

# Inclusion of Mechanical Diagnosis and Therapy (MDT) in the Management of Cervical Radiculopathy: A Case Report

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**Abstract:** Various interventions are used by physical therapists to treat neck conditions. Treatments may include exercises based on a direction of preference, cervical spine stabilization, neuromobilization, or traction. The purpose of this case study was to describe the use of mechanical diagnosis and therapy (MDT) in the management of a patient diagnosed with cervical radiculopathy. The case study involved a 39-year-old male (subject), classified with cervical derangement, hypermobility, and adverse neural tension. The subject's intervention included MDT, deep neck flexor muscle strengthening, and neuromobilization. This subject's scores on the Neck Disability Index, Numerical Pain Rating Scale (NPRS), and range of motion were assessed at initial examination, discharge, and 3-month follow-up. The subject improved on all outcome measures and was discharged after four visits with a NPRS of 0/10. Percent improvement per visit was 17.5%. This case describes a positive outcome for a patient diagnosed with cervical radiculopathy in which MDT, deep neck flexor strengthening, and neuromobilization were used as an alternative to cervical traction.

**Key Words:** Cervical Spine Stabilization, Direction of Preference, Exercise, Traction

Neck or cervical pain has a prevalence of 67% among young adults and comprises approximately 1% of costs of total health care expenditures<sup>1</sup>. Of the total patients seen in outpatient physical therapy, 25% are referred for treatment for cervical pain<sup>2</sup>. In terms of mechanism of injury, motor vehicle accidents often result in a chronic cervical dysfunction known as whiplash associated disorder<sup>3</sup>.

Physical therapists may recommend patient-specific treatments for cervical spine pain, or may use a more generalized protocol for management. Treatments may include physical agents, isometric exercises, stretching, and traction<sup>4</sup>. A derangement of the intervertebral disc may lead to a cervical radiculopathy, a condition that can negatively affect mental and physical function<sup>5</sup>.

Although the anatomical source of cervical spine pain can be difficult to determine, classification of the condition

may give direction to intervention. An approach based on responses to repeated end range movements to determine a direction of preference is mechanical diagnosis and therapy (MDT). MDT was previously referred to as the McKenzie approach, which was developed by Robin McKenzie, and involves classifying the patient's condition into postural, dysfunction, or derangement categories based on the patient's responses to repeated end range movements<sup>6,7</sup>. The derangement classification is characterized by the determination that certain repeated movements cause symptoms to become magnified, centralized, reduced, or abolished (Table 1). Those movements that produce or intensify the pain are avoided until the derangement has stabilized. The treatment for the derangement classification involves postural correction and the performance of those repeated movements that improve symptoms. The direction of movement and exercises that produce a favorable response are referred to as the patient's *direction of preference*<sup>8</sup>. A treatment protocol for cervical derangement based on determining a direction of preference has been shown to positively effect the impairments associated with this condition in six weeks<sup>9</sup>. The operational definition of direction of preference used in this study is *an imme-*

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**TABLE 1. Mechanical Diagnosis and Therapy (MDT) Classification Model.<sup>6,7</sup>**

<b>Cervical Spine Derangement Classifications</b>	<b>Symptoms</b>	<b>Key Test Findings</b>
Derangement #1	Central, symmetrical	Worse with cervical flexion/protrusion, better with retraction, retraction with extension No deformity
Derangement #2	Central, symmetrical, symptoms may be referred to scapulae	Worse with cervical flexion/protrusion, may be better with unloaded retraction or retraction with extension Deformity of decreased cervical lordosis
Derangement #3	Unilateral, asymmetrical, symptoms proximal to elbow	Worse with cervical flexion/protrusion, better with retraction, retraction with extension or sidebending or rotation to same side of symptoms No deformity
Derangement #4	Unilateral, asymmetrical, symptoms proximal to elbow	Worse with cervical flexion/protrusion, may be better with sidebending or rotation to same side of symptoms Deformity of torticollis
Derangement #5	Unilateral, asymmetrical, symptoms below elbow	Worse with cervical flexion/protrusion, better with retraction, retraction with extension or sidebending, and rotation to same side of symptoms (unloaded) No deformity
Derangement #6	Unilateral, asymmetrical, symptoms below elbow	Worse with cervical flexion/protrusion, may be better with sidebending or rotation to same side of symptoms Deformity of torticollis
Derangement #7	Central, symmetrical, may be asymmetrical or unilateral	Worse with cervical extension/retraction, better with cervical flexion, protrusion

*diate, lasting improvement in pain from performing either repeated flexion, extension, or sideglide/rotation tests<sup>8</sup>.*

The purpose of this case study was to describe the use of mechanical diagnosis and therapy (MDT) in the management of a patient diagnosed with cervical radiculopathy. Presently, there is little research to support the use of directional exercises, stabilization, and neural-directed treatments in reducing symptoms associated with this diagnosis.

### Case Description

The patient in this case study was a 39-year-old male, who was examined and treated in an outpatient physical therapy clinic of the Catholic Health System (CHS) in Buffalo, New York. The patient met three of the four inclusion criteria for cervical radiculopathy based on the test-item cluster identified by Wainner et al<sup>11</sup>. The test-item cluster includes positive upper limb tension (ULTT), Spurling's compression test, the distraction test, and cervical rotation less than 60 degrees. Of the four inclusion criteria, the patient demon-

strated positive findings for the ULTT, Spurling's compression test, and the distraction test.

The patient's initial examination (IE) consisted of completion of functional questionnaires, subjective examination, and testing of active, repeated, passive movements, strength, and neurological and special tests including adverse neural tension testing.

### History and Interview

The patient described the onset of symptoms as insidious, but upon further questioning, he reported an accident 4 months prior to the IE where he fell off his motorcycle striking the right side of his head without loss of consciousness. He acknowledged he had been wearing a helmet and did not experience neck or arm pain at that time. The patient did not receive medical management for this incident and continued his regular work-related and household activities. He denied pertinent, prior medical, or surgical history related to this incident.

## Present History

Symptoms at the time of IE were aggravated by sitting greater than 10 minutes, driving greater than 20 minutes, as well as turning the head to the left, looking overhead, and reading. Symptoms were relieved by lying supine with the head supported on a pillow. The pain occasionally would wake the patient up at night if he awoke with his neck rotated to the left.

## Prior History

The patient reported receiving chiropractic manipulation to the cervical spine for previous episodes of neck pain. The patient did not seek chiropractic for the presenting episode due to the symptoms radiating to the left upper extremity.

## Behavioral

The patient was concerned that he would not be able to return to coaching high school wrestling in the upcoming season. He did feel that if his present complaints remained unchanged, he would be able to continue his regular employment as a physical education teacher. At the time of the IE, he was not participating in an exercise routine.

## Medications

The patient indicated he self-administered Tylenol for pain as needed.

## Structural Examination

A forward head posture characterized by flexion of the mid-lower cervical spine and extension of the upper cervical spine was present.

## Active Movements

Active cervical spine flexion, extension, and sidebending were measured with an inclinometer, and a standard goniometer was used to measure cervical spine rotation. The range was noted in degrees, and the patient's response to these single movements was also noted (Table 2). Pain during movement (PDM), end range pain (ERP), and peripheralization were among the responses described by the patient.

## Repeated Movements

The purpose of testing repeated motions includes determining a classification and a direction of preference for exercise and patient self-management<sup>7-9</sup>. End range repeated movements were performed by the patient in weight-bearing and non-weight-bearing positions. A baseline assessment of symptoms was determined prior to the performance of each repeated motion, during the performance of that particular motion, and following completion of 10 repetitions of the movement; that assessment is reported in Table 3. Cervical rotation left caused a peripheralization of symptoms, but this response did not occur when the left upper extremity was maintained across the chest (with the elbow flexed and shoulder adducted), indicating possible adverse neural tension. Repeated rotation left of the cervical spine caused centralization of symptoms to the cervical region when the left shoulder was maintained in this position.

## Passive Intervertebral Motion

Passive intervertebral motion of the cervical spine was performed via a translatory sideglide assessment in supine. Hypermobility was noted in sidebending left at the C5-C6 segment<sup>12</sup>.

**TABLE 2. Active cervical spine movements of the patient during the initial examination.**

Motion	Range in degrees	Patient Response
Flexion	60	*PDM and ERP (posterior lower cervical)
Extension	70	Peripheralized symptoms to left upper extremity at end range
Right sidebending	45	No effect
Left sidebending	80	Peripheralized symptoms to left upper extremity at end range
Right rotation	80	No effect
Left rotation	75	Left cervical ERP

PDM = pain during motion; ERP = end range pain

**TABLE 3. Active range of motion and repeated movements of the cervical spine.**

<b>Motion</b>	<b>AROM</b>	<b>Response following one repetition</b>	<b>Repeated movement response</b>
Protrusion	N/A	No effect	No effect
Retraction	N/A	Increased ERP (lower cervical)	Increased ERP, peripheralized to left upper extremity
Retraction with extension	N/A	Increased ERP (lower cervical)	Increased ERP, peripheralized to left upper extremity
Flexion	60 degrees	Increased lower cervical	Worse lower cervical
Right sidebending	45 degrees	No effect	No effect
Left sidebending	80 degrees	Same as retraction with extension response following 1 rep	Same as retraction with extension repeated movement
Right rotation	80 degrees	No effect	No effect
Left rotation	75 degrees	No effect	Centralized left upper extremity symptoms to cervical with left arm across chest
Non-weightbearing retraction	N/A	Increased ERP (lower cervical)	Increased ERP, peripheralized to left upper extremity
Non-weightbearing retraction with extension	N/A	Increased ERP (lower cervical)	Increased ERP, peripheralized to left UE

PDM = pain during motion; ERP = end range pain; N/A =not applicable

### *Neurological Testing*

Neurological testing of the patient included testing dermatomes, myotomes, and muscle stretch reflexes. The patient was found to demonstrate 4/5 strength in the left C6 myotome (weakness in comparison to the right), and the left biceps muscle stretch reflex was hypoactive. The left median upper limb tension test (ULTT2-median) was found to be positive at 130-20 degrees elbow extension, indicating a pain response (P1) at 20 degrees from full elbow extension as the elbow was extended from a flexed position. This test was repeated on the uninvolved side and full elbow extension was achieved without encountering a pain response or resistance to further motion<sup>12</sup>.

### *Special Tests*

Special tests chosen for this patient included tests for cervical compression (Spurling's compression test), distraction, adverse neural tension, and deep neck flexor strength. Spurling's compression test is used to identify cervical radiculopathy and is performed from the seated position with the pa-

tient's neck in side-flexion and slight rotation to the painful side while a gentle compression force is applied through the top of the head to narrow the intervertebral foramen. Cervical distraction is also used to identify cervical radiculopathy and was performed with the patient supine. While gently grasping under the chin and occiput, the physical therapist flexed the subject's neck to a comfortable position and gently applied a distraction force. The adverse neural tension test was performed with the patient supine. The examiner sequentially introduced the following movements to the symptomatic upper extremity as described by Wainner et al<sup>11</sup>: (1) scapular depression, (2) shoulder abduction to 90 degrees with the elbow flexed, (3) forearm supination, and wrist and finger extension, (4) shoulder lateral rotation, (5) elbow extension. A positive test is found with reproduction of the complaint, difference in elbow extension greater than 10 degrees, or, as in the case of this subject, if ipsilateral sidebending decreases the patient's symptoms<sup>11</sup>. The positive Spurling's compression test, relief of symptoms with distraction, and positive ULTT fit three of the test-item cluster identified by Wainner et al<sup>11</sup>.

Deep neck flexor strength was assessed through the use of a stabilizer cuff. The stabilizer cuff (Stabilizer, Chatta-

nooga Group Inc, Chattanooga, TN) is a pressure biofeedback unit designed to indirectly assess the function of the longus colli and longus capitus muscles. The patient was positioned in supine hooklying with the cervical spine in a neutral position. The pressure biofeedback unit was positioned under the occiput and inflated to 20 mmHg. The patient was then instructed to perform a craniocervical flexion movement without superficial muscle activity. He was unable to maintain this position for greater than 10 seconds with the stabilizer cuff inflated to 22 mmHg<sup>2</sup>.

### *Functional Assessment*

LIFeWare<sup>SM</sup> Functional Questionnaire® (Uniform® Data System for Medical Rehabilitation, Amherst, NY) and the Neck Disability Index (NDI) were utilized in this case study to identify the outcomes of physical functioning, pain experience, affective well-being, and neck pain affecting overall activities. Aspects of validity of the 31-item LIFeWare<sup>SM</sup> musculoskeletal assessment form® were investigated during comparison with the Medical Outcomes Trust SF-36® and were found to have good validity<sup>13</sup>. The reliability and validity of the NDI has been established by Vernon and Mior<sup>14</sup>.

The subject completed the LIFeWare<sup>SM</sup> questionnaire to evaluate his physical function, pain experience, and well-being. This form was completed at the beginning of the initial examination and at the time of discharge. At the time of the IE, the subject rated his pain experience on the LIFeWare<sup>SM</sup> as 30/100 (100 indicating complete absence of pain).

### *Neck Disability*

The patient completed a NDI questionnaire to evaluate his perceived level of disability in relation to his neck complaints. The patient rated his perceived level of disability in relation to neck pain as 28% at the IE.

### *Pain Assessment*

The patient described left cervical spine pain with radiation to the radial aspect of the left forearm of 2 months duration. He illustrated his symptoms as intermittent and rated symptoms as 8/10 on the Numerical Pain Rating Scale (NPRS). The 11-point NPRS ranges from 0 (“no pain”) to 10 (worst pain imaginable). A previously explored minimal clinically important difference (MCID) for the lumbar spine has been reported to be 2 points<sup>15</sup>. We are unaware of an MCID for the NPRS specific to the cervical spine.

### *Clinical Impression*

This patient’s signs and symptoms were consistent with cervical radiculopathy. He was classified with a unilateral asym-

metrical derangement (previously posterior derangement #5) and hypermobility in sidebending left at C5-C6. Also significant was the finding of adverse neural tension with the positive adverse neural tension test. Based on his response to the clinical examination procedures, his outcome prognosis was good.

### *Plan for Intervention*

The patient’s impairments were summarized, and the impairment’s relationship to the patient’s perceived level of function was described. The assessment was explained on the basis of a classification according to signs and symptoms rather than a tissue pathology diagnosis. The treatment plan was outlined and consisted of the performance of repeated end range spinal movements in the direction of preference, stabilization, neuromobilization, and addressing those postures that reproduced the complaint.

### *Intervention: Mechanical Diagnosis and Therapy (MDT)*

Consistent with the MDT approach and finding a direction of preference for exercise, the patient was instructed in repeated cervical retraction with rotation left with the left arm maintained across the chest to reduce adverse neural tension. These exercises were performed while the patient maintained an upright sitting position at home and in the clinic. The parameters for this exercise were 10 repetitions of the exercise on an hourly basis. The process of centralization was progressed via manual overpressure (Grades I-III) to the C5-C6 segment. Since this was found earlier to be a hypermobile segment, mobilization grades I-III were performed progressively in sets of 10 repetitions to allow for close monitoring of the patient’s response. MDT also utilizes therapist-generated forces (non-thrust and thrust manipulation) when the patient plateaus with patient-generated forces (exercise)<sup>7</sup>. Once symptoms centralized, the patient was progressed to neck retraction in sitting, and neck retraction with extension in sitting. At the time of discharge from physical therapy, the patient was performing neck retraction with extension in sitting for 10 repetitions hourly.

### *Intervention: Postural correction*

Postural correction is an intervention inherent to MDT. The patient was instructed to perform a slouch/overcorrect exercise for 10 repetitions daily at home. This involved maintaining a neutral lumbar lordosis in sitting for 30 seconds, followed by a 5-second period of rest in a slouch position. The patient was also instructed in the use of a lumbar roll in sitting at his desk, in his chairs at home, and in his car.

## Stabilization

A critical factor in management of cervical derangement is avoidance of aggravating movements or postures. When appropriately applied, stabilization exercises should not produce spinal movement in the painful portion of the range of motion. Strengthening of the deep neck flexor muscles initially involved instruction in performance of a nodding of the chin (upper cervical flexion) in the supine position. The stabilizer was placed in the cervical lordosis and the patient watched the dial on the device to assist in providing feedback regarding correct performance. Once he was able to perform the exercise correctly in supine, he later progressed to performing the exercise in standing. The established parameters were 3 sets of 10 repetitions performed on a daily basis. Progression was followed by performance of the same exercise in pronelying and finally progressing to a sitting position performing the deep neck flexor contraction movement with head in neutral. Eventually, the patient was performing 3 sets of 10 repetitions of the deep neck flexor exercise in the supine, standing, sitting, and prone as a home exercise<sup>16</sup>.

## Intervention: Neuromobilization

Patients diagnosed with cervical radiculopathy often present with adverse neural tension. Indication of adverse neural tension in this case included the positive ULTT and the finding that symptoms did not peripheralize with rotation left with the left upper extremity maintained across the chest. As the symptoms centralized, it was felt that the patient might be a candidate for neuromobilization. On the second visit in physical therapy, the patient received neuromobilization of the left median nerve in the supine position. This was based on the results of the ULTT1-median<sup>12</sup> for 5 sets of 10 oscillations. Table 4 summarizes the treatment interventions.

## Outcomes

The patient had outcomes assessed via the LIFEware<sup>SM</sup> assessment tool, NDI, NPRS, and the number of physical and therapy treatment sessions. The patient was discharged from physical therapy 5 weeks following the initial examination. At the time of discharge and at a 3-month follow-up, the patient reported scores of 0 on the NPRS and the NDI. The results indicated a positive trend toward favorable outcomes as the results met the clinically important difference for the NPRS (8-0) and NDI (28-0).

LIFEware<sup>SM</sup> scores were configured into tables and graphs through the computerized LIFEware<sup>SM</sup> analysis system. Data were collected from the initial treatment session, at the time of discharge, and at the 3-month follow-up. The LIFEware<sup>SM</sup> data showed an improvement in the *Pain Experience* section from 30 to 100, with higher numbers representative of less pain.

The overall improvement within each treatment session was calculated and expressed as a percentage. The percentage improvement was determined by subtracting the discharge pain scale on the LIFEware tool from the initial pain scale, and then divided by the number of treatment sessions. Analysis of the LIFEware<sup>SM</sup> data indicated that the improvement per visit was 17.5%.

## Discussion

The objective of this case study was to describe the use of mechanical diagnosis and therapy (MDT) in the management of a patient diagnosed with cervical radiculopathy. Outcomes were assessed based on the LIFEware<sup>SM</sup> assessment tool, NDI, NPRS, and the number of physical therapy treatment sessions.

**TABLE 4. Summary of treatment interventions used in this case study.**

Intervention	Visit 1	Visit 2	Visit 3	Visit 4
Postural education	Performed	Performed	Performed	Performed
Repeated movements	Neck retraction with rotation left (left arm across chest)	Neck retraction with extension supine	Neck retraction with extension sitting	Repeated cervical flexion for recovery of function
Non-thrust manipulation		Left C5-C6 rotation non-thrust		
Cervical spine stabilization		Deep neck flexor training supine	Deep neck flexor sitting, standing	Deep neck flexor prone
Neuromobilization		Left median nerve bias	Left median nerve bias	

Cervical radiculopathy was the referred diagnosis for the patient. This diagnosis is often associated with increased treatment sessions as well as with a significant number of treatment failures resulting in cervical spine surgery<sup>16</sup>. Although cervical traction is often employed to reduce the peripheral complaints associated with radiculopathy, that particular intervention does not necessarily foster the adoption of postures and exercises that can be used to prevent recurrence<sup>16</sup>.

Abdulwahab et al<sup>6</sup> conducted a study of 13 patients who presented with C7 radiculopathy. Each patient performed neck retractions. The results of the study supported the concept that performing neck retractions may promote cervical root decompression and may reduce radiculopathy symptoms<sup>6</sup>. Although clinicians may attempt neck retraction in patients with peripheral complaints, symptoms that are unilateral or asymmetrical may not respond to sagittal plane movements<sup>7</sup>.

Classification allows clinicians to develop directed and specific treatment interventions based on individualized signs and symptoms. In this case study, the patient performed repeated end range spinal movements based on the classification of derangement and according to a direction of preference. When the patient's symptoms failed to centralize with neck retraction, neck retraction with rotation was attempted. This repeated movement was found to centralize symptoms when the left upper extremity was maintained across the chest to reduce adverse neural tension. The MDT classification system may allow for further investigation into determining a direction of preference in reducing symptoms when the symptoms are unilateral or asymmetrical, which is emblematic in cases of cervical radiculopathy.

MDT provides individuals the ability to self-treat by determining a direction of preference and maintaining correct postures. As demonstrated in this case report, MDT may be preferable to cervical traction because of MDT's emphasis on fostering patient independence. These factors, combined with this patient's adherence to the stabilization exercise program, may account for the fact that his improvement was maintained over a 3-month period<sup>18-23</sup>.

When this patient's unilateral symptoms centralized, stabilization exercises were initiated. A study conducted by Falla et al<sup>18</sup> evaluated the superficial neck musculature fatigability

in 10 patients with unilateral neck pain. The investigators compared EMG activity of the superficial neck musculature on the pain-free side to the painful side and concluded that superficial muscles fatigue occurs in individual experiencing neck pain and the fatigue may also contribute to the pain<sup>18</sup>.

Jull et al<sup>19</sup> investigated the deep neck flexor performance during craniocervical flexion in individuals with neck pain secondary to whiplash injuries. The control group included individuals without cervical spine pathology. The majority of these individuals performed craniocervical flexion with minimal contraction of the superficial neck musculature (sternocleidomastoid and anterior scalenes). Correct performance of stabilization exercises is consistent with MDT in that aggravating movements or postures are avoided early in management. Activation of the deep neck flexors may occur with maintaining correct postures<sup>19</sup>. Although not typically considered a stabilization approach, MDT may also have had a stabilizing effect in this patient due to its emphasis on posture.

### Limitations

Multiple factors limit the ability to generalize results of this study to the population of patients who are diagnosed with cervical radiculopathy, including differences in gender, race, ethnicity, and study design. The findings of this case study may be applicable to this patient only.

## Conclusion

This case report introduces the use of repeated cervical spinal end range movements (MDT) in the treatment of cervical radiculopathy. The combination of MDT, stabilization, and neuromobilization may be considered an integrative approach in the physical therapy management of this diagnosis. Although causality is not possible through a case study, determination of a direction of preference and subsequent use of exercises with neuromobilization and stabilization may have been useful in the reduction in this patient's symptoms and an improvement in his function. At a 3-month follow-up, the patient continued to describe full function on the NDI and rated his symptoms as 0/10 on the NPRS. ■

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