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**The Effects of Neuromobilization Combined With Posture Training in the
Management of a Patient with Cervical Radiculopathy:**

A Case Report

Courtney Naimi

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The patient signed an informed consent allowing the use of medical information and
video footage for this report and received information on the institution's policies
regarding the Health Insurance Portability and Accountability Act.

The author acknowledges Noel Squires, DPT for assistance with case report
conceptualization and Julia Okuly, PT, MS, FAAOMPT for supervision and assistance
with photos.

24 **ABSTRACT**

25 **Background and Purpose:** Management of cervical radiculopathy can include cervical
26 traction, neural mobilization, manual therapy, and therapeutic exercise, whereas
27 management of lateral epicondylitis can include eccentric tendinopathy management,
28 manual therapy, and therapeutic exercise. Some evidence exists discussing
29 neuromobilization for the management of axial diagnoses. However, there is sparse
30 literature describing neuromobilization for management of both the presence of right C7,
31 C8 radiculopathy and contralateral lateral epicondylitis. Therefore, the purpose of this
32 case report is to discuss the outcomes of neuromobilization techniques for a patient
33 presenting with right C7, C8 cervical radiculopathy with contralateral lateral
34 epicondylitis.

35 **Case Description:** A 64-year-old male satisfied the clinical prediction rule for right C7,
36 C8 radiculopathy and contralateral epicondyle pain. Management of C7, C8 included
37 manual therapy, stretching, strengthening exercises and neuromobilization techniques.
38 Management of lateral epicondylitis on the left side included manual therapy, eccentric
39 strengthening, and patient education.

40 **Outcomes:** Improvements from baseline to discharge were noted. The QuickDash score
41 improved from 15% to 6.8%. Visual Analog Scale gains were reported from 8/10 to 3/10
42 at the time of his discharge, and the Neck Disability Index revealed no change with 4%
43 disability at both the initial examination and discharge. The patient's examination showed
44 C7, C8 myotomal weakness and dermatomal parasthesia. Lateral Epicondylitis improved
45 with increased grip strength from 32.5kg to 35 kg and the patient's symptoms declined,
46 with improved function following six therapy sessions.

47 **Discussion:** The results of this case report suggest that neuromobilization along with
48 manual therapy, therapeutic exercise, and education, may be beneficial for the
49 management of cervical radiculopathy and contralateral lateral epicondylitis.
50 Nonetheless, ongoing studies are needed to further investigate the management of both of
51 these diagnoses.

52 (Manuscript word count: 3,496 words)

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70 **Background and Purpose**

71 The objective of nerve tension stretching, often referred to as neuromobilization,
72 is to attempt to restore the dynamic balance between the relative movements of neural
73 tissues and surrounding mechanical interfaces, thereby allowing reduced intrinsic
74 pressures on the neural tissue. By doing so, this will promote optimum physiologic
75 function.¹ Literature has shown that patients complaining of neck pain that have
76 undergone nerve tension stretching have exhibited significantly greater improvements in
77 range of motion.² This intervention is part of the clinical practice guideline for treating
78 cervical radiculopathy. This guideline for neck pain is based on evidence-based practice
79 and has been published in a leading Physical Therapy journal so that it may guide
80 physical therapists in identifying interventions using the strongest and most recent
81 supporting evidence related to neck pain.²

82 The research of neuromobilization as an intervention for treating cervical
83 radiculopathy has been shown to be effective. Whereas, studies of patient populations
84 with an additional diagnosis of contralateral lateral epicondylitis are sparse. This case
85 report will discuss the effectiveness of neurodynamic mobilization on a patient's
86 symptoms resulting from the diagnosis of C7, C8 cervical radiculopathy as well as
87 contralateral epicondylitis. The results of this patient's treatment may however provide
88 indication for further exploration into neurodynamic mobilization on those diagnosed
89 with cervical radiculopathy and contralateral lateral epicondylitis symptoms. Moreover,
90 the purpose of this case report is to establish a conservative management for the treatment
91 of severe cervical radiculopathy and contralateral upper quarter lateral epicondylitis in a

92 patient utilizing median nerve tension stretching techniques, as well as engaging in
93 manual therapy, therapeutic exercise, and posture correction interventions.³

94

95 **PATIENT HISTORY AND SYSTEMS REVIEW**

96 *Right Cervical Related Findings*

97 The patient was a 64-year-old male with an eight-month history of parasthesia in
98 digits four and five of his right hand, with worsening of symptoms since that time. The
99 patient presented to physical therapy with complaints of neck pain and numbness on his
100 right fourth and fifth digits. He reports it worsened in certain sleeping positions, while on
101 the computer at work, while driving, and while holding the phone to his ear. The patient
102 was suspected to have a diagnosis of cervical radiculopathy on the right side. The
103 patient's goals included an increase in neck range of motion (ROM) and to eliminate the
104 numbness in his fingers.

105 *Left Upper Extremity Related Findings*

106 The patient described pain and a burning sensation in his left elbow, which started
107 when he began playing golf about two months prior to the initial examination.
108 Furthermore, he felt as though his forearms were more fatigued with certain activities
109 such as golfing, lifting, or carrying items over five pounds. At this point, the patient was
110 thought to have a second diagnosis of lateral epicondylitis on the left side. The patient's
111 goals included: to acquire tools to manage lateral elbow pain while golfing, lifting items,
112 and swimming.

113 This patient was selected because he presented to physical therapy with a rare
114 combination of symptoms related to his diagnosis of right-sided cervical radiculopathy

115 and left-sided lateral epicondylitis in which limited research has been documented. He
116 also appeared motivated and was interested in trying new intervention strategies.
117 The patient's past medical history was significant for Basal Cell Carcinoma, a heart
118 murmur, hypertension, anxiety, and colonic polyps, which were all being managed by
119 healthcare professionals. Additionally, radiographic images have included a magnetic
120 resonance imaging (MRI) of the cervical spine, which revealed degenerative changes
121 noted at several levels within the cervical spine, leading to narrowing of the right-sided
122 neural foramina, most notably at C6-7, and C7-C8 levels. No significant findings on the
123 left sided neural foramina were noted. Lastly, the patient signed a consent form agreeing
124 to participate in a physical therapy case report and have photographed images made
125 public for teaching purposes.

126 Refer to Table 1 for systems review.

127

128 **CLINICAL IMPRESSION 1**

129 The patient presented to an outpatient spine physical therapy clinic with two
130 separate issues. One issue included an eight-month history of insidious onset parasthesia
131 in his right fourth and fifth digits. The second reason the patient was referred was due to
132 left lateral elbow pain. The patient was referred to physical therapy from a Physical
133 Medicine and Rehabilitation physician, with directions to examine and treat for cervical
134 radiculopathy and secondary elbow pain. It was hypothesized that the patient's diagnosis
135 was right-sided C7, C8 cervical radiculopathy along with a possibly related left lateral
136 epicondylitis based on his signs and symptoms. This patient was suitable for a case report
137 because there is minimal evidence regarding a patient with an unusual presentation of C7,

138 C8 cervical radiculopathy on the right side and a possibly related lateral epicondylitis on
139 the opposite side.

140 Differential diagnoses for cervical radiculopathy included: radial nerve
141 entrapment, carpal tunnel syndrome, lateral epicondylitis, right ulnar neuropathy, cancer,
142 spinal fracture, upper cervical ligamentous instability, and systemic disease. Differential
143 diagnoses for lateral epicondylitis included: cervical myelopathy, radial tunnel syndrome,
144 fracture, or elbow osteoarthritis.

145 In the examination, the plan was to assess posture, active cervical and thoracic
146 range of motion, muscle length of cervical musculature, resisted isometrics of upper
147 extremity myotomal distribution; as well as grip strength, structural restrictions of
148 cervical and thoracic spine and ribs, and neurotension tests for the radial, ulnar, and
149 median nerves. Special tests to confirm or deny right-sided cervical radiculopathy
150 included cervical distraction, Spurling's test A, lateral flexion alar ligament stress test,
151 Sharp-Purser test, and the Brachial Plexus Compression Test. Additionally, grip strength,
152 Cozen's test, and Mill's test were done to rule in/out lateral epicondylitis.

153

154 **EXAMINATION: TESTS AND MEASURES**

155 A neurological screening of the upper extremity was done where the myotomes
156 and dermatomes were assessed with findings of slight weakness in the C7 and C8
157 dermatome. Next, peripheral joint screening was tested with cervical active range of
158 motion (CROM) using the CROM inclinometers.* Findings included restricted range of
159 motion in cervical extension with reproduction of pain and symptoms, side bending

* Brand- Performance Attainment Associates; Model number: 63567754,
Performance Attainment Associates. 12805 Lake Blvd, Lindstrom, MN 55045

160 bilaterally, and rotation to the right. Segmental mobility of the cervical and thoracic facet
161 joints was carried out with grade 3 passive physiological intervertebral movements.
162 Testing to determine the cause of the patient's cervical pain included the Distraction test,
163 Spurling's test A on the right, and Brachial Plexus Compression test on the right. The
164 following tests were carried out on the patient and were negative: lateral flexion alar
165 ligament stress test and sharp purser test. All results can be found in Table 2.

166 Next, testing was carried out to determine the cause of the patient's elbow pain
167 including a positive Cozen's test, a negative Mill's Test, and an MRI, which revealed no
168 evidence of axial compression on the left side. These findings ruled out cervical
169 myelopathy. Grip strength was then assessed using the dynamometer. Testing also
170 revealed weakness in the left hand when compared to the patient's right hand as well as a
171 positive Cozen's test on the left side displaying signs consistent with lateral epicondylitis.
172 All results can be found in Table 3.

173

174 **CLINICAL IMPRESSION 2**

175 The examination findings supported the hypothesis of two diagnoses. One, the
176 patient had a diagnosis of cervical radiculopathy on the right side. Secondly, the patient
177 had a diagnosis of lateral epicondylitis on the left side. The patient continues to be a good
178 candidate for this case report because it is hypothesized that the neurohypomobility may
179 be partial etiology of the left-sided lateral epicondylitis symptoms, indicating the
180 relationship with the diagnosis of right-sided cervical radiculopathy. The goal of this case
181 report is to assess how neurodynamic mobilization affects the outcomes when
182 supplemented with additional physical therapy interventions for patients with cervical

183 radiculopathy and contralateral epicondylitis, with this patient fulfilling these criteria.
184 The medical literature on this subject is limited; therefore, the course of this patient's
185 treatment can serve as a possible reference, in regards to utilizing nerve tension stretching
186 in the treatment of cervical radiculopathy with contralateral lateral epicondylitis.

187 The examination was constructed to distinguish mechanical dysfunction in the
188 cervical spine versus peripheral nervous system involvement versus myofascial
189 involvement. The patient's neck and arm examination findings are consistent with the
190 clinical prediction rule for cervical radiculopathy. The components of the test item
191 cluster indicating a cervical radiculopathy based on the clinical prediction rule: a positive
192 Spurling's test A, positive upper limb tension test, positive distraction test, and ipsilateral
193 cervical rotation active range of motion less than 60 degrees. With four positive criteria
194 met, the clinical prediction rule has a sensitivity of .24 (.05-.43), specificity of .99 (0.97-
195 1.0), positive likelihood ratio of 30.3 (1.7-538.2) and negative likelihood ratio of 0.77.¹³

196 Additionally, the patient had an additional diagnosis of left-sided lateral
197 epicondylitis. This was diagnosed with a positive Cozen's sign and weak grip strength on
198 the left side when compared to the contralateral side. Peripheral source of pain was ruled
199 out in this patient, as the screening of peripheral joints did not reproduce any symptoms.

200 Taking into consideration the subjective and objective findings, combined with
201 the four positive measures in the clinical prediction rule, it was hypothesized that the C7
202 and C8 nerve root was being compromised at the C6/C7/C8/T1 level, also possibly
203 causing lateral epicondylitis from decreased left wrist extensor muscle activation. Given
204 the patient's diagnosis, the selected category from the *Guide to Physical Therapist*
205 *Practice* was neck pain with radiating pain,¹⁴ the relevant ICD-9 code for cervical

206 radiculopathy is 723.4, and the movement system disorder was characterized as cervical
207 dysfunction.

208 The patient's prognosis was based on strong evidence showing the positive and
209 negative contributing factors for the best result in treating cervical radiculopathy with
210 physical therapy interventions.⁷ The patient's positive prognosis factors included age and
211 no medical or bio-behavioral co-morbidities to affect the course of treatment. Also, the
212 patient was motivated and interested in participating in physical therapy. Conversely,
213 poor prognostic factors consisted of the severity of the patient's cervical radiculopathy,
214 which may be considered extreme with nerve root compression and evidence of
215 degenerative changes based on the MRI findings.¹⁵ Thus, the patient was expected to
216 return to his normal level of functioning in six to eight sessions of physical therapy, as
217 long as he maintained his prescribed HEP.

218 The interventions and plans provided were based on the clinical practice guideline
219 for neck pain with radiating pain.² The evidence to support the patient's findings led to a
220 conclusive decision to follow interventions to target the patient's diagnosis of cervical
221 radiculopathy and contralateral lateral epicondylitis. Additionally, the plan of care and
222 the interventions provided to the patient were adjusted depending on his clinical
223 presentation at each session, as mentioned below. At this point, the plan is to continue
224 with the current treatment of care and proceed with scheduled interventions.

225 The plan is to address the examination findings with the following physical
226 therapy interventions: median nerve tension stretching, as well as a typical physical
227 therapy plan of care for cervical radiculopathy. This plan of care was guided by the
228 clinical practice guideline for neck pain² including posture education and training,

229 stretching, and strengthening exercises, along with cervical, thoracic, and rib joint
230 mobilizations. The patient's progress will be examined with the following outcome
231 measures: short form of the Disability of the Arm, Shoulder and Hand (QuickDASH),
232 Neck Disability Index (NDI), and incorporating the pain analog scale to measure his
233 functional progress every 30 days throughout his course of treatment. Additionally, a
234 reassessment of the findings found in the initial examination will be performed in 30 days
235 or at the time of discharge.

236

237 **INTERVENTIONS**

238 Coordination, Communication, and Documentation

239 Communication included documentation in the patient's medical record for each
240 therapy session so that every member of the healthcare team may have access if needed.

241 Patient, Client, and Family Instruction

242 At the initial examination, the patient was educated on his current condition, the
243 impairments noted for the patient's baseline, and his plan of care. Additionally, the
244 patient was taught the importance of performing his HEP daily, in order to maintain any
245 gains he had made throughout physical therapy. The importance of certain techniques,
246 such as upright posture and positioning, including sitting posture and posture with
247 computer ergonomics,¹⁶ were also educated to the patient.

248 Procedural Interventions

249 The patient was scheduled for and compliant with one-hour sessions twice a week
250 for two weeks, followed by once weekly sessions for two additional weeks. He also
251 performed his HEP daily.

252 *Cervical Radiculopathy Interventions*

253 The procedural interventions focused on manual therapy and therapeutic exercise
254 to regain strength and range of motion for functional activities and to improve his
255 posture. These interventions mostly followed a physical therapy plan of care based off the
256 clinical practice guideline for neck pain.² Furthermore, median nerve tension stretching
257 (Figure 1E) was performed at each session and was included in the patient's HEP to
258 determine if it would hasten the recovery process. Of note, the most recent Cochrane
259 Collaboration Review of mobilization and manipulation for mechanical neck disorders
260 included 33 randomized controlled trials, of which 42% were considered high quality.
261 These studies concluded that the most beneficial manipulative interventions for patients
262 with mechanical neck pain should be combined with exercise to reduce pain and improve
263 patient satisfaction. Manipulation and mobilization intervention alone were determined to
264 be less effective than when combined with exercise. Based on the research, each session
265 the patient received manual therapy throughout the course of the therapy. Refer to Table
266 4 for the manual therapy interventions, which correspond with Kaltenborn techniques.³

267 Additionally, strengthening exercise for improved upright posture were explained
268 and demonstrated to the patient. These included: deep neck flexor training, scapular
269 retraction in the prone position, which progressed to sitting on the third session and
270 further progressed to sitting and using a Theraband[†] on the fifth session, and deep neck
271 flexor training (each demonstrated in Figure 1 and parameters provided in Table 4). In a
272 study by Chiu et al, evidence showed that those engaged in motor control training of the
273 deep neck flexors and dynamic strengthening had significantly better improvements in

[†]The McKenzie Institute - 432 N Franklin Street Ste 40 Syracuse, NY 13204-15591

274 their disability scores, pain levels, and isometric neck muscle strength.⁸ Of note, the
275 physical therapist verbally explained and demonstrated the following stretches: anterior
276 scalene stretch in sitting with first rib towel mobilization (Figure 1), seated thoracic
277 extension with the patient's hands supporting his neck and pointing his elbows to the
278 ceiling in a seated position, and a bilateral pectoral stretch in the doorframe. Although
279 general research does not support the effect of interventions that focus on stretching and
280 flexibility; clinical experience suggests that addressing specific impairments of muscle
281 length is beneficial when combined with a comprehensive program including additional
282 interventions.² The self-suboccipital release prescribed included the use of two tennis
283 balls placed just below the base of the skull while lying in a supine position. Lastly, the
284 median nerve tension stretching in sitting with elbow flexion and extension oscillations
285 for nerve gliding was done manually by the physical therapist and also revised to be
286 performed at home daily with his HEP. Refer to Figure 1 and Table 4 for further detail.

287 Various changes were made to the plan of interventions, reflecting the patient's
288 progress. One important event displayed in Table 4 is that the first rib traction was
289 discharged after session four because the effects of the patient performing this at home
290 were successful in maintaining the position of the first rib. Also, scapular training
291 progressed from a prone position to a sitting position, with added resistance using an
292 orange TherabandTM [*] in the fifth session, as the patient's scapular muscles continued
293 to strengthen. As noted in Table 4 and 5, the patient's confidence grew throughout his
294 sessions and he and the therapist felt comfortable to correctly carry out the exercises at
295 home on a daily basis. Further details about the parameters of the interventions are
296 provided in Table 4 and Figure 1.

297

298 *Lateral Epicondylitis Interventions*

299 The interventions for lateral epicondylitis included manual cross friction massage
300 at the wrist extensor insertion, wrist extensor stretch, and strengthening of the left wrist
301 extensors. A study by Ackermann and Renström suggested that this is the first line of
302 treatment for lateral epicondylitis in the conservative, therapy-based regimen.¹⁷
303 Therefore, the patient was prescribed an eccentric wrist extensor strengthening exercise
304 with a 5-pound weight to perform at home daily and examined during therapy sessions.
305 Refer to Figure 1 and Table 5 for details of the patient’s interventions and HEP for lateral
306 epicondylitis.

307

308 **OUTCOMES**

309 The patient responded well throughout his plan of care, his impairments were
310 reduced, and he met all of his functional goals prior to being discharged. The patient's
311 impairments and areas of improvement reflected his goals set initially. As therapy
312 progressed, he was able to minimize his treatment sessions to once per week and shift the
313 focus towards his HEP. At the time of discharge, the patient improved in each of the
314 areas mentioned above.

315 *Cervical Radiculopathy Outcomes*

316 The Visual Analog Scale (VAS) for neck pain improvements were reported from
317 8/10 at the initial examination to 1/10 at the time of his discharge (Appendix 1) and the
318 NDI revealed no change with 4% disability at the initial examination and discharge. He
319 also had complained of discomfort while swimming, and reported pain and numbness in

320 his right fingers while at his office desk job during the initial examination. At discharge,
321 the patient reported that he was no longer limited in these activities due to pain. It was
322 noted that the patient had a decreased cervical range of motion, pain with the cervical
323 compression test, and hypertonicity in his postural neck muscles. See Table 2 for a
324 detailed comparison of his outcomes at discharge to his baseline measures.

325 Lateral Epicondylitis Outcomes

326 Upon the initial examination, the patient presented with a QuickDASH score of 15%,
327 which improved, to 6.8% at discharge (Appendix 2). Additionally, the patient's grip
328 strength score increased in the left hand from 32.5kg to 35 kg. Functionally, he was
329 unable to play golf more than once per week, which was less than his baseline. At
330 discharge, the patient reported that left elbow pain was no longer limiting him in these
331 activities. See Table 3 for a detailed comparison of his outcomes at discharge to his
332 baseline measures.

333

334 **DISCUSSION**

335 The patient progressed well during the eight weeks of outpatient rehabilitation
336 and was on track to attain his goal of playing golf more than once per week, as well as
337 swimming without pain in regards to both his cervical radiculopathy and contralateral
338 lateral epicondylitis symptoms. He developed gains in function and his pain decreased
339 throughout the course of therapy. Furthermore, he consistently showed a motivation and
340 desire to improve. He was subsequently discharged with a plan to maintain his gains in
341 therapy by performing his HEP daily.

342 This case study was created to explain the specific treatment for a patient with
343 cervical radiculopathy and contralateral lateral epicondylitis. It was felt that the focus on
344 median nerve tension stretching had a positive effect on the patient's outcomes in this
345 case. For example, the patient's VAS for neck pain and NDI improved indicating
346 improvement in cervical radiculopathy symptoms. Additionally, The patient's
347 QuickDASH scores, grip strength, and pain with activities improved, indicating
348 reductions in his lateral epicondylitis related symptoms. The patient demonstrated
349 dramatic improvements in pain and neck range of motion, postural strength, and
350 functional activities such as swimming and golfing. The patient was pleased with his
351 progress and reported feeling minimal pain during his golf trip near the end of therapy.
352 Factors that may have positively influenced the patient's outcomes included age, constant
353 motivation, support from his wife, and lack of medical or bio-behavioral co-morbidities
354 that would have affected the course of treatment.¹⁵ The patient had chronic neck pain,
355 numbness, and tingling in his right hand as a result of cervical radiculopathy. The
356 chronicity of the patient's condition may have negatively impacted the outcome since it
357 was difficult to adjust to the new lifestyles necessary to maintain his function and reduce
358 pain levels including daily exercises and consistent upright posture.

359 The purpose of this case study was to publish the effects of median nerve tension
360 stretching, including a general physical therapy plan of care for a patient with cervical
361 radiculopathy and contralateral lateral epicondylitis, including the plan of care related to
362 the clinical practice guideline for neck pain.² The assessment of the patient's median
363 nerve tension using the upper limb nerve tension test changed minimally, although the
364 patient's pain improved tremendously. The patient's progress with the interventions

365 provides merit for further studies to be investigated on this topic. This may be done in
366 various ways by possibly including research on the effect of neurodynamic mobilization
367 on a patient's upper nerve tension test, pain, or even functional activities.

368 For future research, it may be beneficial to determine whether additional patients
369 with similar cases would benefit from neurodynamic mobilization with the radial nerve
370 rather than the median nerve to specifically treat lateral epicondylitis. It would also be
371 interesting to determine if the combination of the two diagnoses studied in the future are
372 related to cervical myelopathy.

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439 **TABLES AND FIGURES**

440

TABLE 1. SYSTEMS REVIEW	
Cardiovascular/Pulmonary	Mild Atrial Stenosis under control, High Blood Pressure controlled with medications
Musculoskeletal	Neck Stiffness and bilateral knee Surgery in~ 1986
Neuromuscular	Tingling and numbness in digit 4/5; C7 Dermatome Numbness
Integumentary	No Deficits Noted; history of Basal Cell Carcinoma
Communication	No Deficits Notes
Affect, Cognition, Language, Learning Style	Alert and Oriented X 3, No cognitive Deficits, language barrier or preferred learning style

TABLE 2. CERVICAL RADICULOPATHY EXAMINATION RESULTS & OUTCOMES			
Tests & Measures	Initial Examination Results	Outcomes	Psychometric Values
Cervical Range of Motion: measured with CROM	Measured in Degrees	Measured in Degrees	R= .80-.89 ⁴
Flexion	50	60	
Extension	36 with increased symptoms in R UE and increased	42	

	numbness in digit 4/5		
Side bend Right	14	24	
Side bend Left	22	38	
Rotation Right	51	62	
Rotation Left	68	74	
Muscle Length:	Measured on a 4 point scale likert mild, minimal, moderate, or severe decrease in muscle in specific positions ¹⁶ Based on qualified therapist's clinical experience	Measured on a 4 point scale likert mild, minimal, moderate, or severe decrease in muscle in specific positions ¹⁶ Based on qualified therapist's clinical experience	R= .58 ⁵ ICC= .62 ⁵
Suboccipital:	Right: Moderate Left: Moderate	Right: minimal Left: minimal	
Upper Trapezius:	Right: Moderate Left: Moderate +	Right: Moderate Left: Moderate	
Scalene muscles:	Right: Severe Left: Severe	Right: Moderate Left: Moderate	
Sternocleidomastoid:	Right: Moderate + Left: Severe	Right: Moderate + Left: Moderate +	
Levator Scapulae:	Right: Mild Left: Mild	Right: Mild Left: Mild	
STRUCTURAL RESTRICTIONS: Passive physiological intervertebral movements	(0=no movement, 1=hypomobility, 2=slight hypomobility, 3=normal, 4=slight	(0=no movement, 1=hypomobility, 2=slight hypomobility, 3=normal, 4=slight	Structural Restriction using the application of a posteroanterior (PA) pressure to the joint ³ Specificity 99.5%; CI 97–100% ⁶

	hypermobility, 5=moderate hypermobility, 6=excessive hypermobility)	hypermobility, 5=moderate hypermobility, 6=excessive hypermobility)	Construct Validity for function: $r=.88^7$
First rib: elevated	Right: 1+ Left: 2	Right: 3 Left: 2	
Upper Cervical	Right: 1+ Left: 2	Right: 2 Left: 2	
Mid Cervical:	Right: 3+ Left: 4	Right: 2 Left: 2	
Lower Cervical:	Right: 2 Left: 1+	Right: 2 Left: 1+	
Cervico-Thoracic Junction:	Right: 1 Left: 1	Right: 1 Left: 1	
Thoracic with associated rib mobility	Right: 1 Left: 1	Right: 1 Left: 1	
<u>Special Tests</u>			
Cervical Distraction	Positive	Negative- no symptoms present for testing	Reliability: $k=.88^8$ Specificity: .90; Sensitivity: .44 -LR: .62; +LE: 4.4 ⁸
Spurling's test A	Right: Positive Left: Negative	Right: Negative Left: Negative	Reliability: $k=0.62^7$ Specificity: .74; Sensitivity: .72 .50; -LR: .67; +LR: 1.92 ⁷
Brachial Plexus Compression Test	Right: Positive Left: Negative	Right: Negative Left: Negative	Reliability and Validity unknown ⁷
Median Nerve Tension	Right: Positive- Tested in sitting with - 20 degrees from full elbow extension Left: Negative	Right: positive- Tested in sitting with - 15 degrees from full elbow extension Left: Negative	Reliability: $k=0.83^7$ Specificity: .33 Sensitivity: .72 -LR: .85; +LR: 1.07 ⁷

Visual Analog Scale	8/10	1/10	Reliability and validity unknown
Neck Disability Index (NDI) Interpreted as: 0-	2/50=4%	2/50=4%	r=.89 ⁷ Validity: r=.77 Specificity: .59; Sensitivity: .52 -LR: .81; +LR: 1.27 ⁷

Table 3: Lateral Epicondylitis Examination Results & Outcomes

Tests & Measures	Initial Examination Results	Outcomes	Psychometric Values
Resisted Isometric Movements of Upper Extremity Myotomes	<ul style="list-style-type: none"> 5=Normal 4=Good 3=Fair 2=Poor 1=Trace 0=Not Palpable 	<ul style="list-style-type: none"> 5=Normal 4=Good 3=Fair 2=Poor 1=Trace 0=Not Palpable 	<ul style="list-style-type: none"> Unknown Reliability and Validity⁹
Upper Trapezius (C4)	<ul style="list-style-type: none"> Right: 5 Left: 5 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Biceps(C5)	<ul style="list-style-type: none"> Right: 5 Left: 5 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Supraspinatus (C5)	<ul style="list-style-type: none"> Right: 4 Left: 4+ 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Wrist Extensors (C6)	<ul style="list-style-type: none"> Right: 5 Left: 4 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Finger flexion/extension (C7,C8)	<ul style="list-style-type: none"> Right: 5 Left: 4 with pain 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Finger Abduction (T1)	<ul style="list-style-type: none"> Right: 5 Left: 4 	<ul style="list-style-type: none"> Right: 5 Left: 5 	
Special Tests			
Cozen's test	<ul style="list-style-type: none"> Right: Positive Left: Negative 	<ul style="list-style-type: none"> Right: Negative Left: Negative 	<ul style="list-style-type: none"> Reliability and Validity unknown¹⁰
Quick Dash	<ul style="list-style-type: none"> 15% 	<ul style="list-style-type: none"> 6.8% 	<ul style="list-style-type: none"> r=.96¹⁰ Construct Validity for function: r=.88¹⁰

Table 3. Lateral Epicondylitis Examination Results & Outcomes			
Tests & Measures	Initial Examination Results	Outcomes	Psychometric Values
Resisted Isometric Movements of Upper Extremity Myotomes	5=Normal 4=Good 3=Fair 2=Poor 1=Trace 0=Not Palpable	5=Normal 4=Good 3=Fair 2=Poor 1=Trace 0=Not Palpable	Unknown Reliability and Validity ³
Upper Trapezius (C4)	Right: 5 Left: 5	Right: 5 Left: 5	
Biceps(C5)	Right: 5 Left: 5	Right: 5 Left: 5	
Supraspinatus (C5)	Right: 4 Left: 4+	Right: 5 Left: 5	
Wrist Extensors (C6)	Right: 5 Left: 4	Right: 5 Left: 5	
Finger flexion/extension (C7,C8)	Right: 5 Left: 4 with pain	Right: 5 Left: 5	
Finger Abduction (T1)	Right: 5 Left: 4	Right: 5 Left: 5	
<u>Special Tests</u>			
Cozen's test	Right: Positive Left: Negative	Right: Negative Left: Negative	Reliability and Validity unknown ⁵
Quick Dash	15%	6.8%	r=.96 ³ Construct Validity for function: r=.88 ³
Grip Strength	32.5 kg	35 kg	ICC= .97 ²²
C=Cervical Vertebra R=reliability, LR= likelihood ratio, ICC=interclass correlation coefficient			

TABLE 4. PROCEDURAL INTERVENTIONS FOR CERVICAL RADICULOPATHY						
Intervention	Tx Day 1	Tx Day 2	Tx Day 3	Tx Day 4	Tx Day 5	Tx Day 6
Median Nerve Tension stretching	2 min	2 min	2 min	2 min	2 min	2 min
T1-T6 bilateral facet traction	5 min	5 min	5 min	5 min	5 min	5min
Occipito-atlanto joint Dorsal Caudal Glide	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3
First Rib mobilization on right	2 min Grade 3	2 min Grade 3	2 min Grade 3	Modified for HEP	Modified for HEP	Modified for HEP
C7 Dorsal Caudal glide bilateral	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3	2 min Grade 3
Anterior Scalene stretch with first rib towel mobilization				2X 30 sec bilateral	2X 30 sec bilateral	2X 30 sec bilateral
Seated Thoracic Extension	10 times every hour during the day	10 times every hour during the day	10 times every hour during the day	10 times every hour during the day	10 times every hour during the day	10 times every hour during the day
Self suboccipital release with tennis balls	2 minutes 1 time per day	2 minutes 1 time per day	2 minutes 1 time per day	2 minutes 1 time per day	2 minutes 1 time per day	2 minutes 1 time per day
Median Nerve Tension	30 seconds 2 times	30 seconds 2 times	30 seconds 2 times	30 seconds 2 times	30 seconds 2 times	30 seconds 2 times

stretch bilateral (Figure 1E)	per day	per day	per day	per day	per day	per day
Deep neck flexor training	10 reps for ten seconds	10 reps for ten seconds	10 reps for ten seconds	10 reps for ten seconds	10 reps for ten seconds	10 reps for ten seconds
Scapular Retraction	10 reps 3 sets (prone)	10 reps 3 sets (prone)	10 reps 3 sets (prone progressed to sitting)	10 reps 3 sets (sitting)	10 reps 3 sets (sitting)	10 reps 3 sets (Sitting progressed with orange theraband)
<p>** indicates inclusion in home exercise program Tx: Treatment min: Minutes T: Thoracic vertebra C: Cervical Vertebra Reps: Repetitions</p>						

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TABLE 5. PROCEDURAL INTERVENTIONS FOR LATERAL EPICONDYLITIS						
Intervention	Tx Day 1	Tx Day 2	Tx Day 3	Tx Day 4	Tx Day 5	Tx Day 6
Cross Friction Massage to lateral left wrist extensor tendon at origin (Figure 1B)	Until no tenderness is reported by patient	Until no tenderness is reported by patient	Until no tenderness is reported by patient	Until no tenderness is reported by patient	Until no tenderness is reported by patient	Until no tenderness is reported by patient
Eccentric Wrist Extensor Strengthening (Figure 1D)*	10 reps 3 sets	10 reps 3 sets	10 reps 3 sets	10 reps 3 sets	10 reps 3 sets	10 reps 3 sets

Wrist extensor stretch (Figure 1F)	30 seconds 3 reps	30 seconds 3 reps	30 seconds 3 reps	30 seconds 3 reps	30 seconds 3 reps	30 seconds 3 reps
<p>* indicates inclusion in home exercise program Tx: Treatment min: Minutes T: Thoracic vertebra C: Cervical Vertebra Reps: Repetitions</p>						

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<i>Cervical Radiculopathy Interventions</i>	<i>Lateral Epicondylitis Interventions</i>
	
<p>A. Computer posture training</p>	<p>B. Cross friction massage to wrist extensors</p>
	
<p>C. Prone Scapular Retraction</p>	<p>D. Eccentric Wrist Extensor Training</p>
	
<p>E. Median Nerve Tension Stretch</p>	<p>F. Wrist Extensor Stretch</p>

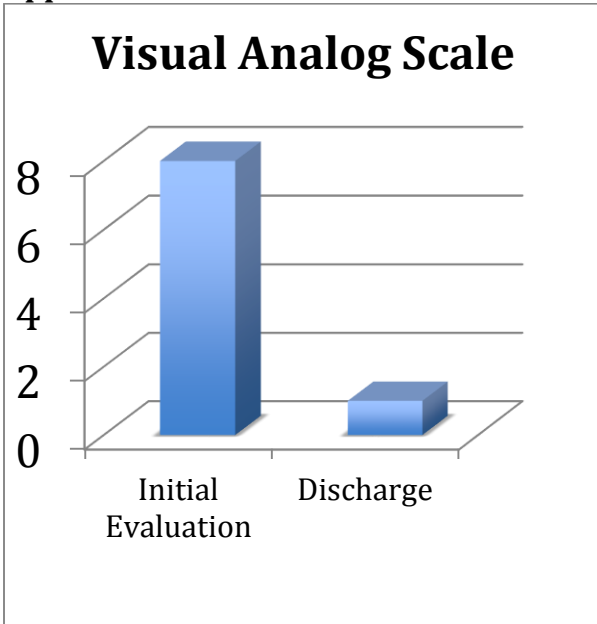
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Figure 1. Therapeutic interventions for cervical radiculopathy (A, C, E) and lateral epicondylitis (B, D, F)

468 **APPENDICES:**

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470 **Appendix 1**

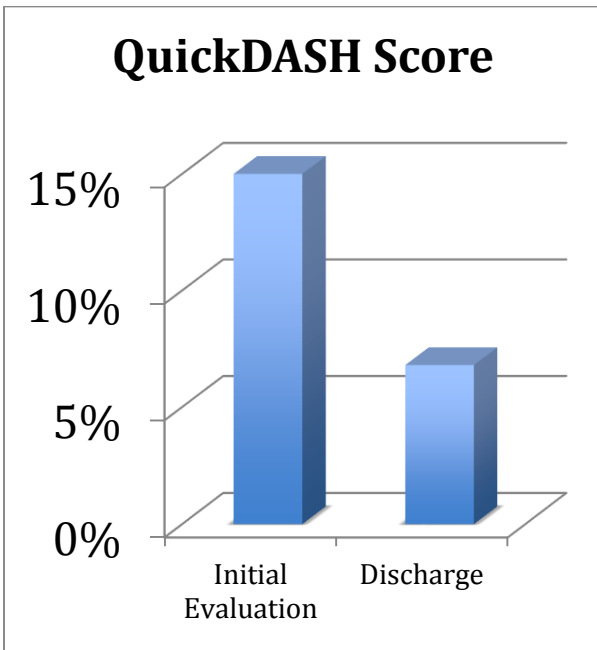


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473 **Appendix 2**

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