classification system were administered with excellent outcomes in cervical ROM, pain, and disability for the patient in this case report. Our attempts to utilize the best available evidence during all phases of care indicated and identified gaps in evidence with regard to evidence-based diagnosis and management of patients with neck and upper extremity complaints. Evidence gaps identified by this case report were many and included VBI testing, ligamentous instability testing, neuroconductive testing, treatment-based classification for neck pain, and the interaction of neck and low back pain. Because of this, best practice still demands the integration of clinician expertise and pathophysiological rationale with best available evidence where research evidence to guide diagnosis and management of this patient category is unavailable. ■

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