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Effectiveness of Nerve Mobilization with Proprioceptive Neuromuscular Facilitation in Patients with Cervical Radiculopathy

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***Abstract*: Background: Cervical radiculopathy is a dysfunction of nerve root of the cervical spine is irritated and compressed, where C6 and C7 nerve roots are most commonly affected. The most common symptoms are pain, parathesia, numbness and muscle weakness in dermatomal or myotomal distribution of an affected nerve root. A multitude of physical therapy interventions have been proposed to be effective in the management of cervical radiculopathy, including both mechanical and manual therapy. Aim: To study the effectiveness of nerve mobilization and PNF technique in the management of cervical radiculopathy. Objective: The objective of this study to evaluate the effectiveness of nerve mobilization And Proprioceptive neuromuscular facilitation (PNF) technique in order to reduce pain, increase ROM and improve the functional Ability in patients with cervical radiculopathy. Methodology: A convenient technique was used to choose 30 individuals, comprising Both males and females aged 30 to 80 years, who met the inclusion and exclusion criteria.30 people with cervical radiculopathy were given Nerve mobilization with PNF contract-relax stretching along with TENS, for a duration of 10 days. Numerical pain rating scale (NPRS), Goniometric measurement of cervical spine, and Neck disability index (NDI) were used as outcome measures for both pre and post-treatment. Result: The statistical analysis shows that nerve mobilization with proprioceptive neuromuscular facilitation is effective in patients with cervical radiculopathy. Conclusion: The study concludes that nerve mobilization with proprioceptive neuromuscular facilitation as more effective in reducing pain and restoring the cervical ROM and functional ability in neck.**

***Keywords*: Cervical radiculopathy, Nerve mobilization, PNF technique, TENS, Numerical pain rating scale (NPRS), Neck disability index (NDI).**

1. Introduction

Cervical radiculopathy is a condition which involves the impairment of cervical nerve roots, often leading to pain that travels from the neck into the area served by the affected nerve root [1]. Injury to this nerve can result in functional disabilities [2]. Sensory, motor, and reflex disturbances may be present, but they are not always observed [1]. The most frequently involved nerve roots are C6 and C7 [3].

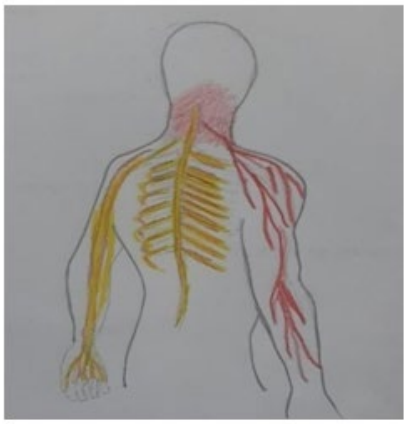

Fig. 1. Cervical radiculopathy

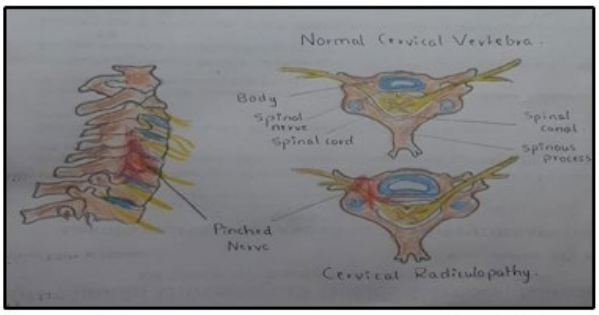

Fig. 2. Pathology of cervical radiculopathy

Annually, 83.2 individuals per 100,000 are diagnosed with this condition, with the rate being 107.3 per 100,000 for men and 64.5 per 100,000 for women [4].

The most prevalent causes of cervical radiculopathy include cervical trauma, spondylosis, disk herniation, spinal instability, and osteophytes [2]. Nerve root impingement by disk herniation is likely to cause nerve damage through both mechanical and chemical mechanisms [5]. Most instances of cervical radiculopathy do not result from disk herniation, but rather from cervical spondylosis, which accounts for 70 % of cases [3]. 22 % of cases occur without any compression as a result of disk herniation [4]. Spondylosis that results in radiculopathy may arise at the facet joints [4]. The degenerative reduction of disk height and consequent arthritic growth can also reduce the size

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of the neural foramen, potentially leading to nerve root compression [4]. Age-related changes in the chemical made-up of the 16 nucleus pulposus and annulus fibrous lead to degenerated disks becoming more compressible and less elastic [6].

Cervical radiculopathy can be characterized as experiencing a sharp, achy, or burning sensation, which may occur in the neck, shoulder, arm, or chest, depending on the specific nerve root affected [6]. Symptoms associated with radiculopathy typically manifest on one side of the body [3]. A reduction in neural mobility and the presence of paraesthesia are the most frequently observed symptoms, while weakness is noted in approximately 15 % of cases [2], [4]. Symptoms often worsen when the neck is extended or flexed laterally toward the side of the affected nerve root [4]. Sensory symptoms, particularly paraesthesia and numbness, are more prevalent than motor deficits and reduced reflexes [6]. Additionally, it is possible for the condition to present without any pain, despite the presence of sensory and motor impairments [5].

The assessment of cervical radiculopathy relies based on the patient's medical history, physical examination, and results from radiographic imaging studies, particularly cervical spine X-rays, to determine nerve root compression resulting from age-related degenerative changes [6]. A CT scan provides direct visualization of the conditions leading to compression of neural structures and can differentiate between neural compression caused by soft tissue and that from bony structures, such as facet hypertrophy [6]. An MRI can noninvasively visualize neural elements and identify significant pathologies [6].

Special examinations like the Spurling test and upper limb tension test (ULTT) can be conducted. The Spurling test involves fully lateral bending and compression of the neck towards the affected side [5], [7].

Management of cervical radiculopathy involves Immobilization by the use of soft collars, alongside massage therapy, anti-inflammatory medications, muscle relaxants, and steroid injections [4]. Physical therapy methods such as intermittent cervical traction, which can be either mechanical or manual, along with electrical stimulation techniques like TENS [8]. Additional treatments include nerve mobilization, manipulation, proprioceptive neuromuscular facilitation, isometric exercises for neck, active range of motion activities for neck, and resistance training for the neck [3], [7], [10].

Surgical options consist of anterior cervical discectomy, cervical disc arthroplasty, and posterior decompression [5].

A. Aim of the Study

To study the effectiveness of nerve mobilization and PNF technique in management of cervical radiculopathy.

B. Objective

The objective of this study is to evaluate the effectiveness of nerve mobilization and the proprioceptive neuromuscular facilitation [PNF]technique in order to reduce pain, increase cervical ROM, and improve the functional ability in patients with cervical radiculopathy.

2. Methodology

A. Source of Data

The patients for the study are scouted from the Dr B R Ambedkar College of Physiotherapy, Bangalore.

B. Study Design

- *Study Type:* Experimental study.
- *Sampling Technique:* Convenient sampling technique.
- *Sample Size:* 30.
- *Duration of Study:* 6 Months.

C. Inclusion Criteria

- With age 30-80.
- Both Subject genders included.
- Patients experiencing pain for over 4 months.
- Radiating pain in at least one upper extremity.

Positive results for the Spurling test and upper limb tension.

D. Exclusion Criteria

- Injuries to the upper limb and spine resulting from trauma.
- Episodes of dizziness.
- Patients may not experience pain but do report with symptoms of tingling and paraesthesia.
- The document starts here. Copy and paste the content in the paragraphs. Circulatory issues affecting the upper extremity.
- Previous history of high-level spinal cord injury and cancer.

E. Out Come Measures

- *NPRS (numerical pain rating scale)*: Was used to measure pain intensity: A scale with 0-10 numerical ranges in which 0 symbolizes no pain and 10 is maximum pain.
- *Goniometer*: A goniometer is utilized to evaluate the neck's range of motion (ROM), assisting in pinpointing restrictions in flexion, extension, lateral flexion, and rotation.
- *Neck disability index (NDI)*: Subject choose from one of six possible responses for each question, with options ranging from no disability (0) to complete disability (5). The scores for the ten items are combined to produce a total score, which can range from 0 (no disability) to 50 (highest level of disability).

F. Interpretation

- Score of less than 4 Indicates no disability
- 5–14 mild disability
- 15–24 moderate disability
- 25–34 severe disability
- scores greater than 35 complete disability.

G. Materials Used

- Cotton
- Chair

- Couch
- Assessment form
- Consent form
- Goniometer
- TENS

Fig. 3. Cotton

Fig. 4. Chair

Fig. 5. Couch

Fig. 6. Signature of consent form

H. Screening Test

Spurling Test: to assess for cervical nerve root compression, which can cause cervical radiculopathy.

Patient position: sitting on the chair comfortably.

Therapist position: Behind the patient.

Procedure: The patient is to extend the head, lateral bending and compression given by the therapist.

Positive sign: The patient complaints of pain [7].

I. Upper Limb Tension Test for All the Nerves

Position of patient: Supine position.

J. Study Procedure

Subject with cervical radiculopathy are taken into consideration. Subject are selected by the proper screening and fulfilling inclusive and exclusive criteria. Inform consent form

Table 1
Procedure

	ULTT1	**ULTT2**	**ULTT3**	**ULTT4**
Shoulder	Depression and abduction (110°)	Depression and abduction (10°)	Depression and abduction (110°)	Depression and abduction (10° to 90°), hand to ear
Elbow	Extension	Extension	Extension	Flexion
Foramen	Supination	Supination	Pronation	Supination or pronation
Wrist	Extension	Extension	Flexion and ulnar deviation	Extension and radial deviation
Finger and Extension thumb	Extension	Extension	Extension	Extension
Shoulder	–	Lateral rotation	Medial	Lateral
Cervical spine	Contralateral side flexion	Contralateral side flexion	Contralateral side flexion	Contralateral side flexion side flexion
Nerve bias	Median nerve, anterior interosseous nerve, C5, C6, C7	Median nerve, anterior interosseous nerve, C5, C6, C7	Median nerve, musculocutaneous nerve, axillary nerve	Radial nerve Ulnar nerve, C8 and T1 nerve roots

was taken from each subject prior to participation, proper instructions were given to the subject about the techniques performed. A total of 30 subject with cervical radiculopathy received nerve mobilization and PNF along with TENS.

1) Nerve Mobilization for Cervical Radiculopathy

- *Patient position*: supine position.
- *Therapist position*: Walk standing position.

K. Procedure

- *Radial Nerve Mobilization*: This technique was carried out with the patient lying on their back in bed and the physiotherapist seated. The shoulder was lifted, while the shoulder girdle was depressed. The elbow was extended with internal rotation of the shoulder, pronation of the forearm, and flexion of the wrist, thumb, and all fingers, followed by ulnar deviation. The tension was adjusted by rotating the head and performing lateral flexion movements.
- *Ulnar Nerve Mobilization*: In this position, the shoulder was depressed with 90° of abduction and the elbow fully flexed, while the forearm was in full pronation and the head turned to the opposite side. The patient's wrist was then positioned in radial deviation with full extension.
- *Median Nerve*: To mobilize the median nerve, the patient was positioned supine in bed. The shoulder was kept in 90° of abduction while depressing the shoulder girdle, the elbow was fully extended, and the wrist and fingers were positioned in ulnar deviation with an extended posture. The degree of tension was modified through lateral flexion and rotation of the head [(12).]

Perform three sets of ten repetitions for each exercise, at a moderate pace, with a three second hold in the final stretched position [9].

Fig. 7. Nerve mobilization technique

L. Proprioceptive Neuromuscular Facilitation for Cervical Radiculopathy

- *Patient position*: Sitting on chair.
- *Therapist position*: Behind the patient.

M. Procedure

PNF contract-relax method involving three sets of repetitions for each neck motion neck flexion, extension, and lateral flexion [10].

Fig. 8. PNF Technique

1) Tens for Cervical Radiculopathy

Patient position: sitting.

N. Procedure

TENS parameters:

- *Frequency*:5 Hz
- *Intensity*: high pulse
- *Intensity Duration*: 300 Micro Sec.
- *Duration*: 20 min ,10 days.

Electrode placement: Area of greatest intensity of pain [8].

Fig. 9. Ten's placement

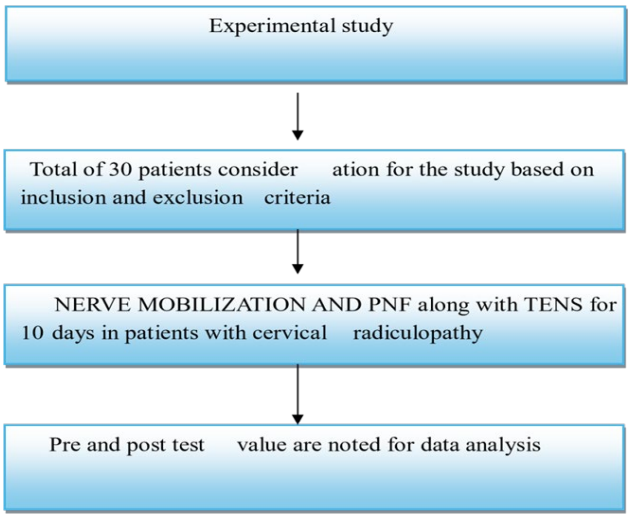

Fig. 10. Consort study

1) *Statistical Analysis*

Table 2
Age-wise distribution

Age groups	Number	Percentage
<=40yrs	14	46.67
41-50yrs	6	20.00
>=51yrs	10	33.33
Total	**30**	**100.00**
Mean	46.03	
SD	12.45	

In this study, the total sample collected/included was so of which 14 samples where with the age <=40yrs will 47%, 10 samples where with the age>=51will 33.33% and 6 samples where with the age from 41-50 yrs will 20.00%.

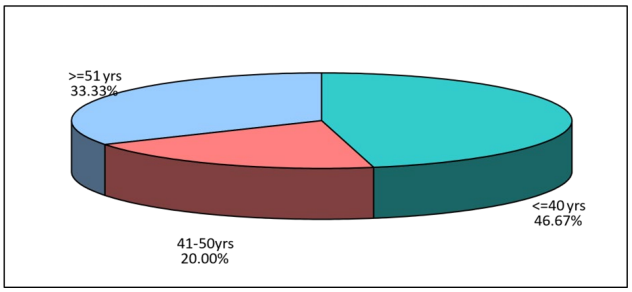

Fig. 11. Age wise distribution

Table 3
Gender wise distribution

Gender	Number	Percentage
Male	12	40.00
Female	18	60.00
Total	**30**	**100.00**

The gender distribution shows that females make up 60.00% of the population with 18 individuals, while males account for 40.00% with 12 individuals.

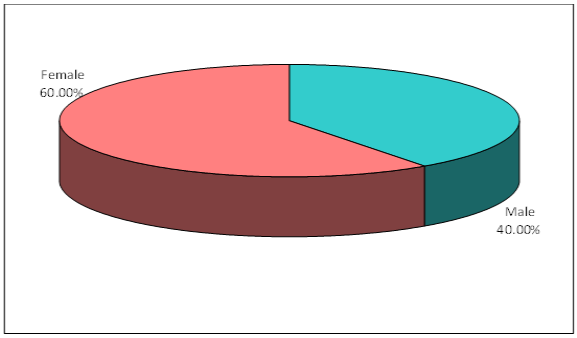

Fig. 12. Gender wise distribution

A significant difference was observed between Day 1 and Day 10 treatment time points with NPRS scores (Z=4.7821, p=0.001) at 5% level of significance. It means that, a significant of 56.35% decrease was observed in NPRS scores after day 10.

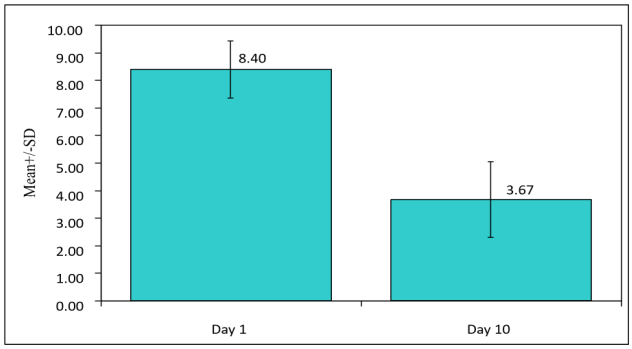

Fig. 13. Comparison of NPRS scores at Day 1 and Day 10 treatment time points

A significant difference was observed between Day 1 and Day 10 treatment time points with NDI scores (Z=4.7821, p=0.001) at 5% level of significance. It means that, a significant of 69.04 % decrease was observed in NDI scores after day 10.

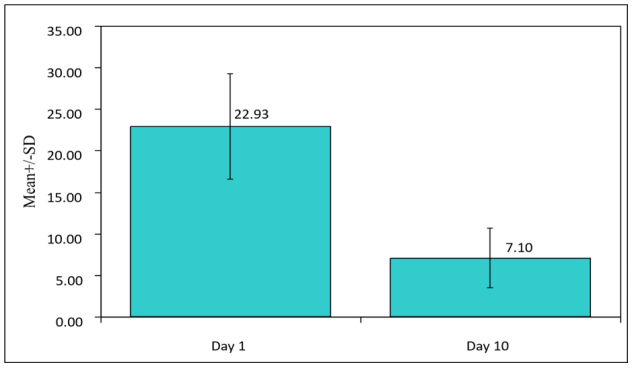

Fig. 14. Comparison of NDI scores at day 1 and day 10 treatment time points

Table 6
Normality of change scores from day 1 to day 10 in all parameters by the Shapiro-Wilk test

Parameters	Shapiro-Wilk	df	Sig.
Flexion	0.7500	30	0.0001*
Extension	0.8390	30	0.0001*
Lateral flexion right	0.9080	30	0.0500*
Lateral flexion left	0.7560	30	0.0001*
Rotation right	0.4920	30	0.0001*
Rotation left	0.7880	30	0.0001*

*p<0.05

Table 4
Comparison of NPRS scores at day 1 and Day 10 treatment time points by Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	8.40	1.04					
Day 10	3.67	1.37	4.73	1.64	56.35	4.7821	0.0001*

*p<0.05

Table 5
Comparison of NDI scores at day 1 and day 10 treatment time points by Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	22.93	6.35					
Day 10	7.10	3.57	15.83	5.89	69.04	4.7821	0.0001*

*p<0.05

Note that, the change scores from day 1 to day 10 in all parameters not follow normal distribution. Therefore, the non-parametric test were applied

A significant difference was observed between Day 1 and Day 10 treatment time points with FLEXION scores (Z=4.2857, p=0.001) at 5% level of significance. It means that, a significant of 14.81% increase was observed in FLEXION scores after day 10.

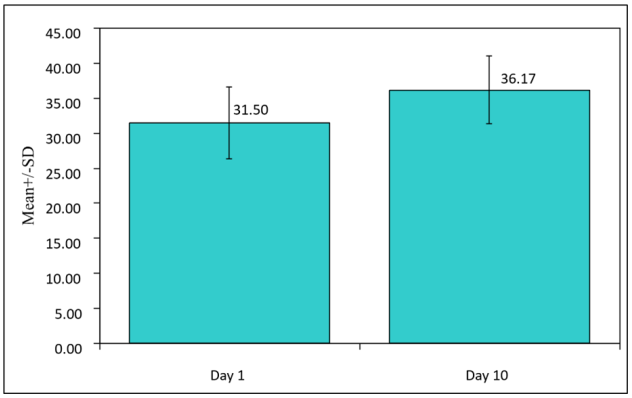

Fig. 15. Comparison of FLEXION scores at Day 1 and Day 10 treatment time points

A significant difference was observed between Day 1 and Day 10 treatment time points with EXTENSION scores (Z=3.8230, p=0.001) at 5% level of significance. It means that, a significant of 15.22% increase was observed in EXTENSION scores after day 10.

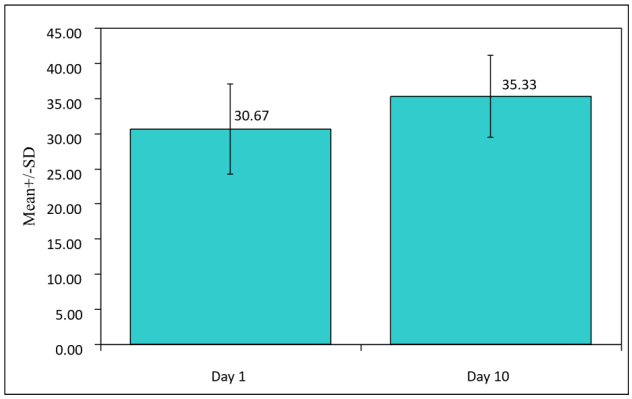

Fig. 16. Comparison of EXTENSION scores at Day 1 and Day 10 treatment time points

A significant difference was observed between Day 1 and Day 10 treatment time points with LATERAL FLEXION RIGHT scores (Z=4.2922, p=0.001) at 5% level of significance. It means that, a significant of 28.44% decrease was observed in LATERAL FLEXION RIGHT scores after day 10.

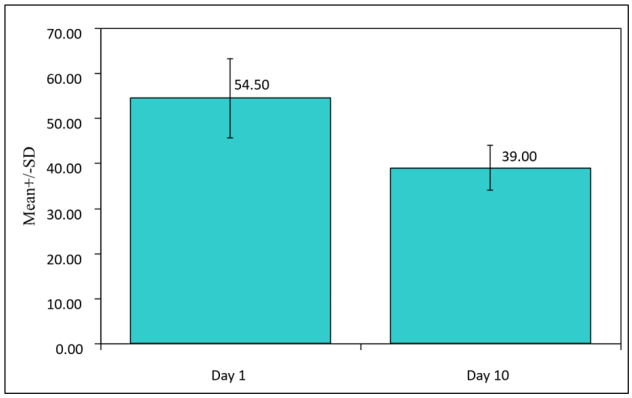

Fig. 17. Comparison of LATERAL FLEXION RIGHT scores at day 1 and day 10 treatment time points

Table 7
Comparison of EXTENSION scores at Day 1 and Day 10 treatment time points by Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	30.67	6.40	-4.67	4.34	-15.22	3.8230	0.0001*
Day 10	35.33	5.86					

*p<0.05

Table 8
Comparison of LATERAL FLEXION RIGHT scores at day 1 and day 10 treatment time points by the Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	54.50	8.80	15.50	12.63	28.44	4.2922	0.0001*
Day 10	39.00	4.98					

*p<0.05

Table 9
Comparison of LATERAL FLEXION LEFT scores at day 1 and day 10 treatment time points by the Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	33.03	6.39	-4.47	3.36	-13.52	4.2571	0.0001*
Day 10	37.50	5.84					

*p<0.05

Table 10
Comparison of ROTATION RIGHT scores at day 1 and day 10 treatment time points by Wilcoxon matched pairs test

Time points	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value
Day 1	36.33	4.90	-4.00	2.03	-11.01	4.2857	0.0001*
Day 10	40.33	4.72					

*p<0.05

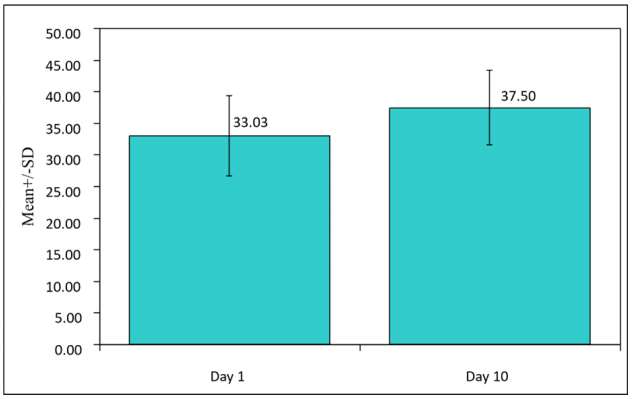

Fig. 18. Comparison of LATERAL FLEXION LEFT scores at day 1 and day 10 treatment time points

A significant difference was observed between Day 1 and Day 10 treatment time points with LATERAL FLEXION LEFT scores (Z=4.2571, p=0.001) at 5% level of significance. It means that, a significant of 13.52% increase was observed in LATERAL FLEXION LEFT scores after day 10.

A significant difference was observed between Day 1 and Day 10 treatment time points with ROTATION RIGHT EFT scores (Z=4.2857, p=0.001) at 5% level of significance. It means that, a significant of 11.01% increase was observed in ROTATION RIGHT scores after day 10.

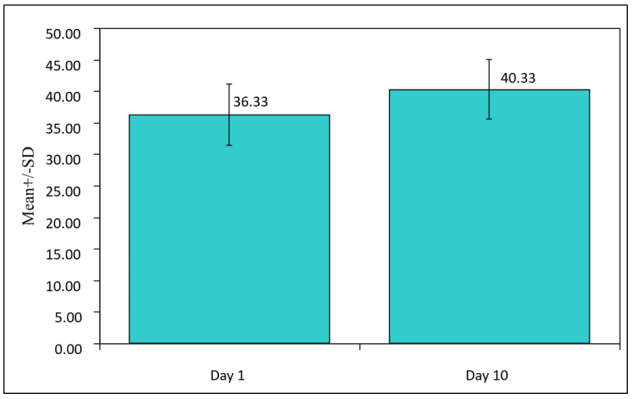

Fig. 19. Comparison of ROTATION RIGHT scores at day 1 and day 10 treatment time points

A significant difference was observed between Day 1 and Day 10 treatment time points with ROTATION LEFT scores (Z=4.1069, p=0.001) at 5% level of significance. It means that, a significant of 12.74% increase was observed in ROTATION LEFT scores after day 10.

O. Result

A total of 30 patients with cervical radiculopathy (age range 30–80 years, both males and females) completed the study. All participants received TENS, nerve mobilization, and PNF contract–relax stretching for 10 consecutive days.

The mean NPRS score reduced significantly from 7.2 ± 1.1 at baseline to 3.1 ± 0.9 postintervention. A paired t-test revealed this reduction to be statistically significant ($p < 0.001$), indicating substantial pain relief following the intervention

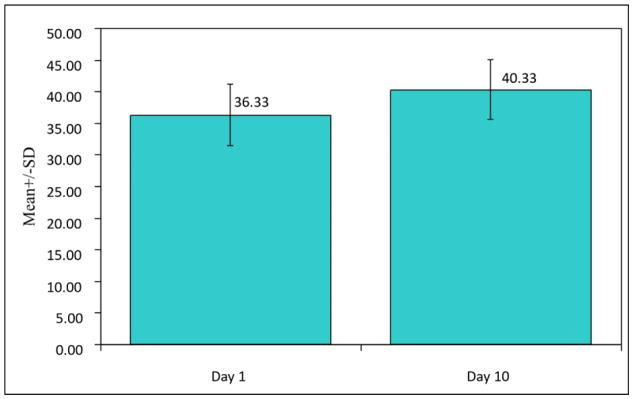

Fig. 20. Comparison of ROTATION LEFT scores at day 1 and day 10 treatment time points

The mean Neck Disability Index (NDI) score decreased from 46.5 ± 6.8 pre-treatment to 21.7 ± 5.3 post-treatment. Statistical analysis showed this difference was highly significant ($p < 0.001$), reflecting marked improvement in functional ability.

Goniometric measurements demonstrated significant improvement across all cervical movements. Flexion improved from 28.6° ± 6.1 to 41.3° ± 5.8 ($p < 0.001$). Extension improved from 30.2° ± 5.4 to 44.6° ± 6.0 ($p < 0.001$). Lateral flexion (R/L) improved from 18.7° ± 4.2 / 19.1° ± 4.5 to 30.8° ± 4.7 / 31.2° ± 4.9 ($p < 0.001$). Rotation (R/L) improved from 38.5° ± 7.3 / 37.9° ± 6.9 to 52.4° ± 6.5 / 53.1° ± 6.2 ($p < 0.001$).

Overall Findings:

The results indicate that a 10-day program of nerve mobilization combined with PNF contract–relax technique and TENS produced statistically significant improvements in pain reduction, cervical mobility, and functional ability in patients with cervical radiculopathy.

3. Discussion

This study evaluates the effectiveness of combining nerve mobilization with PNF to reduce pain, improve range of motion, and enhance functional ability in patients with cervical radiculopathy. Cervical radiculopathy is a disorder caused by compression or irritation of cervical nerve roots—most commonly C6 and C7—leading to neck pain, radiating arm symptoms, sensory changes, and functional limitation. Degenerative changes such as disc herniation, osteophytes, and spondylosis are frequent causes. Physiotherapy is the mainstay of conservative management, aiming to relieve pain and restore cervical motion. Nerve mobilization improves neural tissue mobility, while proprioceptive neuromuscular facilitation (PNF) enhances flexibility and neuromuscular control.

Thirty participants aged 30–80 years, experiencing symptoms for more than four months and demonstrating positive Spurling and upper limb tension tests, were recruited from the outpatient department of Dr. B. R. Ambedkar College of Physiotherapy, Bengaluru. Over a 10-day treatment period, subjects received radial, median, and ulnar nerve mobilization exercises—three sets of ten repetitions with three-second end-range holds—together with PNF contract–relax techniques for cervical flexion, extension, and lateral flexion, and adjunct TENS applied for 20 minutes daily. Pain intensity, cervical

ROM, and functional disability were assessed before and after intervention using the Numerical Pain Rating Scale (NPRS), goniometric measurements, and the Neck Disability Index (NDI).

When comparing pre- and post-intervention outcome measures, significant improvement was observed in pain intensity, neck ROM, and functional ability. These results confirm the hypothesis that combining nerve mobilization with PNF techniques, supported by TENS, provides superior outcomes in managing cervical radiculopathy compared to conventional methods Nerve mobilization, based on Butler's concept, aims to restore the dynamic balance between neural tissues and surrounding mechanical structures. By facilitating neural excursion, reducing intraneural edema, and improving axoplasmic flow, neural mobilization decreases mechanosensitivity and pain. Similar outcomes were reported by Rafiq et al. (2022), who showed that neural mobilization significantly improved pain and disability compared to conservative therapy in cervical radiculopathy patients.

The PNF contract–relax technique addresses muscle tightness and protective spasm through autogenic inhibition, thereby reducing compressive stresses on nerve roots. Gashi et al. (2023) highlighted that PNF stretching enhanced muscle flexibility and cervical mobility, which is consistent with the improvements observed in this study. By combining nerve mobilization and PNF, both neural and muscular components contributing to radicular symptoms were effectively addressed.

The adjunct use of TENS may have further potentiated the analgesic effect. Sharma and Patel (2014) demonstrated that electrotherapy modalities reduce pain perception by altering nociceptive transmission at the spinal cord level. Thus, the combined approach in this study offered both symptomatic relief and functional restoration within a relatively short treatment window of 10 days.

The improvements observed here also align with previous literature emphasizing multimodal physiotherapy interventions. Sambyal and Kumar (2013) found that nerve mobilization was superior to conventional physiotherapy, while Corey and Comeau (2014) stressed that exercise based and manual therapy strategies are essential in cervical radiculopathy management.

Post-intervention outcomes showed clinically meaningful reductions in pain scores, significant gains in cervical ROM, and improved NDI ratings, supporting the hypothesis that combining nerve mobilization with PNF provides superior benefits compared to conventional single modality therapy. These findings highlight the value of an integrated physiotherapy protocol to address both neural and musculoskeletal components of cervical radiculopathy, offering a practical and effective treatment strategy for improving patient function and quality of life.

4. Summary

Cervical radiculopathy, commonly affecting the C6 and C7 nerve roots, leads to pain, paresthesia, numbness, and muscle weakness. This study aimed to assess the effectiveness of nerve mobilization and proprioceptive neuromuscular facilitation (PNF) techniques in managing cervical radiculopathy. A sample of 30 patients (aged 30–80 years) received nerve mobilization combined with PNF contract-relax stretching and TENS for 10 days. Outcomes were evaluated using the Numerical Pain Rating Scale (NPRS), goniometric cervical range of motion (ROM), and Neck Disability Index (NDI) before and after treatment. The intervention demonstrated improvements in pain reduction, cervical ROM, and functional ability, highlighting the clinical value of combining nerve mobilization with PNF techniques in cervical radiculopathy management.

5. Conclusion

The present study demonstrated that the combined use of nerve mobilization and proprioceptive neuromuscular facilitation (PNF) contract-relax techniques, along with TENS, is effective in the management of cervical radiculopathy. Patients showed a significant reduction in pain, improvement in cervical range of motion, and enhancement of functional ability as measured by NPRS, goniometric values, and NDI scores. Therefore, this combined physiotherapy approach can be considered a beneficial and practical intervention for patients with cervical radiculopathy.

6. Limitations

The study had a small sample size (30 participants), which limits the generalizability of the results.

- The short intervention period (10 days) may not reflect long-term outcomes.
- Use of a convenient sampling method could introduce selection bias.
- Lack of a control group receiving only conventional therapy makes it difficult to isolate the effects of nerve mobilization and PNF techniques.
- The study population was restricted to individuals aged 35–80 years, so results may not apply to other age groups.

7. Recommendations

- Future studies should be conducted with a larger and more diverse sample size to enhance external validity.
- A longer follow-up period is recommended to assess sustained effects of the interventions.
- Randomized controlled trials (RCTs) should be carried out to minimize bias and provide stronger evidence.
- Comparative studies with different physiotherapy techniques could help identify the most effective intervention.

Incorporating objective imaging or neurophysiological assessments may strengthen the evaluation of treatment outcomes.

References

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