Effectiveness of manual physical therapy in the treatment of cervical radiculopathy: a systematic review

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Study design: Systematic review of randomized clinical trials.

Objective: Review of current literature regarding the effectiveness of manual therapy in the treatment of cervical radiculopathy.

Background: Cervical radiculopathy (CR) is a clinical condition frequently encountered in the physical therapy clinic. Cervical radiculopathy is a result of space occupying lesions in the cervical spine: either cervical disc herniations, spondylosis, or osteophytosis. These affect the pain generators of bony and ligamentous tissues, producing radicular symptoms (i.e. pain, numbness, weakness, paresthesia) observed in the upper extremity of patients with cervical nerve root pathology. Cervical radiculopathy has a reported annual incidence of 83.2 per 100 000 and an increased prevalence in the fifth decade of life among the general population.

Results: Medline and CINAHL via EBSCO, Cochrane Library, and Google Scholar were used to retrieve the randomized clinical trial studies for this review between the years of 1995 and February of 2011. Four studies met inclusion criteria and were considered to be high quality (PEDro scores of ≥ 5). Manual therapy techniques included muscle energy techniques, non-thrust/thrust manipulation/mobilization of the cervical and/or thoracic spine, soft-tissue mobilization, and neural mobilization. In each study, manual therapy was either a stand-alone intervention or part of a multimodal approach which included therapeutic exercise and often some form of cervical traction. Although no clear cause and effect relationship can be established between improvement in radicular symptoms and manual therapy, results are generally promising.

Conclusion: Although a definitive treatment progression for treating CR has not been developed a general consensus exists within the literature that using manual therapy techniques in conjunction with therapeutic exercise is effective in regard to increasing function, as well as AROM, while decreasing levels of pain and disability. High quality RCTs featuring control groups are necessary to establish clear and effective protocols in the treatment of CR.

Keywords: Cervical radiculopathy, Conservative treatment, Manual therapy, Manipulation, Mobilization, Non-operative, Physiotherapy, Physical therapy

Background

Cervical radiculopathy (CR) is frequently encountered in physical therapy with an annual incidence of 83.2 per 100 000 people and there is an increased prevalence in the fifth decade of life.^{1,2} Cervical radiculopathy is the result of cervical nerve root pathology often caused by space occupying lesions such as cervical disc herniation, spondylosis, or osteophytosis. These space occupying lesions affect the pain generators of bony and ligamentous tissues within the cervical spine, producing upper extremity radicular symptoms (i.e. pain, numbness, weakness, paresthesia).^{3,4} The C6 and C7 nerve roots are most commonly involved in CR.⁵

The presence alone of a cervical space occupying lesion (cervical disc herniation, spondylosis, osteophytosis) is not sufficient for establishing a diagnosis of CR.³ EMG/nerve conduction testing is the diagnostic gold standard to confirm the presence of CR. However, using EMG/nerve conduction testing in a clinical setting is not always feasible because not all professions can use this for diagnostic purposes but are still required to arrive at a clinical decision based on a differential diagnosis list. Likewise, not all professions can use EMG/nerve conduction testing for diagnostic purposes but are still required to make clinical decisions. Therefore, Wainner *et al.*⁶ developed a clinical prediction rule (CPR), consisting of four variables to aid clinicians in the diagnosis of CR. The four variables include: (1) positive Spurling test, (2) positive distraction test, (3) ipsilateral cervical

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spine rotation less than 60°, and (4) positive upper limb tension test A – median nerve bias. With three of the four variables present, the CPR diagnosis has a specificity of 94% and a positive likelihood ratio of 6.1. With all four variables present, the specificity increases to 100% and the positive likelihood ratio increases to 30.3.⁶ Utilizing this CPR, a cluster of four tests, is a useful method of clinically diagnosing CR.

Treatment for CR has been the subject of debate among clinicians and researchers, with recent evidence demonstrating conservative treatment to be more effective than surgical options.⁷ Conservative treatment for CR typically includes therapeutic exercise (ROM, strengthening), manual therapy (muscle energy techniques, non-thrust mobilization, manipulation), modalities (cryotherapy, traction), massage therapy, medication, and cervical collar.^{2–4,7,8} Systematic reviews exist for treatment of the broad category of mechanical neck pain with manual physical therapy.⁹ For example, Gross and colleagues⁹ investigated the effects of graded mobilization or manipulation in the treatment of neck pain and found evidence to suggest some short-term relief with a course of cervical manipulation or mobilization. They also found evidence to support the use of thoracic manipulation for immediate neck pain relief.⁹ To this date, no systematic reviews have investigated the use of manual therapy for the treatment of CR. Therefore, the purpose of this systematic review is to evaluate the literature regarding the effectiveness of using manual physical therapy in the treatment of CR.

Methods

Search strategy

Medline and CINAHL via EBSCO, Cochrane Library, and Google Scholar were used to retrieve the studies for this review. Key words utilized across the databases were *cervical radicul**, *conservative treatment*, *manual therapy*, *manipulation*, *mobilization*, *nonoperative*, *non-operative*, *physiotherapy*, and *physical therapy*. As subject headings varied between the databases, various combinations of the key words were used. The search was limited to studies published on humans, in the English language, performed by physical/physiotherapists, in peer review journals, and between the years of 1995 and February of 2011, in order to locate the most recent publications. A search within the bibliographies of acquired studies was also performed. Figure 1 shows the flow diagram for the studies considered through the review process.

Inclusion criteria

Randomized controlled trials (level 1a) through case series (level 4) of manual physical therapy in

Figure 1 PRISMA flow diagram.

the treatment for CR of adults 18 years of age and older were considered for review.¹⁰ All participants were adults under the care of a physical therapist, which were diagnosed with CR based on MRI, CT-myelography,¹¹ or a positive finding of the Wainner *et al.*⁶ CPR with at least three out of four items present. The interventions of interest were manual physical therapy techniques (muscle energy techniques, non-thrust/thrust manipulation of cervical and/or thoracic spine, soft tissue mobilization, and neural mobilization) performed by a physical therapist either in conjunction with other physical therapy interventions or as a stand-alone treatment. Finally articles were chosen if they included at least one of the following outcome measures: active or passive range of motion, a functional outcome measure specific to the neck [Neck Disability Index (NDI) or Patient-Specific Functional Scale (PSFS)], a quality of life measure [Global Rating of Change (GROC) or Sickness Impact Profile (SIP)], and a pain measure [Numeric Pain Rating Scale (NPRS) or Visual Analogue Scale (VAS)].

Exclusion criteria

Studies that reported participants who had undergone surgical management for the present condition or for any condition in the upper quarter less than one year previous were excluded from review. Other exclusion criteria include manual procedures performed by professionals outside the realm of physical therapy (i.e. chiropractor) and use of cervical collars, mechanical cervical traction, or any other external and/or mechanical devices.

Review process

Four reviewers completed a class to develop efficiency and accuracy in article analysis and extraction of relevant data prior to the initiation of this systematic review. The four reviewers were divided into pairs. During each step of the review process consensus was required within the pair for an article to be considered for review. Upon completion of the initial search, the pair of reviewers determined an article's relevance based on the utilized key words within the article title. Abstracts were obtained and assessed for relevant article titles. A full text article was acquired for abstracts that provided a match to the inclusion criteria.

Upon consensus for inclusion of all full-length articles, each reviewer read and analyzed each study utilizing a data extraction form. The 11-item PEDro (Physiotherapy Evidence Database) scale was used by all reviewers to assess the quality of clinical trials.¹² Each item was answered with either a 'no' or a 'yes', which corresponded to zero or one point, respectively. Only 10 points were possible for the PEDro scale, with the first item (external validity of the article) not included in the total score. A score of zero was utilized for items on the PEDro scale that were not mentioned in the article. Items that were unclear were discussed among all four reviewers until a consensus on the item was reached. To determine an acceptable PEDro scale cutoff point for this review, a systematic review by Maher¹³ was consulted. Results from the review indicated reducing the PEDro scale cutoff from the original strict score of six to a less strict score of five did not affect the overall outcome. Therefore, it was found acceptable to use a cutoff point of five for this systematic review.

Results

The search strategy resulted in a list of 94 articles of which 25 abstracts were determined appropriate for

further review by the consensus of the four reviewers. From this review only 10 abstracts met inclusion criteria for full text evaluation. Each reviewer independently read the 10 articles to verify inclusion criteria and assign a PEDro score. The reviewers arrived at the conclusion that four articles met the specified inclusion criteria and PEDro score cutoff and were retained for in-depth analysis.

Of the four articles reviewed, Persson *et al.*¹¹ determined a diagnosis of CR with diagnostic imaging and used the VAS as an outcome measure. The other three articles used Wainner's CPR for inclusion criteria as well as the NDI and NPRS as outcome measures.^{8,14,15} All four studies included some form of non-thrust mobilization, exercises which targeted the thoracic and/or cervical regions of the spine, and a quality of life outcome measure (GROC or SIP).^{8,11,14,15} Table 2 outlines the studies that were included for review.

Excluded studies

Fifteen articles, which were initially included in the review based on information from the abstracts, were later excluded secondary to: manual therapy techniques performed by those outside of the physical therapy profession,^{16–20} manual therapy techniques not specified within the broader context of 'physical therapy' and/or 'physiotherapy',^{21–23} the article was a review of the literature,^{24,25} and the article was a case study and/or series and therefore had an insufficient PEDro score.^{1,2,7,26}

Quality assessment

Table 1 presents the quality scores for the 11-item PEDro scale for the four included studies, as agreed upon by the reviewers. The mean quality score was 7.25 with a standard deviation of 1.71 and range from 5 to 9. The PEDro score cutoff of 5 was met or exceeded by all the articles in this review. Items 9–11 (intention-to-treat, between-group statistical comparison, provision

Table 1 PEDro scale of quality for included articles

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Total score
Cleland <i>et al.</i> ⁸	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5
Persson <i>et al.</i> ¹¹	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	7
Ragonese ¹⁴	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	8
Young <i>et al.</i> ¹⁵	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	9
% 'Yes'	100	75	75	50	50	0	75	75	100	100	100	
Average PEDro score												7.25

Note: PEDro Criteria.

Item 1: (Not scored) eligibility criteria specified.

Item 2: Subjects were randomly allocated.

Item 3: Allocation was concealed

Item 4: Groups were similar at baseline for most important prognostic indicators.

Item 5: There was blinding of all subjects.

Item 6: There was blinding of all therapists.

Item 7: There was blinding of assessors of outcomes.

Item 8: Measures of at least one key outcome were collected from 85% of subjects initially allocated.

Item 9: Intention-to-treat analysis was performed.

Item 10: Between-group comparisons reported for at least one key outcome.

Item 11: Study provided point measures and measures of variability for at least one key outcome.

Table 2 Details of included studies

Study	Participants	Study design	Pathology	Interventions	Outcome measures	Protocol	Outcomes (mean change from pre to post with 95% CI if supplied)
Cleland et al.	n=96	Patients completed self-reported measures at initial evaluation and discharge or re-examination (descriptive outcome study)	Cervical radiculopathy	Physical therapists selected interventions bases on their own clinical decision including non-thrust/thrust manipulation/mobilizations	<u>1. NDI</u> <u>2. PSFS</u> <u>3. NPRS</u> → 1–3 were taken at baseline and re-examination/discharge <u>4. GROC</u> → taken at re-examination/discharge	Participant's baseline outcome measures were taken, they were evaluated, and mean number of visits were 6.4 with a mean duration of 28 days. Re-examinations happened at every 5–6 visits.	Fifty participants were categorized as successful. <u>(1) NDI: 13.9 (10.5)</u> <u>(2) PSFS: 3.4 (2.0)</u> <u>(3) NPRS: 3.8 (1.6)</u> <u>(4) GROC: 3.8 (1.7)</u>
Persson et al.	n=110 divided into Groups 1, 2, and 3 based on clinical and radiological findings. Only Group 2 constituted this study with n=81	Control 1: base line measure before treatment. Control 2: outcome measurement at 14–16 weeks of treatment. Control 3: follow-up measurements 12 months after control 2	Cervical radicular pain with clinical and radiological findings indicating root compression corresponding to the distribution of pain, but without spinal cord compression. The nerve root compression was caused by spondylotic spurs with or without an additional bulging disc. <i>Note: Wainners CPR was not used to diagnose cervical radiculopathy</i>	<u>Surgery group:</u> performed by different surgeons <u>Physiotherapy group:</u> 25 physiotherapist provided treatment according to their preferences and symptoms. Cervical collar group: a shoulder-resting rigid collar used at daytime, and a soft collar at night if participant wanted to.	<u>1. Pain: Visual Analogue Scale:</u> two different scales were filled out (1) present pain; (2) worst pain the previous week <u>2. Sickness Impact Profile</u> <u>3. Mood Adjective Check List</u>	SG: pt were mobilized post op day 1 and sometimes given a cervical collar for 1–2 days PG: 15 sessions over 3 months, one to two per week, each 30–45 minutes long CG: participants were instructed to wear collars for 3 month period	<u>(1) Pain Difference control 1–3:</u> <u>Present pain VAS:</u> SG: –17 PG: –12 CG: –14 <u>Worst pain past week VAS:</u> SG: –30 PG: –17 CG: –16 <u>(2–3) Sickness impact profile and Mood Adjective Check List:</u> No difference between groups at control 3

Table 2 Continued.

Study	Participants	Study design	Pathology	Interventions	Outcome measures	Protocol	Outcomes (mean change from pre to post with 95% CI if supplied)
Ragonese	n=30	Between group comparison: manual physical therapy vs therapeutic exercise vs combination (no control group)	Cervical radiculopathy	Manual physical therapy group: Cervical lateral glides, thoracic mobilizations, neural dynamic techniques for the median nerve Exercise group: Deep neck flexor strengthening, lower and middle trapezius strengthening, serratus anterior strengthening Combination group: participants received same protocols for the above 2 groups at each session	1. <u>NDI</u> 2. <u>NPRS</u> 3. <u>Active cervical rotation</u> 4. <u>Inclusion criteria tests (Spurling's test, Distraction test, ULTT-A median nerve bias)</u> →All completed initially, once per week and at final session	Each participant was treated 3 times per week for 3 weeks	Note: values represent final mean outcomes (1) <u>NDI</u> : MPTG: 2.4 ± 1.1 EG: 1.6 ± 1.5 CG: 0.9 ± 1.2 (2) <u>NPRS</u> : MPTG: 17.2 ± 10.3 EG: 10.2 ± 7.1 CG: 7.8 ± 5.5 (3) <u>Active cervical rotation</u> : MPTG: $74.3 \pm 3.58^\circ$ EG: $74.4 \pm 4.12^\circ$ CG: $71.4 \pm 3.67^\circ$ (4) <u>Inclusion criteria tests: no significant differences found between groups.</u> Note: The following are the adjusted mean difference between groups (95%CI) at 4 weeks from the revised results published in November 2009. (1) <u>NPRS</u> : $0.5 (-1.0 \text{ to } 2.1)$ (2) <u>NDI</u> : $1.5 (-3.8 \text{ to } 6.8)$ (3) <u>PSFS</u> : $0.3 (-1.2 \text{ to } 1.8)$ (4) <u>FABQ-PA</u> : $-1.8 (-6.6 \text{ to } 3.0)$ <u>FABQ-W</u> : $2.9 (-8.1 \text{ to } 13.9)$ (5) <u>Pain diagram</u> : $0.4 (-7.7 \text{ to } 8.6)$ (6) <u>GROC</u> : $0.3 (-0.7 \text{ to } 1.2)$ (7) <u>Satisfaction rating</u> : $-0.4 (-1.8 \text{ to } 0.9)$
Young et al.	n=81	Between group comparison: manual therapy, exercise, and intermittent cervical traction vs manual therapy, exercise, and sham intermittent cervical traction	Cervical radiculopathy	Manual therapy, exercise, and intermittent cervical traction: Postural education, Manual therapy, Exercise, and traction Manual therapy, exercise, and sham intermittent cervical traction: Postural education, Manual therapy, Exercise, and Sham traction	1. <u>NPRS</u> 2. <u>NDI</u> 3. <u>PSFS</u> 4. <u>FABQ</u> 5. <u>Pain diagram</u> 6. <u>GROC</u> 7. <u>Satisfaction rating</u> →collected at baseline, 2 weeks, and 4 weeks follow-up	2 times per week for an average of 4.2 weeks	

of point measures and measure of variability respectively) all scored a 'yes' on each article. The only item answered 'no' for all the articles was item 6 (blinding of therapists) because it was difficult to do so when performing manual therapy on a patient.

Manual therapy for reduction of pain, improving function, and increasing range of motion

The designs of the included studies in this review are described in Table 2. All four studies utilized a pain measurement tool.^{8,11,14,15} Each study demonstrated reduction of pain with some form of manual therapy treatment; however, only one study randomized a treatment group where patients received just manual therapy treatment.¹⁴ Ragonese¹⁴ performed a study that compared three treatment groups: manual therapy alone, therapeutic exercise alone, and a combination of manual therapy and therapeutic exercise. At the completion of this study, the combination group showed significant improvement in measures of pain when compared to the other two groups.

Three of the four included studies used the NDI as a functional outcome measure.^{8,14,15} Ragonese¹⁴ reported all three groups demonstrated statistically significant improvements in function, with the therapeutic exercise/manual therapy combination group showing the greatest results compared to the other two groups. Cleland *et al.*⁸ and Young *et al.*¹⁵ corroborated these results with their studies.

Range of motion was an impairment measure for only one of the four included studies. Ragonese¹⁴ measured cervical rotation range of motion and reported equal and statistically significant improvement in cervical rotation in all three treatment groups.

Comparing the effects of different types of manual therapy

Four different types of manual therapy techniques were utilized in the included articles: thrust mobilizations, non-thrust mobilizations, neural dynamic techniques, and muscle energy techniques.

Thrust mobilizations of the thoracic spine were utilized in two articles.^{8,14} In the study conducted by Cleland *et al.*,⁸ 27 patients received thoracic spine thrust mobilization as part of their treatment. Eighteen (66.7%) of those patients had a successful outcome, which was classified as surpassing the minimal clinically important change (MCIC) for the NDI, PSFS, NPRS, and GROC at re-examination. Manual therapy procedures performed on the thoracic spine were not specifically described in the article. Ragonese¹⁴ utilized a thrust mobilization directed at the thoracic spine for hypomobile segments of the mid and upper thoracic spine at the initial treatment. Patients in this study with CR all experienced statistically significant improvements in the NDI, PSFS, and NPRS.

Non-thrust mobilizations of the cervical spine were incorporated in all four articles. Young *et al.*¹⁵ required that each patient be treated with some form of cervical mobilization at each visit. Treatment parameters included: one set of 30 seconds, or 15–20 repetitions which were directed toward each desired level of the cervical spine. The techniques chosen could include retractions, rotations, lateral glides in the ULTT1 position, or P-A glides. Ragonese¹⁴ was more specific in terms of which non-thrust manual therapy techniques were performed during each treatment. The treating therapist performed a cervical lateral glide, grade 3–4 (as described by Maitland²⁷), for 30–45 seconds for all segments C2 through C7 at each treatment session. In the Persson *et al.*'s study,¹¹ the therapist used their own discretion regarding which treatments were provided; parameters and guidelines were not specified. The authors did state that 'gentle mobilizations of the cervical spine' were among the most frequent treatments provided. At the end of 14–16 weeks, the physiotherapy group improved in overall SIP ($P < 0.05$) and the more specific 'physical dimension' (ambulation, body care and movement, and mobility) section of the SIP ($P < 0.01$). There were no differences between any of the three groups in pain intensity, function, and mood at 12 months post-treatment. In the Cleland *et al.*'s article,⁸ 47 patients received non-thrust manipulation to the cervical spine. Treatment protocols (technique, force grades, duration) used were determined by the individual therapists. Out of the 47 patients, 57% (27) had successful outcomes.

Neural dynamic techniques for the median nerve were included as treatments in two articles.^{8,14} Ragonese¹⁴ positioned subjects in a manner described by Magee,²⁸ and then utilized a 'sliding' technique, as described by Butler,²⁹ conducted in a slow and oscillatory fashion. With improvement in symptoms, the technique was progressed to a 'tension' technique, also described by Butler.²⁹ Treatment duration was not recorded. In the Cleland *et al.*'s article,⁸ 23 patients either received neural dynamic techniques or neural mobilizations, of which 13 patients (56.5%) had a successful outcome. Exact treatment parameters, the nerve mobilized, the manner of which the mobilization occurred and the length of time the technique performed were not described in the article.

Cleland *et al.*⁸ was the only article which utilized muscle energy techniques. Twenty-eight patients received muscle energy techniques of which 13 (46.4%) had successful outcomes which was classified as surpassing the MCIC for the NDI, PSFS, NPRS, and GROC at re-examination. Descriptions of the performed muscle energy techniques were not included in the article.

Discussion

In the studies which met PEDro score criteria, Ragonese¹⁴ was the only article that utilized manual therapy as a stand-alone intervention for treatment of CR. The remaining authors utilized multimodal treatment regimens, which at the minimum included exercises targeting the muscles in the cervical and/or thoracic region(s) of the spine.

The study performed by Persson *et al.*¹¹ revealed that no significant differences existed between the outcome measures of all three groups (surgery, physiotherapy, cervical collar). This suggests that physical therapy, which includes manual therapy and exercise, is at least as effective as surgery. Considering the effectiveness of the collar/immobilization group in the Persson *et al.*'s article,¹¹ the results indicated that immobilization from a cervical collar were equally effective as its more involved and more expensive counterparts. It was then the expectation of the reviewers that additional literature using immobilization as a control group would be found. However this was not the case.

Cleland *et al.*⁸ found that 53% of their subjects surpassed MCIC on four outcome measures (NDI, PSFS, NPRS and GROC) when treated with a multimodal approach which included manual therapy techniques. This study sets a high standard in defining successful outcomes and achieves it with more than half of the subjects; yet the study lacks a control group and clearly defined interventions making it difficult to determine treatment effectiveness and reproducibility.⁸

Young *et al.*'s study¹⁵ was conducted in an attempt to determine what effect cervical traction would have when added to a regimen of therapeutic exercise and manual therapy. The results did not show any additional benefits. The study reveals that whether assigned to a manual therapy/therapeutic exercise/traction group, or simply a manual therapy/therapeutic exercise group subjects 'experienced significant improvements in both primary and secondary outcomes [NPRS as well as the NDI] following 4 weeks of standardized physical therapy intervention.'¹⁵

Ragonese¹⁴ found that all three treatment groups (manual therapy only, therapeutic exercise only, and a combination group) demonstrated statistically significant improvements in NPRS pain scores after four weeks ($P < 0.01$) as well as in NDI scores ($P < 0.05$).¹⁴ The study found that the combination group had the lowest, albeit not statistically significant, score as compared to the other two groups.

Limitations

This review has several limitations, the first of which was that only one article specifically described performed intervention. The other three allowed the

treating therapist to determine appropriate treatment for a particular patient. Second, none of the included studies were randomized control trials, so determining the cause and effect relationship between manual therapy and the relief of CR symptoms is difficult. Lastly, only articles published in English were reviewed, leading to the possibility of relevant articles existing in other languages.

Conclusion

Although a definitive progression for treating CR has not been developed, a general consensus exists within the literature that using manual therapy techniques in conjunction with therapeutic exercise is effective in regard to increasing function, as well as AROM, while decreasing levels of pain and disability. Because the articles in this review were not specific in the performed manual therapy techniques, it is difficult to predict which intervention will be the most effective in decreasing symptoms and improving function in patients with CR. Future high quality randomized control trials featuring control groups with specific interventions are necessary to develop clear and effective protocols for the treatment of CR.

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