RESEARCH PAPER

Effect of spinal manual therapy with modified rigid taping technique on pain, range of motion, straight leg raising, and nerve conduction velocity in patients with lumbar radiculopathy

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Abstract
Lumbar radiculopathy is often accompanied by pain, limited lumbar range of motion, decreased straight leg raising (SLR), neural involvement and functional disability. In this pilot study, the effect of manual therapy technique on the spine combined with modified rigid taping technique (MRTT) and conventional physiotherapy has been evaluated in patients with lumbar radiculopathy. The 15 participants were evaluated before and after four weeks on Numeric Pain Rating Scale (NPRS), lumbar range of motion (ROM), SLR, tibial nerve and common peroneal nerve conduction velocity (NCV) and Oswestry Disability Index (ODI). Treatment was given three times a week for a period of four weeks. NPRS decreased from 6.67 to 2.40, while ODI decreased from 46.07% to 16.27%. SLR improved from 56.33° to 77.60°. Lumbar ranges of flexion, extension and lateral flexion also improved after treatment. There was slight improvement in tibial and common peroneal NCV. In conclusion, the overall intervention was correlated with a decrease in pain, functional disability, and an increase in lumbar mobility, SLR, and NCV. The results suggest that there may be clinical applications, but more controlled studies are needed.

Keywords: *Lumbar radiculopathy; Maitland mobilization; Modified Rigid Taping Technique; conventional physiotherapy; NPRS; SLR; NCV; ODI.*
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1. Introduction

Lumbar radiculopathy is among the most prevalent issues assessed by a spinal surgeon. Its occurrence has been approximated at 3%-5% of the populace, impacting both genders. Age constitutes a principal risk factor, as it arises as a consequence of the degenerative changes inside the spinal column. Symptoms generally manifest during middle age, with males frequently impacted in their 40s and females in their 50s and 60s [1]. Women face an elevated risk in specific demographics, particularly in physically strenuous professions like military service. In the broader populace, there exists a predominance of males [2].

Degenerative spondyloarthropathies are the primary cause of lumbar radiculopathy. Patients Typically manifests with back discomfort linked to their radiculopathy. Radiculopathy, by its very nature, refers to discomfort that extends down the legs and is frequently characterized by patients as electric, burning, or acute. The predominant underlying factor of radiculopathy is the irritation of a specific nerve, which can transpire at any location along the nerve and is frequently due to a compressive stress [3].

Low back pain (LBP) is a prevalent musculoskeletal issue impacting the general populace, with a worldwide prevalence reaching 10.2%, serving as a significant contributor to years lived with disability. Recovery is less advantageous when back pain is accompanied by leg pain, likely due to the increased impairment involved. Leg discomfort may stem from impaired musculoskeletal or neurological components of the lumbar spine. In instances of neurological impairment, lumbar radiculopathy is regarded as a potential diagnosis, with a lifetime prevalence that may reach 43%. The diagnostic standard encompasses sensory and motor impairments of a particular nerve root, aligning with the pattern of leg symptoms. Discomfort linked to radiculopathy may stem from structural impairment affecting nerve roots, perhaps resulting in neuropathic pain in certain instances [4].

Clinical practice recommendations (National Institute for Health and Care Excellence 2016) advocate for

initial conservative management, which include support and advice, physical activity, manual therapy, psychological interventions, and pharmacological treatment. Alternative physiotherapy suggestions have encompassed mobilization, electrotherapy, traction, taping, and exercise, although there is no definitive data endorsing any single approach. A recent systematic review indicated low to intermediate quality evidence supporting manual therapy for the treatment of lumbar radiculopathy [5].

2. Methodology of the Pilot Study

Fifteen patients with a diagnosis of lumbar radiculopathy were included for evaluation. The participant is asked to record the following pre and post measurements: demographical data, affected limb, duration of symptoms, clinical diagnosis, pain intensity, lumbar range of motion, straight leg raising, nerve conduction velocity, and functional disability.

The intervention protocol adopted consisted of Spinal Manual Therapy, which comprised of Maitland's mobilization, Modified Rigid Taping Technique (MRTT), and Conventional Physiotherapy. The study protocol included three sessions weekly, each conducted for about 40–60 minutes and during a four week intervention period, with assessment at baseline and at the end of the intervention.

Participant characteristics

Participants had a diagnosis of lumbar radiculopathy/PIVD (L4–L5 and/or L5–S1). There were both male and female participants, and affected limbs noted as right, left, or affected side (bilateral if noted).

Table 1. The individual participant records

Patients	Age (in years)	Gender	Height (cm)	Weight (kg)	Occupation	Affected limb	Duration of symptoms	Clinical diagnosis
Patient 1	48	F				RT		L4-L5 PI VD
Patient 2	26	F			Make up artist	L		L5-S1 PI VD
Patient 3	44	F				Right		L5-S1 PI VD
Patient 4	48	M				Rt		L4-L5 PI VD
Patient 5	28	F				RT		L5-S1 PI VD
Patient 6	50	F				left side		L4-L5 and L5-S1 PI VD
Patient 7	26	F				Left		L5-S1 PI VD
Patient 8	26	F				Left		L4-L5 PI VD
Patient 9	50	F				Rt.		L4-L5 and L5-S1 PI VD
Patient 10	40	F				Lt		L5-S1 PI VD
Patient 11	41	F	165 cm	67.8	Homemaker	Left	8 weeks	L4-L5 and L5-S1 PI VD
Patient	44 y.	F	165	68	Teacher	Right	7 weeks	L4-L5 and L5-S1 PI VD

12								S1 PI VD
Patient 13	48	F	162	59	Home maker	Right	7 weeks	L4-L5 and L5-S1 PI VD
Patient 14	33	M	168	69	Engineer	Right	4 weeks	L4-L5 PW D
Patient 15	26	M	170	70	Raft guide	Left	5 weeks	L5-S1 PW D

The clinical features presented to the participants were typical of lumbar radiculopathy: pain, reduced lumbar movement, reduced straight leg raising and functional disability were recorded on the data sheets. The most common clinical diagnoses in the participants forms were L4–L5 PIVD, L5–S1 PIVD, and L4–L5 and L5–S1 PIVD. The study protocol defines lumbar radiculopathy as a condition with radiating pain, tingling numbness and muscle weakness, and defines MRI confirmed lumbar radiculopathy as an inclusion criterion.

- **The participants presented with:**
  - Low back and/or radiating pain associated with lumbar radiculopathy.
  - Increased pain intensity as recorded on the Numeric Pain Rating Scale.
  - Restricted lumbar flexion.
  - Restricted lumbar extension.
  - Restricted lateral flexion.
  - Reduced Straight Leg Raise range.
  - Functional disability as reflected by the Oswestry Disability Index.
  - Altered motor nerve conduction measurements in some participants.

3. Baseline clinical assessment

Pre-testing of baseline was conducted prior to intervention. The assessment consisted of the measurement of pain intensity, the range of motion of the lumbar spine, Straight Leg Raise, nerve conduction velocity and functional disability

1. **Numeric Pain Rating Scale (NPRS)** – assessment of pain intensity.
2. **Lumbar Range of Motion (ROM)** – flexion, extension and lateral flexion.
3. **Straight Leg Raise (SLR)** – assessment of SLR range/pain response.
4. **Nerve Conduction Velocity (NCV)** – tibial and common peroneal nerve measurements.
5. **Oswestry Disability Index (ODI)** – assessment of functional disability.

4. Intervention

The intervention consisted of:

4.1 Spinal Manual Therapy

The spinal manual therapy was added to the intervention as mobilization of Maitland.

4.2 Modified Rigid Taping Technique

The manual therapy and conventional physiotherapy were combined with Modified Rigid Taping Technique as an extra therapeutic factor.

4.3 Conventional Physiotherapy

Treatment protocol included conventional physiotherapy.

5. Procedure followed

Those who met the inclusion and exclusion criteria were assessed as the participants. The baseline assessment took place prior to intervention.The following sequence was used:

Participants selection → Baseline assessment → Spinal Manual Therapy + MRTT + Conventional Physiotherapy → Post intervention assessment

The following baseline and post-intervention measurements were taken:

- NPRS
- Lumbar flexion
- Lumbar extension
- Lumbar lateral flexion
- SLR
- Tibial nerve NCV
- Common peroneal nerve NCV
- ODI

6. Result and Analysis

The comparison of the pre- and post-intervention NPRS scores, lumbar range of motion, straight leg raising, nerve conduction velocity, and functional disability was done to assess the effect of spinal manual therapy with the Modified Rigid Taping Technique (MRTT) and conventional physiotherapy in patients with lumbar radiculopathy. The results obtained indicated that the outcomes improved after the intervention. The average pre-intervention NPRS score was 6.40 (SD = 1.51) and the average post-intervention NPRS score was 2.20 (SD = 2.15), and it was observed that pain had reduced after the intervention. Similarly, lumbar flexion improved from 42.20° (SD = 12.04°) to 52.50° (SD = 10.37°), lumbar extension from 28.70° (SD = 7.35°) to 31.40° (SD = 7.46°), lateral flexion from 21.00° (SD = 5.33°) to 25.50° (SD = 5.70°), and straight leg raising from 59.00° (SD = 15.06°) to 78.40° (SD = 13.21°).

The ODI score decreased from 43.10% (SD = 13.52%) to 15.50% (SD = 12.63%), indicating an improvement in functional status. Table 1 shows the values of the pre- and post-intervention measurements for every participant, as well as the percentage change calculated.

Table 2. NPRS – Pain Intensity

Participant	Pre-test	Post-test	Change	% Change
P1	7	3	-4	-57.14%
P2	9	2	-7	-77.78%
P3	8	3	-5	-62.50%
P4	5	1	-4	-80.00%
P5	7	5	-2	-28.57%
P6	6	1	-5	-83.33%
P7	8	6	-2	-25.00%
P8	6	1	-5	-83.33%
P9	8	6	-2	-25.00%
P10	4	1	-3	-75.00%
P11	7	2	-5	-71.43%
P12	8	3	-5	-62.50%
P13	7	1	-6	-85.71%
P14	6	1	-5	-83.33%
P15	4	0	-4	-100.00%
Mean	**6.67**	**2.40**	**-4.27**	**-64.00%**



Figure 1 Comparison of Pre- and Post-Intervention NPRS – Pain Intensity

Table 2 and Figure 1 present the pre-test and post-test scores of the 15 participants and demonstrate a consistent reduction in scores following the intervention. All 15 participants showed improvement, with their scores decreasing from pre-test to post-test. The percentage reduction ranged from 25.00% to 100.00%, indicating variation in the magnitude of improvement across participants. The greatest reduction was observed in P15, whose score decreased from 4 at pre-test to 0 at post-test, representing a 100.00% reduction. This was followed by P13, with an 85.71% reduction, and P6, P8, and P14, each showing an 83.33% reduction. P4 also demonstrated substantial improvement, with an 80.00% reduction, while P2 and P10 showed reductions of 77.78% and 75.00%, respectively. P11 showed a 71.43% reduction, whereas P3 and P12 each demonstrated a 62.50% reduction. P1 showed a 57.14% reduction. The lowest reductions were observed in P5 (28.57%) and P7 and P9 (25.00%), indicating comparatively smaller improvements among these participants. Overall, the mean score decreased from 6.67 at pre-test to 2.40 at post-test, representing a mean reduction of 4.27 points or 64.00%. These findings indicate a substantial overall improvement following the intervention, with all participants experiencing a reduction in their scores and the magnitude of improvement varying across individuals.

Table 3. Lumbar Flexion

Participant	Pre-test (°)	Post-test (°)	Change (°)	% Change
P1	35	50	15	42.86%
P2	20	60	40	200.00%
P3	60	65	5	8.33%
P4	35	40	5	14.29%

P5	40	51	11	27.50%
P6	40	55	15	37.50%
P7	50	55	5	10.00%
P8	50	60	10	20.00%
P9	15	25	10	66.67%
P10	60	63	3	5.00%
P11	40	55	15	37.50%
P12	42	56	14	33.33%
P13	35	50	15	42.86%
P14	40	51	11	27.50%
P15	50	55	5	10.00%
Mean	**40.80**	**52.73**	**11.93**	**29.25%**

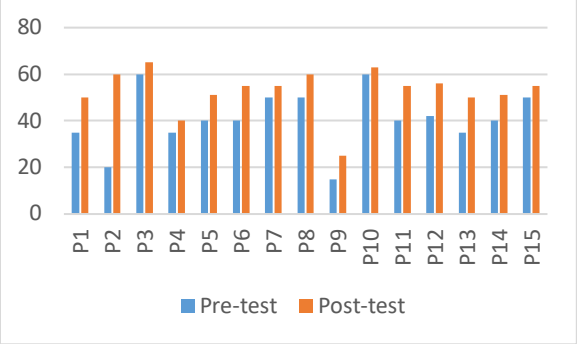


Figure 2 Comparison of Pre- and Post-Intervention lumbar flexion

Table 3 and Figure 2 present the pre-test and post-test scores of the 15 participants and demonstrate an overall improvement in scores following the intervention. All 15 participants showed an increase in their scores from pre-test to post-test, indicating consistent improvement across the sample. The percentage increase ranged from 5.00% to 200.00%, reflecting considerable variation in the magnitude of improvement among participants. The greatest improvement was observed in P2, whose score increased from 20° at pre-test to 60° at post-test, representing an increase of 40° or 200.00%. This was followed by P9, whose score increased from 15° to 25°, representing a 10° improvement or 66.67%. P1 and P13 each demonstrated a 15° increase, corresponding to a 42.86% improvement. P6 and P11 also showed a 15° increase, representing a 37.50% improvement in both cases. P12 demonstrated a 14° increase, corresponding to a 33.33% improvement, while P5 and P14 each showed an 11° increase, representing a 27.50% improvement. P8 showed a 10° increase, equivalent to a 20.00% improvement. P4 demonstrated a 5° increase or 14.29% improvement, whereas P7 and P15 each showed a 5° increase, corresponding to a 10.00% improvement. The smallest percentage improvement was observed in P10, whose score increased from 60° to 63°, representing an increase of 3° or 5.00%. P3 showed a 5° increase, corresponding to an 8.33% improvement. Overall, the mean score increased from 40.80° at pre-test to 52.73° at post-test, representing a mean improvement of 11.93° or 29.25%. These findings indicate a substantial overall improvement following the intervention, with all participants demonstrating positive changes, although the magnitude of improvement varied considerably across individuals.

Table 4. Lumbar Extension

Participant	**Pre-test**	**Post-test**	**Change (°)**	**% Change**
P1	30	33	3	10.00%
P2	10	30	20	200.00%
P3	30	32	2	6.67%
P4	20	21	1	5.00%
P5	33	35	2	6.06%
P6	28	30	2	7.14%
P7	30	32	2	6.67%
P8	25	30	5	20.00%
P9	10	12	2	20.00%
P10	34	34	0	0.00%
P11	28	31	3	10.71%
P12	30	33	3	10.00%

P13	32	36	4	12.50%
P14	35	39	4	11.43%
P15	35	37	2	5.71%
Mean	**27.33**	**31.00**	**3.67**	**13.41%**

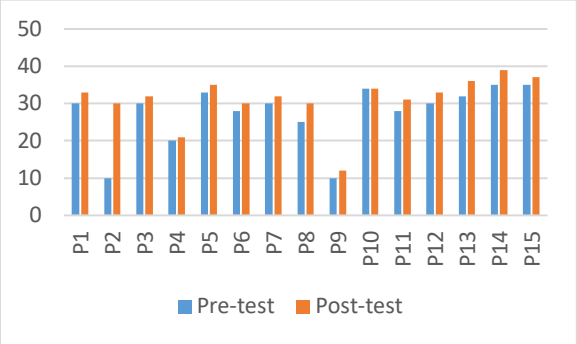


Figure 3 Comparison of Pre- and Post-Intervention lumbar extension

Table 4 and Figure 3 present the pre-test and post-test scores of the 15 participants and demonstrate an overall improvement in scores following the intervention. The findings show that most participants experienced an increase in their scores from pre-test to post-test, indicating positive changes following the intervention. Out of the 15 participants, 14 demonstrated improvement, while P10 showed no change in score. The percentage increase ranged from 0.00% to 200.00%, reflecting considerable variation in the magnitude of improvement among participants. The greatest improvement was observed in P2, whose score increased from 10° at pre-test to 30° at post-test, representing an increase of 20° or 200.00%. This was followed by P8 and P9, which each demonstrated a 20.00% improvement. P13 showed a 4° increase, corresponding to a 12.50% improvement, while P14 demonstrated a 4° increase or 11.43% improvement. P11 showed a 3° increase, representing a 10.71% improvement, whereas P1 and P12 each demonstrated a 3° increase, corresponding to a 10.00% improvement. P6 and P7 each showed a 2° increase, representing improvements of 7.14% and 6.67%, respectively. P3 also demonstrated a 2° increase, corresponding to a 6.67% improvement, while P15 showed a 2° increase or 5.71% improvement. P5 demonstrated a 2° increase, representing a 6.06% improvement, and P4 showed a 1° increase, corresponding to a 5.00% improvement. P10 showed no change, with the score remaining at 34° in both the pre-test and post-test, resulting in 0.00% change. Overall, the mean score increased from 27.33° at pre-test to 31.00° at post-test, representing a mean improvement of 3.67° or 13.41%. These findings indicate an overall positive change following the intervention, with the majority of participants demonstrating improvement, although the magnitude of change varied substantially across individuals.

Table 5. Lumbar Lateral Flexion

Participant	Pre-test	Post-test	Change (°)	% Change
P1	17	25	8	47.06%
P2	10	25	15	150.00%
P3	28	30	2	7.14%
P4	20	23	3	15.00%
P5	20	25	5	25.00%
P6	25	28	3	12.00%
P7	25	27	2	8.00%
P8	20	23	3	15.00%
P9	10	10	0	0.00%
P10	28	29	1	3.57%
P11	20	28	8	40.00%
P12	23	28	5	21.74%
P13	17	26	9	52.94%
P14	17	26	9	52.94%
P15	25	28	3	12.00%
Mean	20.33	25.40	5.07	24.92%

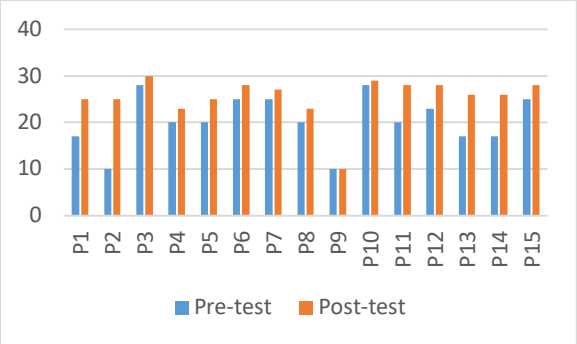


Figure 4 Comparison of Pre- and Post-Intervention lateral flexion

Table 5 and Figure 4 present the pre-test and post-test scores of the 15 participants and demonstrate an overall improvement in scores following the intervention. The findings show that 14 out of 15 participants experienced an increase in their scores, while P9 showed no change between the pre-test and post-test assessments. The percentage increase ranged from 0.00% to 150.00%, indicating variation in the magnitude of improvement across participants. The greatest improvement was observed in P2, whose score increased from 10° at pre-test to 25° at post-test, representing an increase of 15° or 150.00%. This was followed by P13 and P14, who each demonstrated a 9° increase, corresponding to a 52.94% improvement. P1 showed an 8° increase, representing a 47.06% improvement, while P11 demonstrated an 8° increase or 40.00% improvement. P5 and P12 each showed a 5° increase, corresponding to improvements of 25.00% and 21.74%, respectively. P4 and P8 each demonstrated a 3° increase, representing a 15.00% improvement, while P6 and P15 also showed a 3° increase, corresponding to 12.00% improvement in both cases. P7 demonstrated a 2° increase, representing an 8.00% improvement, whereas P3 showed a 2° increase or 7.14% improvement. P10 demonstrated the smallest positive change, with an increase of 1°, corresponding to a 3.57% improvement. P9 showed no change, with the score remaining at 10° in both the pre-test and post-test, resulting in 0.00% change. Overall, the mean score increased from 20.33° at pre-test to 25.40° at post-test, representing a mean improvement of 5.07° or 24.92%. These findings indicate a clear overall improvement following the intervention, with the majority of participants demonstrating positive changes, although the magnitude of improvement varied considerably across individuals.

Table 6. Straight Leg Raising (SLR)

Participant	Pre-test	Post-test	Change (°)	% Change
P1	45	60	15	33.33%
P2	35	54	19	54.29%
P3	70	95	25	35.71%
P4	40	60	20	50.00%
P5	65	85	20	30.77%
P6	70	80	10	14.29%
P7	80	85	5	6.25%
P8	50	80	30	60.00%
P9	40	50	10	25.00%
P10	80	90	10	12.50%
P11	50	75	25	50.00%
P12	60	90	30	50.00%
P13	45	69	24	53.33%
P14	45	96	51	113.33%
P15	70	95	25	35.71%
Mean	56.33	77.60	21.27	37.75%

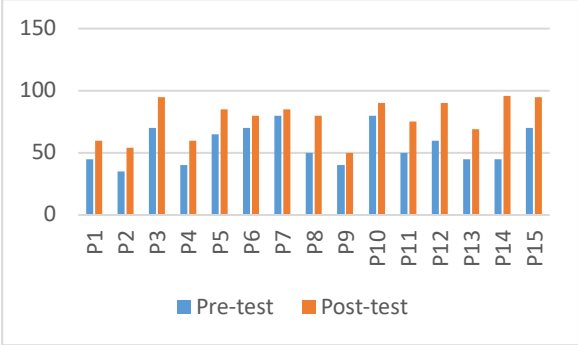


Figure 5 Comparison of Pre- and Post-Intervention straight leg raising (SLR)

Table 6 and Figure 5 present the pre-test and post-test scores of the 15 participants and demonstrate a clear overall improvement in scores following the intervention. All 15 participants showed an increase in their scores from pre-test to post-test, indicating consistent positive changes across the entire group. The percentage increase ranged from 6.25% to 113.33%, reflecting substantial variation in the magnitude of improvement among participants. The

greatest improvement was observed in P14, whose score increased from 45° at pre-test to 96° at post-test, representing an increase of 51° or 113.33%. This was followed by P8 and P12, which each demonstrated a 30° increase, corresponding to improvements of 60.00% and 50.00%, respectively. P13 showed a 24° increase, representing a 53.33% improvement, while P2 demonstrated a 19° increase or 54.29% improvement. P4 and P11 each showed a 20° increase, corresponding to a 50.00% improvement in both cases. P3 and P15 each demonstrated a 25° increase, representing improvements of 35.71%. P1 showed a 15° increase, corresponding to a 33.33% improvement, while P5 demonstrated a 20° increase or 30.77% improvement. P9 showed a 10° increase, representing a 25.00% improvement, whereas P6 demonstrated a 10° increase or 14.29% improvement. P10 showed a 10° increase, corresponding to a 12.50% improvement. The smallest percentage improvement was observed in P7, whose score increased from 80° to 85°, representing an increase of 5° or 6.25%. Overall, the mean score increased from 56.33° at pre-test to 77.60° at post-test, representing a mean improvement of 21.27° or 37.75%. These findings indicate a substantial overall improvement following the intervention, with every participant demonstrating a positive change in scores, although the magnitude of improvement varied considerably across individuals.

Table 7. Tibial Nerve Conduction Velocity (NCV)

Participant	Pre-test	Post-test	Change	% Change
P1	46.0	46.7	0.7	1.52%
P2	46.2	47.8	1.6	3.46%
P3	46.3	49.8	3.5	7.56%
P4	46.0	46.1	0.1	0.22%
P5	46.3	46.4	0.1	0.22%
P6	45.1	46.5	1.4	3.10%
P7	46.6	46.7	0.1	0.21%
P8	46.6	46.6	0.0	0.00%
P9	46.4	46.5	0.1	0.22%
P10	46.5	46.5	0.0	0.00%
P11	45.2	46.3	1.1	2.43%
P12	45.1	45.1	0.0	0.00%
P13	46.0	46.0	0.0	0.00%
P14	46.4	46.4	0.0	0.00%
P15	48.2	48.2	0.0	0.00%
Mean	46.19	46.77	0.58	1.26%

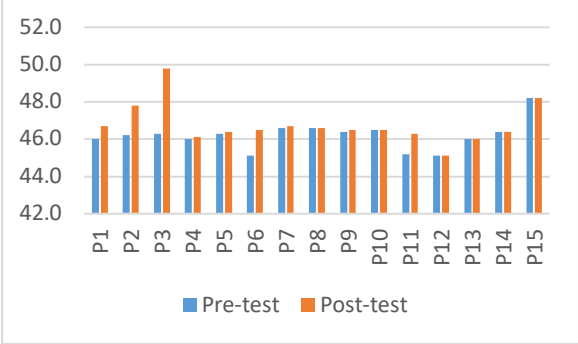


Figure 6 Comparison of Pre- and Post-Intervention tibial nerve conduction velocity (NCV)

Table 7 and Figure 6 present the pre-test and post-test scores of the 15 participants and show a small overall increase following the intervention. Unlike the previous measures, the magnitude of change in this variable was relatively limited, with several participants showing no change between the pre-test and post-test assessments. Out of the 15 participants, 8 demonstrated an increase in scores, while 7 participants showed no change. The percentage increase ranged from 0.00% to 7.56%, indicating relatively small individual changes across the participants. The greatest improvement was observed in P3, whose score increased from 46.3 at pre-test to 49.8 at post-test, representing an increase of 3.5 points or 7.56%. P2 showed the second-largest improvement, with an increase from 46.2 to 47.8, representing a change of 1.6 points or 3.46%. P6 demonstrated an increase of 1.4 points, corresponding to a 3.10% improvement, while P11 showed an increase of 1.1 points or 2.43%. P1 demonstrated a 0.7-point increase, representing a 1.52%

improvement. P4, P5, and P9 each showed a small increase of 0.1 point, corresponding to a 0.22% change. P7 also demonstrated a 0.1-point increase, representing a 0.21% improvement. In contrast, P8, P10, P12, P13, P14, and P15 showed no change between their pre-test and post-test scores, resulting in 0.00% change. Overall, the mean score increased from 46.19 at pre-test to 46.77 at post-test, representing a mean improvement of 0.58 points or 1.26%. These findings indicate a slight overall improvement following the intervention; however, the magnitude of change was considerably smaller than that observed for the other measures, with nearly half of the participants showing no measurable change in their scores.

Table 8. Common Peroneal Nerve Conduction Velocity (NCV)

Participant	Pre-test	Post-test	Change	% Change
P1	46.7	52.3	5.6	11.99%
P2	47.5	49.3	1.8	3.79%
P3	49.1	49.2	0.1	0.20%
P4	47.1	47.1	0.0	0.00%
P5	49.1	49.0	-0.1	-0.20%
P6	49.3	49.8	0.5	1.01%
P7	47.3	47.3	0.0	0.00%
P8	47.0	47.1	0.1	0.21%
P9	47.8	49.0	1.2	2.51%
P10	49.1	49.1	0.0	0.00%
P11	49.0	49.3	0.3	0.61%
P12	49.3	49.4	0.1	0.20%
P13	46.8	49.3	2.5	5.34%
P14	47.3	47.3	0.0	0.00%
P15	49.5	49.5	0.0	0.00%
Mean	48.13	48.93	0.81	1.68%



Figure 7 Comparison of Pre- and Post-Intervention common peroneal nerve conduction velocity (NCV)

Table 8 and Figure 7 present the pre-test and post-test scores of the 15 participants and show a slight overall improvement following the intervention. The findings indicate that the magnitude of change was relatively small compared with the improvements observed in the other measures. Out of the 15 participants, 9 demonstrated an increase in their scores, 5 participants showed no change, and 1 participant showed a slight decrease. The percentage change ranged from -0.20% to 11.99%, indicating considerable variation in the magnitude of individual changes. The greatest improvement was observed in P1, whose score increased from 46.7 at pre-test to 52.3 at post-test, representing an increase of 5.6 points or 11.99%. This was followed by P13, whose score increased from 46.8 to 49.3, representing an improvement of 2.5 points or 5.34%. P2 demonstrated an increase of 1.8 points, corresponding to a 3.79% improvement, while P9 showed an increase of 1.2 points or 2.51%. P6 demonstrated a 0.5-point increase, representing a 1.01% improvement, and P11 showed a 0.3-point increase or 0.61% improvement. P3, P8, and P12 each demonstrated a small increase of 0.1 point, corresponding to changes of 0.20%, 0.21%, and 0.20%, respectively. P4, P7, P10, P14, and P15 showed no change between pre-test and post-test scores, resulting in 0.00% change. In contrast, P5 showed a slight decrease from 49.1 to 49.0, representing a reduction of 0.1 point or -0.20%. Overall, the mean score increased from 48.13 at pre-test to 48.93 at post-test, representing a mean improvement of 0.81 points or 1.68%. These findings indicate a modest overall improvement following the

intervention, with the largest gains concentrated among a few participants, while several participants showed either no measurable change or only minimal changes in their scores.

Table 9. Oswestry Disability Index (ODI)

Participant	Pre-test	Post-test	Change (%)	% Change
P1	60	19	-41	-68.33%
P2	70	20	-50	-71.43%
P3	40	10	-30	-75.00%
P4	40	10	-30	-75.00%
P5	50	30	-20	-40.00%
P6	40	10	-30	-75.00%
P7	30	20	-10	-33.33%
P8	40	10	-30	-75.00%
P9	60	50	-10	-16.67%
P10	20	8	-12	-60.00%
P11	40	10	-30	-75.00%
P12	40	10	-30	-75.00%
P13	60	15	-45	-75.00%
P14	61	13	-48	-78.69%
P15	40	9	-31	-77.50%
Mean	46.07	16.27	-29.80	-64.69%

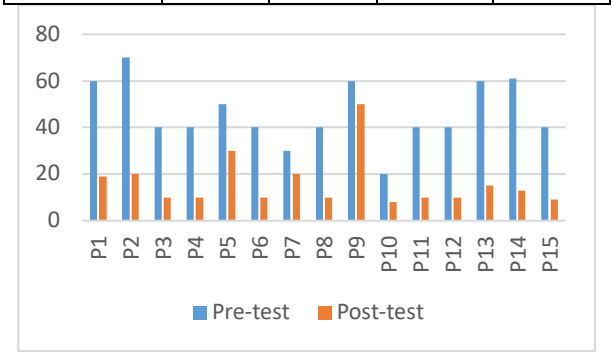


Figure 8 Comparison of Pre- and Post-Intervention Oswestry Disability Index (ODI)

Table 9 and Figure 8 present the pre-test and post-test scores of the 15 participants and demonstrate a consistent and substantial reduction in scores following the intervention. All 15 participants showed a decrease in their scores from pre-test to post-test, indicating improvement in the measured outcome when lower scores represent better performance or reduced severity. The percentage reduction ranged from 16.67% to 78.69%, demonstrating considerable variation in the magnitude of improvement across participants. The greatest reduction was observed in P14, whose score decreased from 61 at pre-test to 13 at post-test, representing a reduction of 48 points or 78.69%. This was followed by P15, whose score decreased from 40 to 9, representing a reduction of 31 points or 77.50%. P3, P4, P6, P8, P11, P12, and P13 each demonstrated a 75.00% reduction in scores. P2 showed a reduction of 50 points, corresponding to a 71.43% decrease, while P1 demonstrated a 41-point reduction or 68.33% decrease. P10 showed a reduction of 12 points, representing a 60.00% decrease, whereas P5 demonstrated a 20-point reduction or 40.00% decrease. P7 showed a 10-point reduction, corresponding to a 33.33% decrease. The smallest percentage reduction was observed in P9, whose score decreased from 60 to 50, representing a reduction of 10 points or 16.67%.

Overall, the mean score decreased from 46.07 at pre-test to 16.27 at post-test, representing a mean reduction of 29.80 points or 64.69%. This substantial decline in the mean score indicates a marked overall improvement following the intervention. The consistency of the reduction across all 15 participants further suggests that the intervention had a positive effect on the measured outcome, although the magnitude of improvement varied among individual participants.

Table 10. Descriptive Statistics of Pre- and Post-Intervention NPRS

Measure	Pre-Intervention	Post-Intervention
Mean NPRS (0–10)	6.67	2.40
Standard Deviation	1.50	1.92
Range	4–9	0–6
Effect Size (Cohen's d)	—	2.87
95% Confidence Interval (Pre − Post)	3.44 to 5.09	—

There was a clear reduction in pain intensity following the intervention, as reflected by the decrease in mean NPRS from 6.67 (SD = 1.50) at pre-intervention to 2.40 (SD = 1.92) at post-intervention. The mean reduction in NPRS was 4.27 points, corresponding to an approximate 64.00% reduction from the baseline value. The range of NPRS scores also decreased from 4–9 at pre-intervention to 0–6 at post-intervention, indicating an overall shift towards lower pain intensity after the intervention. The 95% confidence interval for the pre- to post-intervention difference ranged from 3.44 to 5.09, suggesting that the reduction in pain scores was consistently positive across the participants. The effect size, calculated using Cohen's d, was 2.87, indicating a very large intervention effect on pain intensity. The findings therefore demonstrate a substantial reduction in pain among the participants following the intervention.

Table 11. Descriptive Statistics of Pre- and Post-Intervention Lumbar Flexion

Measure	Pre-Intervention	Post-Intervention
Mean Lumbar flexion (°)	40.80	52.73
Standard Deviation (°)	12.52	9.80
Range (°)	15–60	25–65
Effect Size (Cohen's d)	—	1.34
95% Confidence Interval (Pre − Post)	-16.87 to -7.00	—

There was a notable improvement in lumbar flexion following the intervention. The mean lumbar flexion increased from 40.80° (SD = 12.52°) at pre-intervention to 52.73° (SD = 9.80°) at post-intervention. This represented a mean increase of 11.93°, corresponding to a 29.24% improvement from the baseline value. The range of lumbar flexion also increased from 15–60° at pre-intervention to 25–65° at post-intervention, indicating an overall improvement in lumbar mobility following the intervention. The 95% confidence interval for the pre- to post-intervention difference ranged from −16.87° to −7.00°, supporting a consistent improvement in lumbar flexion. The Cohen's d value was 1.34, indicating a large effect of the intervention on lumbar flexion. These findings suggest that the intervention produced a substantial improvement in lumbar mobility among the participants.

Table 12. Descriptive Statistics of Pre- and Post-Intervention Lumbar Extension

Measure	Pre-Intervention	Post-Intervention
Mean Lumbar extension (°)	27.33	31.00
Standard Deviation (°)	8.04	6.68
Range (°)	10–35	12–39
Effect Size (Cohen's d)	—	0.78
95% Confidence Interval (Pre − Post)	-6.26 to -1.07	—

Lumbar extension also demonstrated an overall improvement following the intervention. The mean lumbar extension increased from 27.33° (SD = 8.04°) at pre-intervention to 31.00° (SD = 6.68°) at post-intervention. The mean improvement was 3.67°, representing a 13.43% increase from the baseline value. The 95% confidence interval for the pre- to post-intervention difference ranged from −6.26° to −1.07°, indicating a consistent improvement in lumbar extension. The Cohen's d was 0.78, demonstrating a moderate to large effect size. These findings indicate that the intervention contributed to a meaningful improvement in lumbar extension among the participants.

Table 13. Descriptive Statistics of Pre- and Post-Intervention Lateral Flexion

Measure	Pre-	Post-

	Intervention	Intervention
Mean Lateral flexion (°)	20.33	25.40
Standard Deviation (°)	5.59	4.73
Range (°)	10–28	10–30
Effect Size (Cohen's d)	—	1.26
95% Confidence Interval (Pre − Post)	-7.29 to -2.85	—

Lateral flexion also demonstrated an overall improvement following the intervention. The mean lateral flexion increased from 20.33° (SD = 5.59°) at pre-intervention to 25.40° (SD = 4.73°) at post-intervention. The mean improvement was 5.07°, representing a 24.94% increase from the baseline value. The 95% confidence interval for the pre- to post-intervention difference ranged from −7.29° to −2.85°, indicating a consistent improvement in lateral flexion. The Cohen's d was 1.26, demonstrating a large effect size. These findings indicate that the intervention contributed to a substantial improvement in lateral flexion among the participants.

Table 14. Descriptive Statistics of Pre- and Post-Intervention SLR

Measure	Pre-Intervention	Post-Intervention
Mean SLR (°)	56.33	77.60
Standard Deviation (°)	15.17	15.56
Range (°)	35–80	50–96
Effect Size (Cohen's d)	—	1.89
95% Confidence Interval (Pre − Post)	-27.51 to -15.02	—

Descriptive Statistics and Change in Straight Leg Raising

The SLR measurements showed a considerable improvement after the intervention. At pre-intervention, the mean SLR was 56.33° (SD = 15.17°), which increased to 77.60° (SD = 15.56°) at post-intervention. This reflects a mean gain of 21.27°, equivalent to a 37.78% improvement over the baseline measurement. The observed range also shifted from 35–80° before the intervention to 50–96° after the intervention, indicating improved lower-limb flexibility and overall SLR performance. The 95% confidence interval for the pre- to post-intervention difference was −27.51° to −15.02°, suggesting that the improvement was consistently observed across the participants. The Cohen's d value of 1.89 represents a very large effect size. Overall, the findings indicate that the intervention was associated with a substantial improvement in SLR among the participants.

Table 15. Descriptive Statistics of Pre- and Post-Intervention Tibial NCV

Measure	Pre-Intervention	Post-Intervention
Mean NCV – Tibial	46.19	46.77
Standard Deviation	0.76	1.10
Range	45.1–48.2	45.1–49.8
Effect Size (Cohen's d)	—	0.59
95% Confidence Interval (Pre − Post)	-1.12 to -0.04	—

Descriptive Statistics and Change in Tibial NCV

The NCV of the tibial nerve showed a slight improvement following the intervention. The mean NCV increased from 46.19 (SD = 0.76) at pre-intervention to 46.77 (SD = 1.10) at post-intervention. This reflected a mean increase of 0.58, representing a 1.26% improvement from the baseline value. The range also showed a small shift, increasing from 45.1–48.2 before the intervention to 45.1–49.8 after the intervention. The 95% confidence interval for the pre- to post-intervention difference ranged from −1.12 to −0.04, indicating a consistent positive change in tibial nerve conduction. The Cohen's d was 0.59, suggesting a moderate effect size. Overall, the findings indicate that the intervention was associated with a modest improvement in tibial nerve conduction among the participants.

Table 16. Descriptive Statistics of Pre- and Post-Intervention Common Peroneal NCV

Measure	Pre-Intervention	Post-Intervention

Mean NCV – Common peroneal	48.13	48.93
Standard Deviation	1.08	1.34
Range	46.7–49.5	47.1–52.3
Effect Size (Cohen's d)	—	0.53
95% Confidence Interval (Pre − Post)	-1.66 to 0.04	—

The NCV of the common peroneal nerve showed a small increase following the intervention. The mean NCV rose from 48.13 (SD = 1.08) at pre-intervention to 48.93 (SD = 1.34) at post-intervention, indicating a mean improvement of 0.80, equivalent to a 1.66% increase from the baseline value. The observed range also shifted from 46.7–49.5 before the intervention to 47.1–52.3 after the intervention, reflecting a modest improvement in nerve conduction values. The 95% confidence interval for the pre- to post-intervention difference ranged from −1.66 to 0.04, showing that the estimated change was relatively small and included values close to no change. The Cohen's d was 0.53, indicating a moderate effect size. Overall, the findings suggest that the intervention was associated with a modest improvement in common peroneal nerve conduction among the participants.

Table 17. Descriptive Statistics of Pre- and Post-Intervention ODI

Measure	Pre-Intervention	Post-Intervention
Mean ODI (%)	46.07	16.27
Standard Deviation (%)	13.60	11.12
Range (%)	20–70	8–50
Effect Size (Cohen's d)	—	2.33
95% Confidence Interval (Pre − Post)	22.71 to 36.89	—

The ODI scores demonstrated a marked reduction in disability following the intervention. The mean ODI decreased from 46.07% (SD = 13.60%) at pre-intervention to 16.27% (SD = 11.12%) at post-intervention. This represented a mean reduction of 29.80 percentage points, corresponding to a 64.64% improvement from the baseline level of disability. The range of ODI scores also shifted from 20–70% before the intervention to 8–50% after the intervention, indicating an overall reduction in disability among the participants. The 95% confidence interval for the pre- to post-intervention difference ranged from 22.71 to 36.89 percentage points, supporting a consistent reduction in disability following the intervention. The Cohen's d was 2.33, demonstrating a very large effect size. Overall, these findings indicate that the intervention was associated with a substantial improvement in functional status and a marked reduction in disability among the participants.

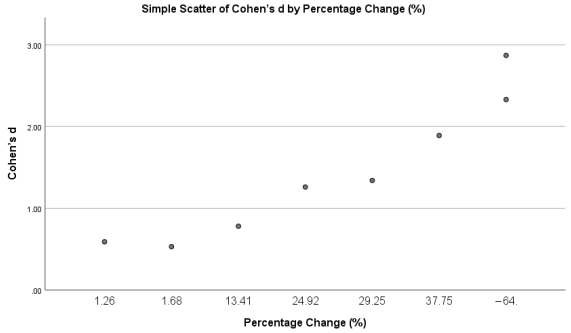


Figure 9 Effect Size (Cohen's d) and Percentage Change

Figure 9 illustrates the relationship between percentage change and Cohen's d effect size across the measured outcomes. The scatter plot shows variation in both the magnitude of percentage change and the corresponding intervention effect sizes. The NPRS and ODI outcomes are positioned at the negative end of the percentage-change axis, with percentage changes of approximately −64.00% and −64.69%, respectively. NPRS shows the highest effect size (Cohen's d = 2.87), while ODI also demonstrates a very large effect size (d = 2.33). These findings indicate substantial reductions in pain intensity and functional disability following the intervention.

Among the outcomes with positive percentage changes, SLR shows the largest percentage improvement (37.75%) with a very large effect size (d = 1.89). Lumbar flexion also demonstrates a relatively high percentage improvement of 29.25%, accompanied by a large effect size (d = 1.34). Lateral flexion shows a 24.92% improvement with a large effect size (d = 1.26), whereas lumbar extension shows a 13.41% improvement with a moderate-to-large effect size (d = 0.78). In contrast, the nerve conduction measures are clustered close to the zero percentage-change region. Tibial NCV shows a 1.26% increase with an effect size of d = 0.59, while common peroneal NCV shows a 1.68% increase with

a slightly smaller effect size of d = 0.53. Overall, the figure demonstrates that the greatest changes were observed for pain, disability, SLR, and lumbar mobility, which were generally accompanied by larger effect sizes. The relatively small percentage changes and lower effect sizes observed for tibial and common peroneal NCV suggest more limited changes in nerve conduction measures following the intervention.

8. Discussion

In the present pilot study, the effect of spinal manual therapy using Modified Rigid Taping Technique and conventional physiotherapy was evaluated in patients with lumbar radiculopathy. The results showed that the overall pain, lumbar mobility, straight leg raising, nerve conduction velocity and functional disability improved after 4 weeks of intervention. Considering pain intensity, there was a significant improvement: mean NPRS score from 6.67 to 2.40, which is a 64% improvement. This large decrease indicates that the combined intervention could prove to be beneficial for reducing symptoms related to LR.

The range of motion in the Lumbar area also was enhanced after treatment. Lumbar flexion increased from 40.80° to 52.73%, extension from 27.33° to 31.00°, and lateral flexion from 20.33° to 25.40°. From these results, it can be concluded that the intervention has led to increased mobility in the spine. The significant improvement in straight leg raising was from 56.33° to 77.60° (about 37.75%). This can suggest enhanced mobility of the nerve and decreased restriction of radiating signs.

A relatively smaller change was seen in Nerve conduction velocity (NCV). Tibial nerve conduction velocity rose from 46.19 to 46.77, and common peroneal nerve conduction velocity went up from 48.13 to 48.93. The changes were small, but they provide some evidence for some improvement in the parameters measured electrophysiologically. There was significant improvement in functional disability with a 46.07% reduction to 16.27% ODI, which was about 64.64% improvement. This decrease implies that the ability to carry out activities of daily living after therapy.

The overall results showed that the combined intervention was related to significant pain improvement, functional disability, straight leg raising, and mobility of the lumbar level. This was a small pilot study without a control group and therefore conclusions to causal interpretations cannot be made. These preliminary findings will need to be confirmed with larger studies of controlled patients, with longer follow-up periods.

9. Conclusion

This current pilot study demonstrated that manual therapy techniques to the spine with Modified Rigid Taping Technique and conventional physiotherapy techniques resulted in positive clinical outcomes in patients with lumbar radiculopathy. After 4 weeks of treatment, improvements were seen in all major clinical outcomes—pain intensity, ROM of the lumbar spine, straight leg raising, nerve conduction velocity, and functional disability. The mean NPRS score dropped from 6.67 to 2.40, which is about a 64% reduction in the intensity of pain. In the same way, the ODI score fell from 46.07% to 16.27% signifying significant reduction in disability and improvement in functional performance.

Mobility of the lumbar spine also improved, increasing flexion from 40.80° to 52.73°, extension from 27.33° to 31.00° and lateral flexion from 20.33° to 25.40°. Straight leg raising increased significantly after intervention from 56.33° to 77.60° indicating greater mobility of the lower limb and neural mobility. Although the improvements were relatively small when compared with improvements in pain, mobility, and disability, tibial nerve conduction velocity increased from 46.19 to 46.77 and common peroneal nerve conduction velocity increased from 48.13 to 48.93.

The results are preliminary support for using combined spinal manual therapy, Modified Rigid Taping Technique and conventional physiotherapy for treating lumbar radiculopathy. The intervention seemed to be especially effective in reducing pain and functional disability and enhancing spinal and neural mobility. The small size of the samples, however, and the lack of a control group reduces the capacity to determine a clear cause-and-effect relationship. Thus, it is advisable to repeat these results with larger controlled studies having standardized treatment protocols and longer follow-up.

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