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Simultaneous versus consecutive administration of cervical traction and neural mobilization in patients with cervical radiculopathy: A randomized controlled trial

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Abstract

Background & Objective: Cervical traction and neural mobilization are frequently utilized in the management of cervical radiculopathy. However, there is a paucity of literature concerning the best order of application of these techniques. The aim of this study was to compare the effects of simultaneous and consecutive administration of cervical traction and neural mobilization on pain and function in cervical radiculopathy. *Methods:* Thirty patients were randomly assigned to two equal groups: consecutive (CON) and simultaneous (SIM) cervical traction and neural mobilization in this single-blind randomized controlled trial. The inclusion criteria comprised age 20-60 years, unilateral cervical radiculopathy ≥ 6 months, and positive upper limb neural tension tests of radial, median or ulnar nerve, and positive Spurling test. Outcome measurement tools were numeric pain rating scale, cervical goniometry, neck disability index, and short-form health survey. Data was analyzed with SPSS 23. *Results:* Significant improvement was evident in all parameters in CON after 1-week rehabilitation ($P \leq 0.001$ for seven of the ten variables). Similarly, all parameters showed significant improvement in SIM ($P \leq 0.001$ for all variables except mental component score of SF-12 with $P < 0.05$). After rehabilitation, SIM was significantly better with respect to pain ($P < 0.05$), flexion-extension mobility ($P < 0.001$), and quality of life ($P < 0.01$). No differences were found in other variables.
Conclusion: Simultaneous use of cervical traction and neural mobilization resulted in significantly better outcomes with regards to pain, flexion-extension mobility, and quality of life. The two groups performed similarly on other outcome measures.

Keywords: Cervical radiculopathy; cervical traction; neural mobilization; neck pain; cervical mobility; neck disability Index.

INTRODUCTION

Dysfunction of the spinal nerve roots in the cervical region can lead to a neurological disorder - cervical radiculopathy (CR) – involving chronic pain, functional limitation, and poor quality of life. Although this dysfunction is usually caused by a mechanical compression of the nerve roots, the problem could also have biochemical basis.[1] A recent systematic review reported the incidence of CR from 0.832 to 1.79 per 1,000 person-years based on three studies. Similarly, the prevalence of CR was reported to range from 1.21 to 5.8 per 1,000 person-years, based on four studies, with females slightly more prone than males.[2]

CR is usually accompanied by a positive upper limb neural tension tests. Most commonly involved spinal nerve roots are C7 followed by C6 while it is rare to have compression of C5 and C8 roots. Risk factors include older age, female gender, higher stress levels, and poor posture.[3,4] The common complaints include pain, sensory problems, and motor weakness. Diagnosis is usually reached through history and clinical examination despite a lack of globally established

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diagnostic criteria. Plain radiographs, MRI and computerized tomography scan may help in the diagnosis. A thorough insight into the role of each spinal root is imperative to locate the source of problem since several other disorders may present similarly such as axial neck pain, shoulder disorders, and brachial plexopathy.[1]

Both conservative and surgical interventions are available for the management of CR. Conservative management include medications, cervical collar, strengthening and stretching exercises, manual and mechanical traction, neurodynamic techniques, and physical therapeutic modalities such as transcutaneous electric nerve stimulation, inferential therapy, thermotherapy, cryotherapy, laser therapy. The main mechanism of such management is to decompress the spinal root, improve circulation and oxygen supply.[5-7] Arguably the two most common noninvasive interventions are cervical traction (CT) and neural mobilization (NM). Each has been studied extensively in the literature although the research quality is not always high. CT can be administered manually or mechanically and latter can be used either in continuous or intermittent mode.[3,8] Patient position has also been shown to influence the clinical outcomes with supine position yielding better results compared to sitting with regards to disability index.[9] Manual traction, when compared against manual intervertebral foramen opening technique or in combination with it produced similar effects on pain, disability, and cervical range of motion in CR.[6]

The use of intermittent CT (ICT) in the management of unilateral CR has been systematically reviewed. It was concluded that patients experience considerably reduced pain, increased mobility, and improved nerve function when treated with ICT.[10] Mechanical traction when combined with exercise as a physical therapy management of CR lead to significantly lower pain and disability especially at longer follow-ups of 6 and 12 months.[11] Similarly, a 30-minute cervical traction protocol, twice a day, for five successive days resulted in statistically and clinically significant reduction in neck disability index which persisted 3 months after treatment. Furthermore, subjective pain improved significantly during the course of treatment and stayed less at the midterm with reduced need of pain medication.[12]

Neural mobilization is a commonly used technique for the management of cervical radiculopathy, and has been found to be effective in reducing patient's pain and disability and improving cervical range of motion, quality of life, grip strength and deep flexor endurance. Although it has been accepted and used as a treatment strategy in cervical radiculopathy, no consensus was observed in the literature regarding its effectiveness in improving function, range of motion, pain, and disability.[13,14] More recently, it has been reported in an RCT that such techniques could significantly reduce pain, increase cervical active mobility, and improve disability when used in conjunction with exercise without affecting pressure pain threshold and heat/cold pain threshold in six sessions.[15]

The mechanism of symptom relief is quite different between the two techniques. Cervical traction is aimed at segmental distraction to relive the compression that is being applied at the level of the spinal nerve root[10] whereas neural mobilization is focused at restoring peripheral nerve mobility and addressing soft tissue adhesions that may form along the course of peripheral nerve resulting in abnormal tensile stress and impaired neural mobility.[4] To the best of authors' knowledge, no randomized controlled trial has been reported comparing the effect of order of application of cervical traction and neural mobilization in patients with unilateral cervical radiculopathy.

Therefore, the purpose of the current trial was to seek the preferred order of application of CT and NM concerning effects on pain, disability, neck mobility, and quality of life. It was hypothesized that there would be no significant differences between the simultaneous and consecutive administration of cervical traction and neural mobilization in terms of pain, cervical spine mobility, neck function, and quality of life.

METHODS

This single-blinded (patients) randomized controlled trial was conducted in accordance with the declaration of Helsinki. The data was collected after the institutional review board approved the research proposal. All patients provided written informed consent prior to their participation in the trial. Non-probability, convenience sampling technique was utilized to recruit patients with cervical radiculopathy from a private physiotherapy clinic in Rawalpindi, Pakistan. All data for a patient during a given data point was completed within a single session.

The online calculated sample size, using OpenEpi tool (www.openepi.com), based on a past similar study was 22.[16] Fifty patients were screened for eligibility to participate in the

study. Thirty patients who fulfilled the inclusion criteria were randomly allocated through sealed envelope method to two equal groups: consecutive (CON) and simultaneous (SIM) cervical traction and neural mobilization (Figure 1). All patients were diagnosed based on history and clinical examination without the use of radiology. The inclusion criteria were age between 20 and 60 years, unilateral cervical radiculopathy for at least 6 months, positive Spurling test, and positive Upper Limb Neural Tension Tests of radial, median or ulnar nerve. The patients with cervical myelopathy, vertigo/dizziness, bilateral symptoms and other musculoskeletal conditions in the affected limb were not included. None of the recruited patients complain of any other symptoms such as numbness or muscle weakness.

Patient information: The mean age, body mass, height, and body mass index of the patients in CON group were 37.4±8.1 years, 73.8±10.0 kg, 165.9±6.9 cm, and 26.9±3.1 kg/m2 respectively while SIM group values were 39.1±9.1 years, 73.0±13.2 kg, 165.0±7.2 cm, and 26.8±5.2 kg/m2 respectively. The ratio of male-to-female patients was 7:8 and 6:9 for CON and SIM respectively. None of the patients were using pain relief medication during their participation in the current trial. Both groups were statistically similar in terms of gender-distribution (P>0.05).

Data collection procedure: Data was collected before and after one-week rehabilitation for all patients in both groups. Baseline data was obtained before the first treatment session while post-rehabilitation data was collected immediately after the last treatment session. Demographic data included age, body mass, height, gender, body mass index, and systolic and diastolic blood pressures.

Numeric pain rating scale (NPRS) was used to assess subjective pain intensity which has high validity and reliability. In order to evaluate cervical pain and functional disability, neck disability index (NDI) was used. NDI comprise 10 questions and a score of 35 or more would denote complete disability while scores of 34-25, 24-15, and 14-5 represent severe, moderate, and weak disabilities respectively. Cervical spine range of motion was measured using a universal goniometer. The measurements included movements of flexion, extension, and lateral flexion and axial rotation to both sides. Patient-reported short-form health survey (SF-12) was used to measure the quality of life. Physical component score (PCS) value of less than 51 signify a physical condition while an mental component score (MCS) value of less than 43 may indicate clinical depression.[17]

Rehabilitation protocol: The rehabilitation regimen comprised 4 sessions of 45 minutes each

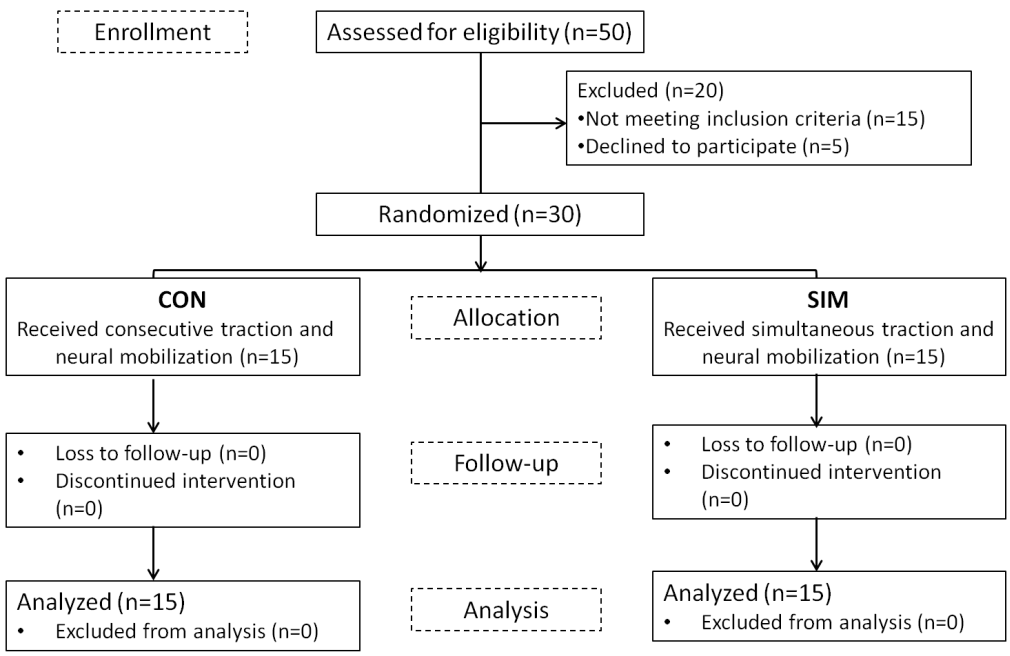


Figure 1. CONSORT Diagram

conducted on alternative days. The treatment components administered to both groups were identical in nature comprising hot packs for warm-up, segmental mobilization, mechanical cervical traction, and neural mobilization. The only difference was in the order of application of cervical traction and neural mobilization. CON group received neural mobilization ten minutes after the traction while both were given simultaneously to the SIM group (Table 1). No harms or unintended effects were observed in either group.

Statistical analyses: Data analyses were carried out using IBM SPSS 23.0 (IBM, New York, NY) software. Data distribution was evaluated with Shapiro-Wilk test. Unpaired samples t-test and Mann-Whitney U test were used for between-groups analyses while within-group changes were computed with paired samples t-test and Wilcoxon signed-rank test for normally and non-normally distributed parameters respectively. Effect size (E.S) was obtained by computing Cohen's *d*. Chi square test was applied for gender-distribution differences between the groups. Alpha level of significance was chosen as a P value less than 0.05.

RESULTS

Both groups were statistically similar in terms of all study parameters and basic demographics (P>0.05). Significant decline in pain was observed in both CON (7.6 ± 1.2 vs. 3.1 ± 1.1; P<0.01; E.S = 3.89) and SIM (7.3 ± 0.9 vs. 2.2 ± 1.7; P<0.001; E.S = 3.92) groups after treatment. Range of extension movement significantly improved in both CON (35.8 ± 11.6 vs. 46.9 ± 5.2; P<0.001; E.S = 1.31) and SIM (41.9 ± 10.7 vs. 57.5 ± 5.7; P<0.001; E.S = 1.90) groups as a result of treatment.

Similarly, treatment resulted in significant increase in right side-flexion (30.7 ± 6.4 vs. 38.3 ± 4.8; P<0.001; E.S = 1.36) and left side-flexion (33.1 ± 5.0 vs. 39.5 ± 4.3; P<0.01; E.S = 1.38) in CON group (Table 2). Furthermore, significant improvements were seen in flexion (43.8 ± 4.5 vs. 65.3 ± 13.2; P<0.001; E.S = 2.43) and left rotation (55.9 ± 12.3 vs. 74.0 ± 9.6; P<0.001; E.S = 1.65) range of motion in SIM. Additionally, the physical component score of SF-12 jumped over the cutoff point of 51 (42.6 ± 8.5 vs. 51.3 ± 5.1; P<0.01; E.S = 1.28) in SIM (Table 3).

After treatment, the range of motion in both flexion (48.1 ± 7.5 vs. 65.3 ± 13.2; P<0.001; E.S = 1.66) and extension (46.9 ± 5.2 vs. 57.5 ± 5.7; P<0.001; E.S = 1.96) was significantly greater in SIM (Figure 2). Similarly both PCS (45.5 ± 5.2 vs. 51.3 ± 5.1; P<0.001; E.S = 1.12) and MCS (45.5 ± 9.0 vs. 52.1 ± 10.6; P<0.05; E.S = 0.67) were significantly better in SIM (Figure 3). Additionally, SIM group reported significantly less pain (3.1 ± 1.1 vs. 2.2 ± 1.7; P<0.05; E.S = 0.66) and disability score (26.0 ± 12.9 vs. 17.3 ± 12.0; P=0.06; E.S = 0.70) compared to CON. No significant differences were evident in other parameters.

DISCUSSION

Significant improvement was seen in all parameters after consecutive and simultaneous administration of intermittent cervical traction and neural mobilization. The null hypothesis is rejected for five parameters namely pain, flexion and extension range of motion, and physical and mental component scores of short-form health survey. No significant between-groups differences were found in rotation and side flexion range of motion, and neck disability index scores.

A recent three-group RCT involving 66 patients with unilateral cervical radiculopathy reported that the patients who received intermittent mechanical

Table 1: Rehabilitation protocol

CON group	SIM group
• Hot-packs on cervical region for 10 minutes. • On first session, 3 sets of gentle segmental mobilization (Unilateral Posterior-Anterior Glide) of 15-20 repetitions each. • Mechanical cervical traction for 15 minutes using 10% body mass while neck flexed at 15°. • Passive upper extremity neural mobilization of 6-8 repetitions immediately after the cervical traction.	• Hot-packs on cervical region for 10 minutes. • On first session, 3 sets of gentle segmental mobilization (Unilateral Posterior-Anterior Glide) of 15-20 repetitions each. • Mechanical cervical traction for 15 minutes using 10% body mass while neck flexed at 15° accompanied by passive upper extremity neural mobilization of 6-8 repetitions during the holding phase of intermittent cervical traction.

(**CON:** consecutive application of-, **SIM:** simultaneous application of traction and neural mobilization)

Table 2: Treatment-induced changes in the study parameters in consecutive administration group

	Baseline		Post-training		P value	Cohen's *d*
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)		
Pain	7.6 ± 1.2	8.0 (3.0)	3.1 ± 1.1	3.0 (1.0)	0.001**	3.89
Flexion (°)	42.7 ± 5.9	45.0 (10.0)	48.1 ± 7.5	48.0 (13.0)	0.001**	0.81
Extension (°)	35.8 ± 11.6	38.0 (17.0)	46.9 ± 5.2	46.0 (9.0)	<0.001***	1.31
Rotation (R) (°)	62.3 ± 15.5	60.0 (26.0)	73.7 ± 6.9	73.0 (5.0)	0.002**	1.02
Rotation (L) (°)	60.0 ± 12.2	60.0 (20.0)	71.1 ± 5.5	70.0 (7.0)	0.001**	1.25
Side flexion (R) (°)	30.7 ± 6.4	30.0 (7.0)	38.3 ± 4.8	38.0 (7.0)	<0.001***	1.36
Side flexion (L) (°)	33.1 ± 5.0	33.0 (5.0)	39.5 ± 4.3	40.0 (4.0)	0.001**	1.38
SF-12 (PCS)	40.0 ± 11.2	33.5 (22.9)	45.5 ± 5.2	42.7 (11.6)	0.015*	0.67
SF-12 (MCS)	40.9 ± 7.3	36.4 (7.5)	45.5 ± 9.0	45.8 (20.4)	0.034*	0.56
Neck Disability Index	29.4 ± 14.2	35.0 (24.0)	26.0 ± 12.9	30.0 (20.0)	0.001**	0.25

* (P value <0.05); ** (P value <0.01); *** (P value <0.001); PCS (Physical Component Score); MCS (Mental Component Score)

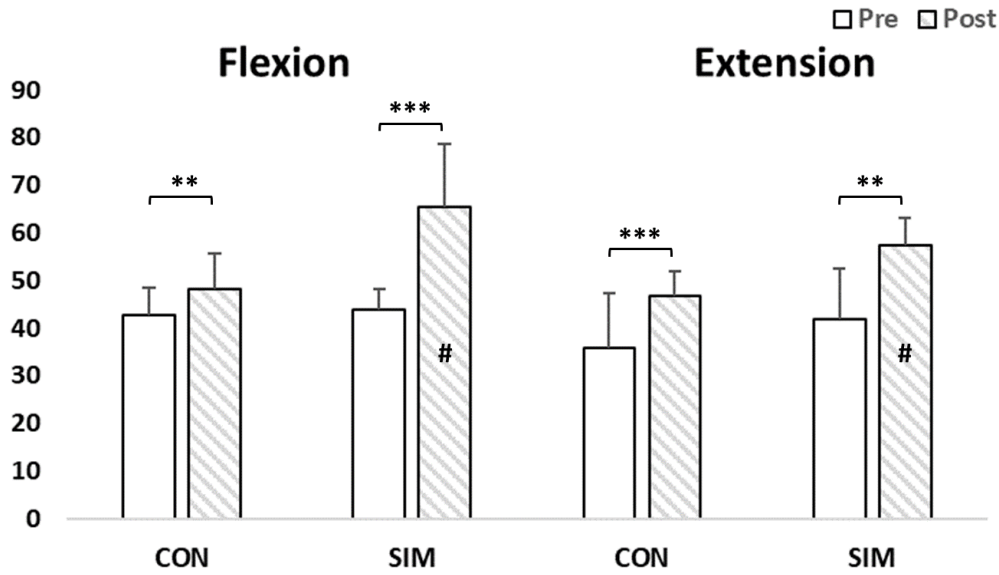
cervical traction followed by neural mobilization improved significantly with regards to pain, function, and disability after 1 week. No significant improvements were seen in traction + sham NM and wait-list control groups. Additionally, the experimental group reported significantly less pain at the end of the rehabilitation compared to both other groups.[16] The current study employed CT and NM in two different combinations and found similar significant improvements in pain, mobility, disability, and quality of life in both groups. Furthermore, a systematic review conducted on 9 trials using intermittent mechanical traction (IMT) for the treatment of CR concluded that IMT was useful in decreasing pain and disability in CR although none of the included studies provided high-level evidence but only low and moderate level evidence.[10]

Similarly, another RCT investigated the effects of simultaneous administration of CT and NM in patients with unilateral CR against the control group without receiving any treatment or medication. Twelve treatment sessions resulted in significant improvement in pain, disability,

Table 3: Treatment-induced changes in the study parameters in simultaneous administration group

	Baseline		Post-training		P value	Cohen's *d*
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)		
Pain	7.3 ± 0.9	7.0 (1.0)	2.2 ± 1.7	2.0 (2.0)	<0.001***	3.92
Flexion (°)	43.8 ± 4.5	45.0 (8.0)	65.3 ± 13.2	65.0 (23.0)	<0.001***	2.43
Extension (°)	41.9 ± 10.7	44.0 (20.0)	57.5 ± 5.7	55.0 (8.0)	<0.001***	1.90
Rotation (R) (°)	57.2 ± 11.0	60.0 (22.0)	74.9 ± 6.7	75.0 (11.0)	<0.001***	2.00
Rotation (L) (°)	55.9 ± 12.3	56.0 (20.0)	74.0 ± 9.6	75.0 (14.0)	<0.001***	1.65
Side flexion (R) (°)	30.1 ± 8.4	28.0 (14.0)	37.9 ± 4.7	38.0 (7.0)	<0.001***	1.19
Side flexion (L) (°)	30.3 ± 8.1	32.0 (14.0)	37.5 ± 6.5	39.0(4.0)	0.001**	1.00
SF-12 (PCS)	42.6 ± 8.5	42.4 (16.0)	51.3 ± 5.1	52.3 (9.5)	0.001**	1.28
SF-12 (MCS)	46.8 ± 9.6	49.1 (16.9)	52.1 ± 10.6	57.8 (6.1)	0.046*	0.53
Neck Disability Index	29.9 ± 13.6	34.0 (24.0)	17.3 ± 12.0	16.0 (16.0)	<0.001***	0.98

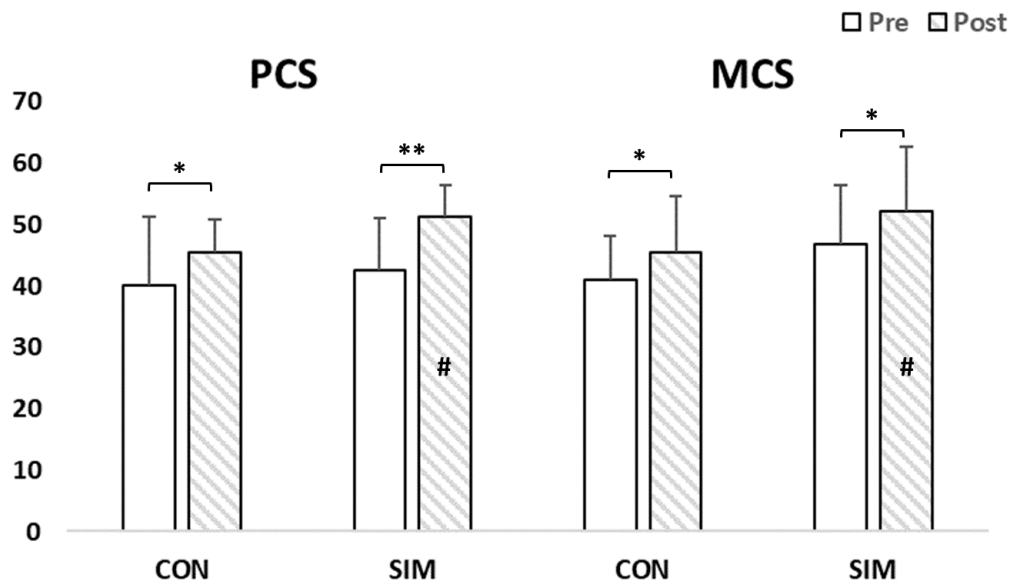
* (P value <0.05); ** (P value <0.01); *** (P value <0.001); PCS (Physical Component Score); MCS (Mental Component Score)



** (P value <0.01), *** (P value <0.001), # (P value <0.001 difference with CON),
CON (consecutive administration group), SIM (simultaneous administration group)

Figure 2. Within-group changes and between-groups differences in flexion and extension range of motion

function, grip strength, and cervical mobility (other than side-flexion). No significant changes were observed in the control group.[18] The present trial confirmed these results wherein significant improvement was found in pain, disability, quality of life, and mobility after simultaneous use of CT and NM. Another trial comparing the effects of simultaneous application of NM with either segmental cervical traction or total cervical traction reported that segmental CT and NM resulted in significantly better outcomes in terms of pain, disability, and cervical extension, side flexions, and left rotation. Both combinations caused significant improvements in pain,



** (P value <0.01), *** (P value <0.001), # (P value <0.001 difference with CON),
CON (consecutive administration group), SIM (simultaneous administration group)

Figure 3. Within-group changes and between-groups differences in physical (PCS) and mental (MCS) component scores of SF-12

endurance, and disability.[19] Raval and colleagues (2014) also compared the simultaneous use of CT and NM with CT and NM given alone in a randomized controlled trial. The simultaneous combination of the techniques was reported to be significantly more effective in decreasing pain and disability than other groups.[20]

Neural mobilization combined with manual traction has also been shown to yield better pain, disability, and ROM outcomes compared to manual traction alone in groups of 15 CR patients each. Significant between-groups differences were reported at 4 and 8 weeks.[21] Another randomized trial compared the effects of a combination of CT and NM with those of CT alone on pain and cervical flexibility in patients with unilateral CR after 12 treatment sessions administrated in two weeks. The combination therapy resulted in significantly reduction in pain and passive range of motion. No possible explanation was provided by the authors concerning the surprising and very substantial decline in the range of motion.[22] A recent systematic review based on 10 trials involving the use of neural mobilization in CR concluded that although NM was reported to be effective by most studies, it was difficult to clearly confirm the effectiveness of NM owing to diversity in methodology and participants of the trials. Further high-quality research was needed to confirm the therapeutic role of NM in such patients.[4]

Cervical traction has also been compared with other combinations for its therapeutic effects in CR. Barot and Shukla (2020) comparatively studied the effects of a combination of NM and conventional, CT and conventional, and conventional alone with 9 patients of unilateral CR in each group. After 12 treatment sessions in 2 weeks, it was reported that NM combined with conventional treatment comprising interferential therapy, chin nods, and isometric neck and scapular strengthening exercises caused significantly more improvements in pain and cervical flexibility. All the study groups demonstrated significant improvement in the outcome measures.[23] Similarly another trial comparing the consecutive combination of CT and NM with CT alone on 80 patients with unilateral CR reported significantly lesser pain on visual analogue scale and improved range of motion.[24]

Effects of CT and NM, administered either alone or in combination, on quality of life are also well known. Both NM and CT, combined with conventional physiotherapy, yielded significant improvement in quality of life measured by SF-12 in CR. Additionally, CT provided better mental component score when combined with convetional treatment.[23] Similarly, significant improvement was reported in the physical scale of the Nottingham Health Profile questionnaire after treatment with intermittent CT in middle-aged patients with chronic neck pain.[8]

Literature has suggested the minimal clinically important change for NPRS and NDI in terms of minimal detectable change (MDC) and the optimal cutoff point of the receiver operating characteristic (ROC) curve. MDC and ROC were suggested to be 4.3 and 2.5 for NPRS and 10.5 and 3.5 for NDI respectively.[25] In the current study, participants in both CON and SIM reported decline in pain that exceeded the MDC signifying significant clinical improvement. However, only SIM showed a drop of more than MDC in the disability index. Similarly, the official cutoff scores of PCS and MCS in SF-12 have been recommended as <51 and <43 to indicate chances of having a physical condition and indication of clinical depression respectively.[17] In the present trial, mean PCS of SIM group ascended above the cutoff point due to treatment while it stayed below in CON. On the other hand, mean MCS of CON group ascended above the cutoff point due to treatment while it was already above 43 in SIM.

The limitations of this study were: First, all patients were recruited from a single clinic which may have implications on the generalizability of the findings. Second, the use of other objective measures such as grip test for muscle strength and pain pressure threshold could have improved the quality of the study.

In conclusion, intermittent mechanical cervical traction combined with neural mobilization leads to significant improvement in pain, disability, range of motion, and quality of life in patients with cervical radiculopathy regardless of whether the techniques were applied simultaneously or not. The simultaneous use of the techniques resulted in significant better outcomes in pain, flexion and extension range of motion, and quality of life.

DISCLOSURE

Trial registry: This trial has been registered at the clinicaltrials.gov (U.S National Library of Medicine) under the identifier number NCT05021510.

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Conflict of interest: None

REFERENCES

1. Woods BI, Hilibrand AS. Cervical radiculopathy: Epidemiology, etiology, diagnosis, and treatment. *J Spinal Disord Tech* 2015; 28(5), E251-E259. DOI: 10.1097/BSD.0000000000000284
2. Mansfield M, Smith T, Spahr N, Thacker M. Cervical spine radiculopathy epidemiology: a systematic review. *Musculoskeletal Care* 2020; 18(4), 555-67. DOI: 10.1002/msc.1498
3. Romeo A, Vanti C, Boldrini V, *et al*. Cervical radiculopathy: effectiveness of adding traction to physical therapy—a systematic review and meta-analysis of randomized controlled trials. *Phys Ther* 2018; *98*(4):231-42. DOI: 10.1093/physth/pzy001
4. Liniewski P, Buczek T, Michalak K, Linek P, Wolny T. Effectiveness of neurodynamic techniques in conservative treatment of cervical spine radiculopathy-critical evaluation of the literature. *Physiother Health Act* 2020; (28):74-82. DOI: 10.32087/pha-2020-0009
5. Childress M, Becker BA. Nonoperative management of cervical radiculopathy. *Am Fam Physician* 2016; 93(9), 746-54.
6. Afzal R, Ghous M, Shakil Ur Rehman S, Masood T. Comparison between manual traction, manual opening technique and combination in patients with cervical radiculopathy: randomized control trial. *J Pak Med Assoc* 2019; 69, 1237-41.
7. Elyaspour D, Rayegani SM, Elahi-Movahed M, Sedighi S, Hojjati F. Efficacy of pneumatic collar versus hard collar on cervical radiculopathy. *JPMRE* 2019; 1(3), 136-44. https://doi.org/10.22122/pmre.v1i3.44
8. Borman P, Keskin D, Ekici B, Bodur H. The efficacy of intermittent cervical traction in patents with chronic neck pain. *Clin Rheumatol* 2008; 27(10): 1249-53. DOI: 10.1007/s10067-008-0895-z
9. Khan RR, Awan WA, Rashid S, Masood T. A randomized controlled trial of intermittent cervical traction in sitting vs. supine position for the management of cervical radiculopathy. *Pak J Med Sci* 2017; 33(6): 1333. DOI: 10.12669/pjms.336.13851
10. Gregory G, McKivigan JM. Effectiveness of intermittent mechanical traction in cervical radiculopathy: a systematic review. *J Med Res Practice* 2018; 7(2):39. DOI: 10.1002/14651858.CD006408.pub2
11. Fritz JM, Thackeray A, Brennan GP, Childs JD. Exercise only, exercise with mechanical traction, or exercise with over-door traction for patients with cervical radiculopathy, with or without consideration of status on a previously described subgrouping rule: a randomized clinical trial. *J Orthop Sports Phys Ther* 2014; 44(2):45-57. DOI: 10.2519/jospt.2014.5065
12. Rulleau T, Abeille S, Pastor L, *et al*. Effect of an intensive cervical traction protocol on mid-term disability and pain in patients with cervical radiculopathy: An exploratory, prospective, observational pilot study. *Plos One* 2021; 16(8): e0255998. DOI: 10.1371/journal.pone.0255998
13. Boyles R, Toy P, Mellon J, Hayes M, Hammer B. Effectiveness of manual physical therapy in the treatment of cervical radiculopathy: a systematic review. *J Man Manip Ther* 2011; 19(3): 135-42. DOI: 10.1179/2042618611Y.0000000011
14. Efstathiou MA, Stefanakis M, Savva C, Giakas G. Effectiveness of neural mobilization in patients with spinal radiculopathy: a critical review. *J Bodyw Mov Ther* 2015; 19(2): 205-12. DOI: 10.1016/j.jbmt.2014.08.006
15. Alshami AM, Bamhair D. A. Effect of manual therapy with exercise in patients with chronic cervical radiculopathy: a randomized clinical trial. *Trials* 2021; 22(1): 1-12. DOI: 10.1186/s13063-021-05690-y
16. Savva C, Korakakis V, Efstathiou M, Karagiannis C. Cervical traction combined with neural mobilization for patients with cervical radiculopathy: A randomized controlled trial. *J Bodyw Mov Ther* 2021; 26: 279-89. DOI: 10.1016/j.jbmt.2020.08.019
17. Ware J, Kosinski M, Keller S. How to score the SF-12 physical. The mental health summary scales. Boston, MA: The Health Institute, New England Medical Center. 1995
18. Savva C, Giakas G, Efstathiou M, Karagiannis C, Mamais I. Effectiveness of neural mobilization with intermittent cervical traction in the management of cervical radiculopathy: A randomized controlled trial. *Int J Osteopathic Med* 2016; 21: 19-28. https://doi.org/10.1016/j.ijosm.2016.04.002
19. Yun YH, Lee BK, Yi JH, Seo DK. Effect of nerve mobilization with intermittent cervical segment traction on pain, range of motion, endurance, and disability of cervical radiculopathy. *Phys Ther Rehabil Sci* 2020; 9(3): 149-54. https://doi.org/10.14474/ptrs.2020.9.3.149
20. Raval VR, Babu KV, Kumar NS, Ghosh A. Effect of simultaneous application of cervical traction and neural mobilization for subjects with unilateral cervical radiculopathy. *Int J Physiother* 2014; 1(5): 269. https://doi.org/10.15621/ijphy/2014/v1i5/55287
21. Kim DG, Chung SH, Jung HB. The effects of neural mobilization on cervical radiculopathy patients' pain, disability, ROM, and deep flexor endurance. *J Back Musculoskelet Rehabil* 2017; 30(5), 951-9. DOI: 10.3233/BMR-140191
22. Lamba D, Rani D, Gaur N, Upadhyay R, Bisht N. The effect of neural mobilization with cervical traction in cervical radiculopathy patients. *Indian J Physiother Occup Ther* 2012; 6(2): 45-8.
23. Barot AP, Shukla YU. Effects of neural tissue mobilization versus intermittent cervical traction in unilateral cervical radiculopathy on pain, range of motion and quality of life-A comparative study. *Int J Sci Healthcare Res* 2020; 5(1): 132-42.
24. Liaqat S, Fatima U, Bhukhari S. The effect of intermittent traction along with neural mobilization in cervical radiculopathy. *Int J Engineering Sci Mathematics* 2014; 3(3): 15.
25. Pool JJ, Ostelo RW, Hoving JL, Bouter LM, De Vet HC. Minimal clinically important change of the Neck Disability Index and the Numerical Rating Scale for patients with neck pain. *Spine* 2007; 32(26): 3047-51. DOI: 10.1097/BRS.0b013e31815cf75b