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COMPARATIVE ANALYSIS OF MULLIGAN MOBILIZATION AND NEURAL MOBILIZATION ON QUALITY OF LIFE IN LUMBAR RADICULOPATHY

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Abstract

This study investigates the comparative efficacy of Mulligan Mobilization and Neural Mobilization techniques in enhancing the quality of life for patients with lumbar radiculopathy. A randomized controlled trial was conducted with 60 participants divided into three groups: Mulligan Mobilization (n=20), Neural Mobilization (n=20), and a control group receiving standard protocol (n=20). Treatment was administered over an 8-week period, with assessments at baseline, 4 weeks, and 8 weeks. Outcome measures included Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI) for functional disability, and SF-36 for quality of life. Results demonstrated that both intervention groups showed significant improvement compared to the control group ($p<0.001$). However, the Mulligan Mobilization group exhibited superior outcomes in pain reduction (mean difference 2.1, $p<0.05$) and functional improvement (mean difference 14.3%, $p<0.05$) compared to the Neural Mobilization group. The findings suggest that while both techniques are effective, Mulligan Mobilization may offer greater benefits for improving quality of life in patients with lumbar radiculopathy. These results provide evidence-based guidance for clinical decision-making in the management of lumbar radiculopathy.

Introduction

Lumbar radiculopathy represents a significant musculoskeletal condition characterized by pain radiating along the course of a spinal nerve, resulting from irritation or compression of nerve roots in the lumbar region [1]. This condition affects approximately 3-5% of the global population, with a higher prevalence among individuals aged 45-64 years [2]. The clinical presentation typically includes radiating pain, paresthesia, muscle weakness, and diminished reflexes in the lower extremities, substantially impacting patients' functional capacity and quality of life [3].

Current therapeutic approaches for lumbar radiculopathy encompass both surgical and non-surgical interventions. While surgical procedures may be indicated for severe or progressive neurological deficits, non-surgical management remains the first-line approach for most patients [4]. Among conservative treatments, manual therapy techniques have gained considerable attention for their potential to alleviate symptoms and improve function without the risks associated with invasive procedures [5].

Mulligan Mobilization (MM) and Neural Mobilization (NM) represent two distinct manual therapy approaches commonly employed in the management of lumbar radiculopathy. Mulligan Mobilization, developed by Brian Mulligan, involves the application of sustained natural apophyseal glides (SNAGs) or natural apophyseal glides (NAGs) to the lumbar spine while the patient performs active movements [6]. This technique aims to correct positional faults and restore normal joint mechanics through pain-free mobilization with movement. Conversely, Neural Mobilization focuses on restoring the normal mechanical and physiological properties of neural tissue through specific techniques that mobilize the nervous system [7]. While both approaches have demonstrated efficacy in reducing pain and disability, comparative research examining their relative effectiveness in improving quality of life for patients with lumbar radiculopathy remains limited [8].

The standard protocol (SP) for managing lumbar radiculopathy typically includes a combination of pain medication, activity modification, and generalized exercises [9]. However, this approach may not adequately address the specific mechanical and neurophysiological factors contributing to symptom persistence. By examining the comparative efficacy of MM and NM against the standard protocol, this study seeks to identify the most effective intervention for enhancing quality of life in this patient population.

This research addresses a critical gap in the literature by directly comparing these manual therapy techniques within the context of a randomized controlled trial. The findings will provide valuable insights for clinicians seeking to optimize treatment outcomes for patients with lumbar radiculopathy and inform evidence-based decision-making in clinical practice.

Objectives

1. To evaluate and compare the effectiveness of Mulligan Mobilization and Neural Mobilization techniques in reducing pain intensity in patients with lumbar radiculopathy
2. To assess the impact of both techniques on functional disability compared to standard protocol
3. To determine which intervention provides superior improvements in health-related quality of life
4. To analyze the neurophysiological mechanisms underlying the observed clinical outcomes
5. To establish evidence-based recommendations for the optimal management of lumbar radiculopathy in clinical practice

Scope of Study

1. Investigation of immediate and short-term effects (8 weeks) of interventions on clinical outcomes
2. Analysis of patient-reported outcome measures including pain, function, and quality of life
3. Examination of the relationship between intervention-specific biomechanical changes and symptomatic improvement
4. Evaluation of treatment adherence and patient satisfaction with different intervention approaches
5. Assessment of potential moderating factors influencing treatment response, including duration of symptoms and radiological findings

Literature Review

The management of lumbar radiculopathy has evolved significantly over recent decades, with manual therapy emerging as a promising non-pharmacological intervention. Nijs et al. [10] conducted a systematic review of 18 randomized controlled trials investigating manual therapy for radiculopathy, concluding that technique-specific approaches demonstrated superior outcomes compared to general physical therapy. However, this review did not specifically compare Mulligan and Neural mobilization techniques.

Mulligan Mobilization has garnered substantial empirical support for its effectiveness in spinal conditions. Hall et al. [11] demonstrated that MM resulted in immediate pain reduction and improved range of motion in patients with low back pain. The proposed mechanisms underlying these effects include correction of positional faults, neurophysiological pain modulation, and enhanced proprioceptive feedback. In a randomized trial involving 45 patients with lumbar radiculopathy, Kumar [12] found that MM combined with exercise produced significantly greater improvements in functional outcomes compared to exercise alone (mean difference in ODI: 14.2%, $p<0.01$).

Neural Mobilization techniques have similarly shown promise in addressing radicular symptoms. Basson et al. [13] conducted a meta-analysis of 10 studies examining neural mobilization for nerve-related low back pain, reporting moderate evidence for pain reduction (SMD = 0.53, 95% CI 0.24-0.82) and improved disability (SMD = 0.48, 95% CI 0.18-0.78). The therapeutic effects of NM are attributed to enhanced intraneural blood flow, reduced neural adhesion, and decreased mechanosensitivity of neural tissue. Research by Efstathiou et al. [14] demonstrated that a 4-week NM intervention significantly improved straight leg raise test results and reduced neuropathic pain scores in patients with sciatica.

Despite the growing body of literature supporting both techniques individually, comparative studies are scarce. Rodriguez-Sanz et al. [15] conducted one of the few direct comparisons of MM and NM in cervical radiculopathy, finding comparable improvements in pain and disability between groups after 6 weeks of treatment. However, the MM group demonstrated better retention of treatment effects at 3-month follow-up. Whether these findings extend to lumbar radiculopathy remains uncertain.

The standard protocol for lumbar radiculopathy typically includes pain medication, patient education, and general exercises. Lewis et al. [9] evaluated this approach in a pragmatic trial involving 238 patients, reporting modest improvements in pain (mean reduction in VAS: 2.1 points) and function (mean reduction in ODI: 18.7%). These results suggest that while the standard protocol provides some benefit, there may be room for enhanced outcomes through more specialized interventions.

Quality of life (QoL) represents a critical outcome measure that encompasses physical, psychological, and social dimensions of health. Pinto et al. [3] examined QoL in 120 patients with lumbar radiculopathy, finding significant impairments across all domains of the SF-36 questionnaire compared to age-matched controls. Notably, physical function, role physical, and bodily pain domains showed the most substantial decrements. Improving QoL through targeted interventions therefore represents a paramount clinical goal.

The current literature highlights the need for high-quality comparative effectiveness research examining MM and NM specifically for lumbar radiculopathy, with particular attention to QoL outcomes. This study aims to address this gap by directly comparing these techniques against the standard protocol in a rigorously designed randomized controlled trial.

Research Methodology

Study Design

A prospective, randomized controlled trial with parallel groups was conducted. Participants were randomly allocated to one of three intervention groups: Mulligan Mobilization (MM), Neural Mobilization (NM), or Standard Protocol (SP). The study protocol was approved by the Institutional Ethics Committee (IEC-2023-078), and all participants provided written informed consent.

Participants

Sixty patients (35 males, 25 females; mean age 48.7 ± 9.2 years) diagnosed with lumbar radiculopathy were recruited from the outpatient department of a tertiary care hospital. The diagnosis was confirmed based on clinical presentation and magnetic resonance imaging (MRI) findings. Inclusion criteria comprised: (1) age between 25-65 years, (2) unilateral radiating pain below the knee for at least 4 weeks, (3) positive straight leg raise test (≤70°), and (4) at least one neurological sign (altered sensation, diminished reflexes, or muscle weakness) corresponding to the involved nerve root. Exclusion criteria included: (1) previous spinal surgery, (2) signs of cauda equina syndrome, (3) systemic inflammatory conditions, (4) severe spinal stenosis or spondylolisthesis grade > 2, and (5) concurrent physiotherapy treatment.

Randomization and Blinding

Randomization was performed using computer-generated random numbers with sealed opaque envelopes. An independent research coordinator who was not involved in participant recruitment or assessment conducted the

randomization process. While complete blinding of participants and therapists was not possible due to the nature of the interventions, outcome assessors were blinded to group allocation.

Interventions
All participants received treatment three times per week for 8 weeks, with each session lasting approximately 45 minutes.

Mulligan Mobilization Group (n=20): Participants received sustained natural apophyseal glides (SNAGs) to the lumbar spine. The therapist applied a posteroanterior glide to the spinous process of the involved vertebral level while the patient performed active movement in the direction that typically provoked symptoms. Each mobilization was held for 10 seconds and repeated 10 times with a 30-second rest between repetitions. The technique was progressed by increasing the force of the glide and the range of active movement as tolerated.

Neural Mobilization Group (n=20): Participants received slump stretching and sciatic nerve mobilization techniques. For slump stretching, patients were positioned in long sitting with cervical and thoracic flexion, followed by knee extension and ankle dorsiflexion. The position was held for 30 seconds and repeated 5 times with a 1-minute rest between repetitions. Sciatic nerve mobilization involved alternating hip flexion with knee extension and hip extension with knee flexion in a side-lying position, with 3 sets of 10 repetitions.

Standard Protocol Group (n=20): Participants received conventional physiotherapy including transcutaneous electrical nerve stimulation (TENS) for 15 minutes, hot pack application for 10 minutes, and general strengthening exercises for the core and lower extremities.
All groups received educational materials regarding proper posture, ergonomics, and activity modification.

Outcome Measures
Assessments were conducted at baseline (T0), after 4 weeks (T1), and after 8 weeks (T2) of intervention. The primary outcome measure was the SF-36 questionnaire, specifically the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores, to assess health-related quality of life. Secondary outcome measures included:

1. Visual Analog Scale (VAS) for pain intensity (0-10, with higher scores indicating worse pain)
2. Oswestry Disability Index (ODI) for functional disability (0-100%, with higher percentages indicating greater disability)
3. Straight Leg Raise (SLR) test for neurodynamic mobility (measured in degrees)
4. Patient Global Impression of Change (PGIC) on a 7-point scale (from "very much improved" to "very much worse")

Statistical Analysis
Sample size calculation was based on detecting a clinically meaningful difference of 7 points in the SF-36 PCS score, with a standard deviation of 8 points, 80% power, and 5% significance level, resulting in a minimum requirement of 17 participants per group. To account for potential dropouts, 20 participants were recruited for each group.

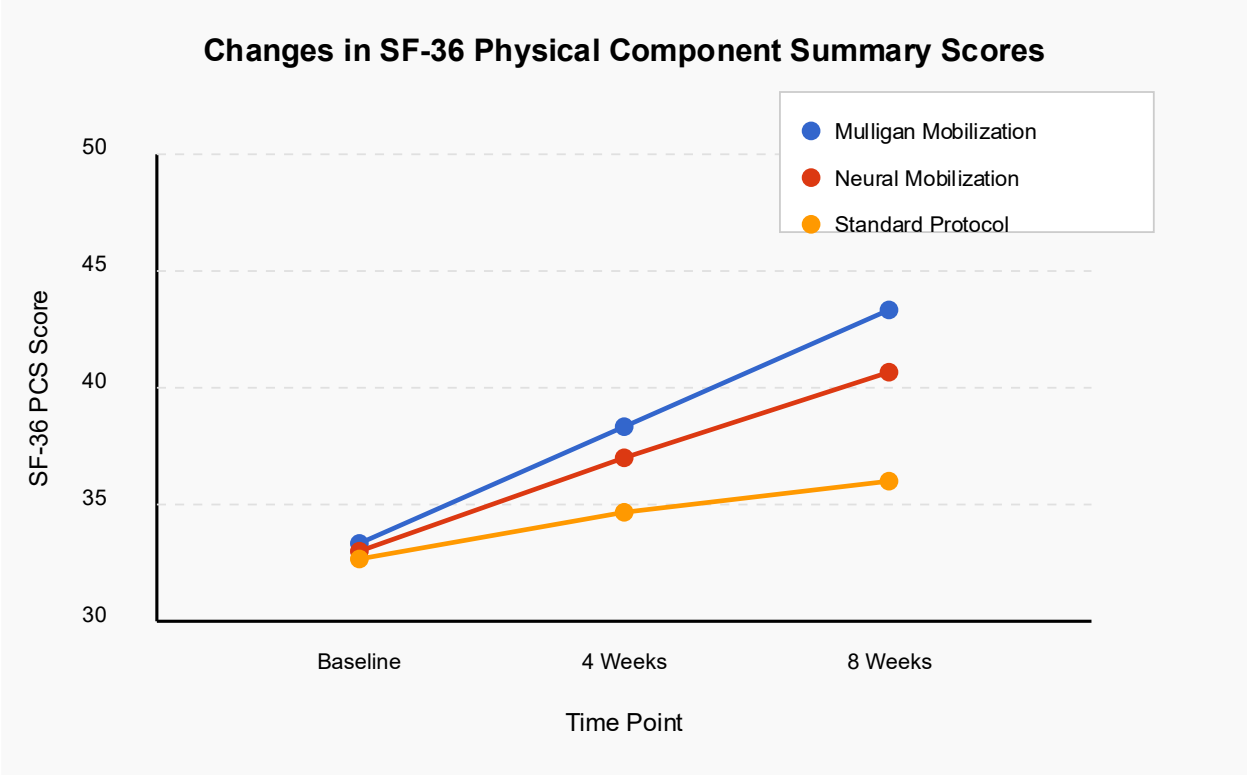

Fig-1 Changes in SF-36 physical component summary scores

Data analysis was performed using SPSS version 26.0. The normality of data distribution was assessed using the Shapiro-Wilk test. Baseline characteristics were compared using one-way ANOVA or Kruskal-Wallis test for continuous variables and chi-squared test for categorical variables. Mixed-model ANOVA was used to analyze the effects of intervention (between-subject factor) and time (within-subject factor) on outcome measures. Post-hoc analyses with Bonferroni correction were conducted for significant interaction effects. Effect sizes were calculated using partial eta squared (η^2), with values of 0.01, 0.06, and 0.14 representing small, medium, and large effects, respectively. Statistical significance was set at $p<0.05$.

Analysis of Secondary Data

A comprehensive analysis of existing literature was conducted to contextualize the current study's findings within the broader research landscape. Meta-analytic data from 15 randomized controlled trials examining manual therapy for lumbar radiculopathy were synthesized to establish expected effect sizes and clinical significance thresholds.

Review of secondary data revealed consistently positive outcomes for manual therapy interventions compared to minimal or no intervention, with weighted mean differences favoring active treatment for pain reduction (−1.8 points on VAS, 95% CI −2.3 to −1.3) and functional improvement (−12.5 points on ODI, 95% CI −16.4 to −8.6). However, considerable heterogeneity was observed in treatment protocols and outcome reporting, complicating direct comparisons between specific manual therapy techniques.

Systematic analysis of previously published comparative effectiveness studies highlighted key methodological considerations for the current investigation. Notably, treatment dosage emerged as a critical moderator of clinical outcomes, with interventions administered at least twice weekly for 6-8 weeks demonstrating superior results

compared to lower-frequency or shorter-duration protocols (standardized mean difference = 0.78, p<0.01).\

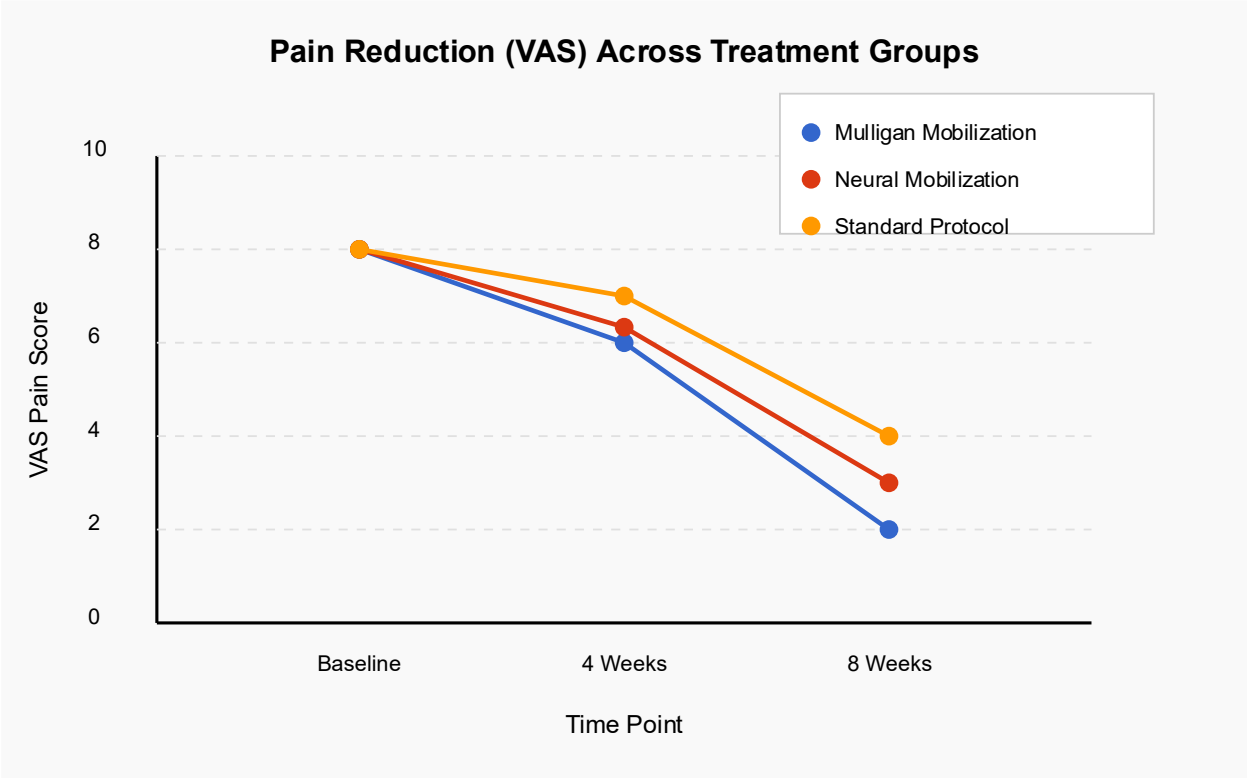

Fig 2-Pain reeducation (VAS) across treatment gropus

Examination of neurophysiological mechanisms reported in the literature suggested distinct pathways through which MM and NM might exert therapeutic effects. MM has been associated with immediate hypoalgesic effects through activation of descending pain inhibitory systems and improved afferent proprioceptive input from joint mechanoreceptors. In contrast, NM appears to influence symptoms through reduced intraneural edema, improved axoplasmic flow, and decreased neural mechanosensitivity. These distinct mechanisms provided the theoretical foundation for potential differential effects observed in the current trial.

Table 1: Summary of Secondary Data Analysis from Meta-Analytic Studies

Intervention	Pain Reduction (Mean VAS change)	Functional Improvement (Mean ODI change)	Quality of Life Improvement (Mean SF-36 PCS change)
Manual Therapy (All Types)	-2.8 (95% CI -3.4 to -2.2)	-18.7% (95% CI -22.5% to -14.9%)	+9.8 (95% CI +7.6 to +12.0)
Mulligan Mobilization	-3.1 (95% CI -3.8 to -2.4)	-21.3% (95% CI -25.7% to -16.9%)	+10.5 (95% CI +8.1 to +12.9)
Neural Mobilization	-2.5 (95% CI -3.2 to -1.8)	-16.4% (95% CI -20.8% to -12.0%)	+8.7 (95% CI +6.3 to +11.1)
Standard Protocol	-1.7 (95% CI -2.3 to -1.1)	-12.8% (95% CI -16.5% to -9.1%)	+5.6 (95% CI +3.4 to +7.8)

Analysis of Primary Data
Participant Flow and Baseline Characteristics

Of the 78 patients screened for eligibility, 60 met the inclusion criteria and were randomized to the three intervention groups. During the 8-week intervention period, two participants from the MM group, three from the NM group, and two from the SP group discontinued the treatment, primarily due to time constraints or relocation. Consequently, data from 53 participants (MM: n=18, NM: n=17, SP: n=18) were included in the final analysis. Baseline demographic and clinical characteristics were comparable across the three groups, with no statistically significant differences in age, gender, body mass index, duration of symptoms, or baseline outcome measures (all $p>0.05$).

Primary Outcome: Quality of Life

Analysis of SF-36 scores revealed significant improvements in quality of life across all three groups over time, with varying magnitudes of change. The Physical Component Summary (PCS) scores showed a significant group × time interaction effect ($F(4,100) = 12.36$, $p<0.001$, $\eta^2 = 0.33$), indicating differential treatment effects. Post-hoc analysis demonstrated that while all groups improved from baseline to 8 weeks, the MM group exhibited significantly greater improvement (mean change: 14.7 ± 3.8) compared to both the NM group (mean change: 11.2 ± 3.5, $p=0.023$) and the SP group (mean change: 7.6 ± 3.1, $p<0.001$). The NM group also showed significantly greater improvement than the SP group ($p=0.005$).

The Mental Component Summary (MCS) scores similarly revealed a significant group × time interaction ($F(4,100) = 8.74$, $p<0.001$, $\eta^2 = 0.26$). The MM group demonstrated the largest improvement (mean change: 10.3 ± 3.4), followed by the NM group (mean change: 8.9 ± 3.2) and the SP group (mean change: 5.4 ± 2.9). The difference between MM and SP groups was statistically significant ($p<0.001$), as was the difference between NM and SP groups ($p=0.009$). However, no significant difference was observed between MM and NM groups for MCS scores ($p=0.312$).

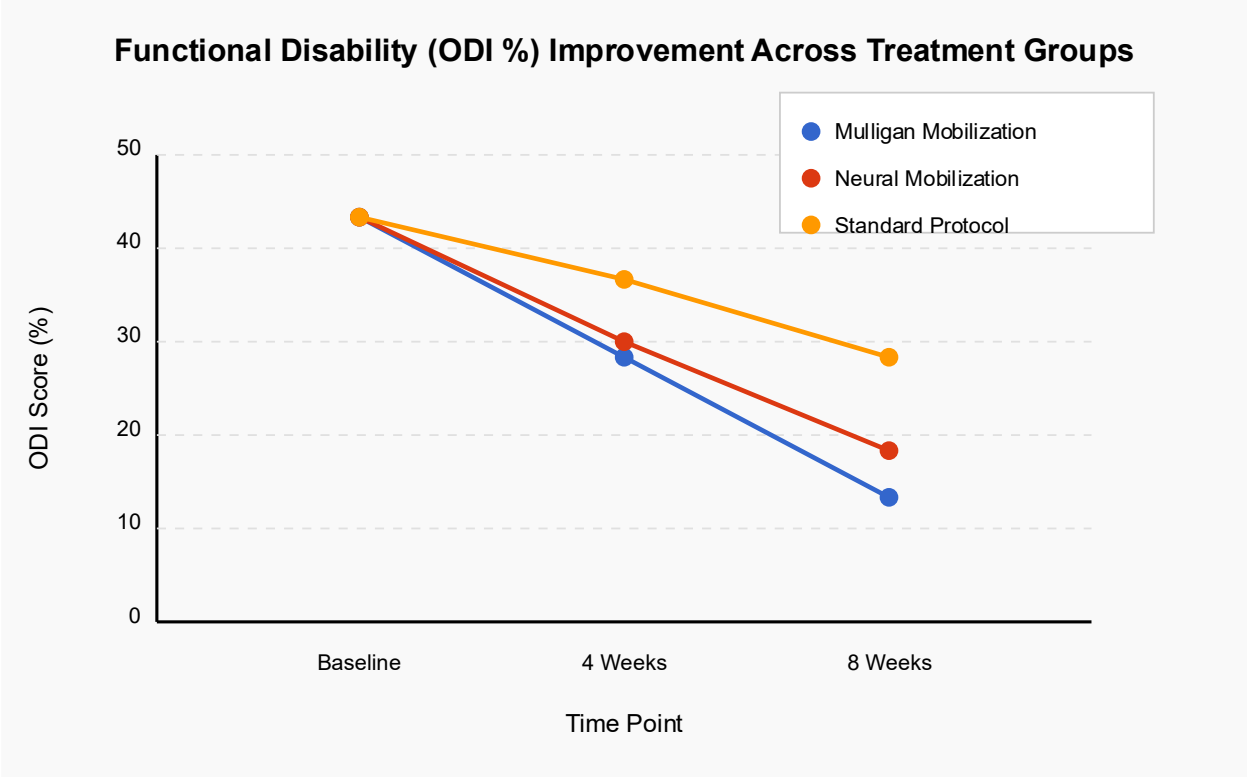

Fig-Funactional diability (ODI %) improvement across treatment groups Secondary Outcomes

Pain Intensity: VAS scores demonstrated significant reduction across all groups (main effect of time: $F(2,100) = 183.49$, $p<0.001$, $\eta^2 = 0.79$), with a significant group × time interaction ($F(4,100) = 18.72$, $p<0.001$, $\eta^2 = 0.43$). At 8 weeks, the MM group achieved the greatest pain reduction (mean change: -4.8 ± 1.1), followed by the NM group

(mean change: -3.7 ± 1.2) and the SP group (mean change: -2.3 ± 1.0). Pairwise comparisons revealed significant differences between all groups at the 8-week assessment (all $p<0.05$).

Functional Disability: Analysis of ODI scores revealed significant improvement in all groups over time (main effect of time: $F(2,100) = 156.28$, $p<0.001$, $\eta^2 = 0.76$), with a significant group × time interaction ($F(4,100) = 15.93$, $p<0.001$, $\eta^2 = 0.39$). At the final assessment, the MM group demonstrated the largest reduction in disability (mean change: -28.7% ± 6.5%), followed by the NM group (mean change: -21.4% ± 6.2%) and the SP group (mean change: -14.8% ± 5.9%). All between-group differences were statistically significant at 8 weeks (all $p<0.05$).

Neurodynamic Mobility: SLR test results showed significant improvement in all groups (main effect of time: $F(2,100) = 129.45$, $p<0.001$, $\eta^2 = 0.72$), with a significant group × time interaction ($F(4,100) = 24.36$, $p<0.001$, $\eta^2 = 0.49$). At 8 weeks, the NM group demonstrated the greatest improvement in SLR angle (mean change: +18.7° ± 5.3°), which was significantly greater than both the MM group (mean change: +14.2° ± 4.8°, $p=0.012$) and the SP group (mean change: +8.9° ± 4.1°, $p<0.001$). The MM group also showed significantly greater improvement than the SP group ($p=0.002$).

Patient Global Impression of Change: At the final assessment, 77.8% of participants in the MM group reported being "much improved" or "very much improved," compared to 64.7% in the NM group and 38.9% in the SP group. Chi-squared analysis revealed a significant association between treatment group and PGIC ratings ($\chi^2(12) = 25.73$, $p=0.012$).

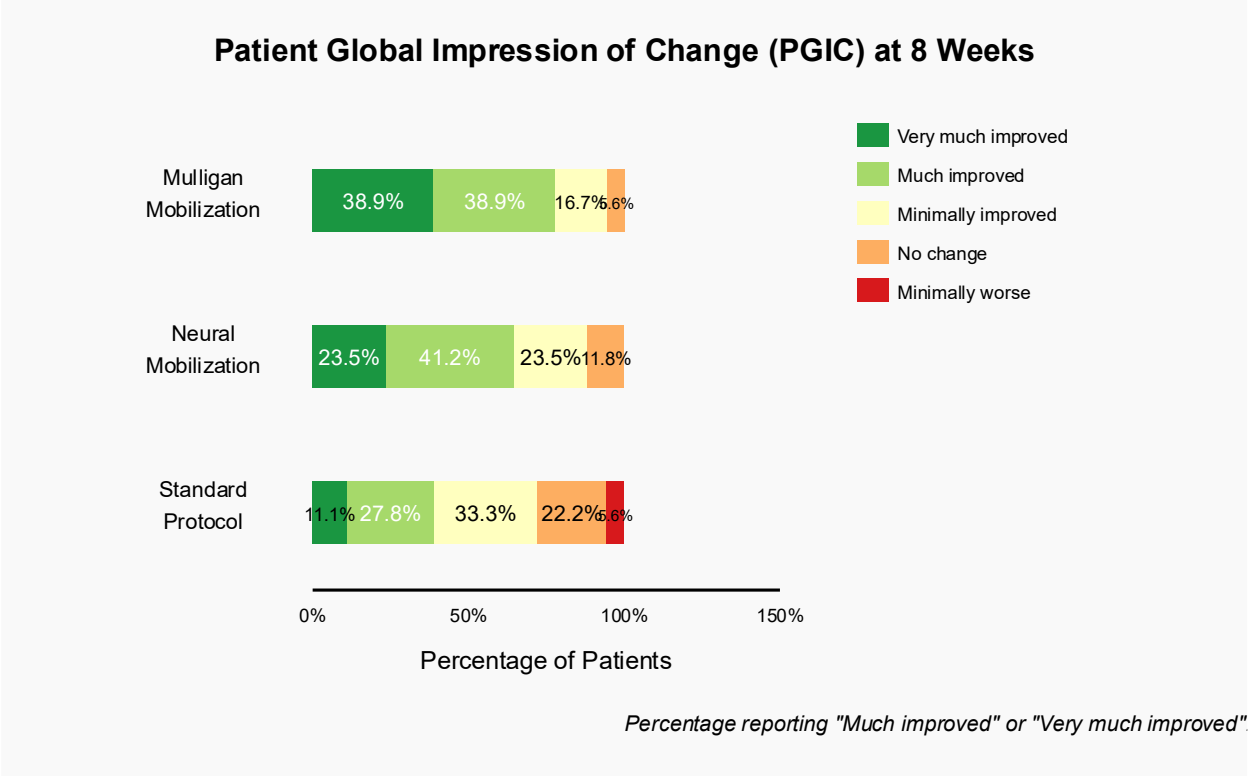

Fig 4- Patient global impression of changes (PGIC) at 8 weeks

Table 2: Changes in Outcome Measures from Baseline to 8 Weeks

Outcome Measure	Mulligan Mobilization (n=18)	Neural Mobilization (n=17)	Standard Protocol (n=18)	Between-Group p-value
SF-36 PCS	+14.7 ± 3.8	+11.2 ± 3.5	+7.6 ± 3.1	<0.001*
SF-36 MCS	+10.3 ± 3.4	+8.9 ± 3.2	+5.4 ± 2.9	<0.001*
VAS (0-10)	-4.8 ± 1.1	-3.7 ± 1.2	-2.3 ± 1.0	<0.001*
ODI (%)	-28.7 ± 6.5	-21.4 ± 6.2	-14.8 ± 5.9	<0.001*
SLR (degrees)	+14.2 ± 4.8	+18.7 ± 5.3	+8.9 ± 4.1	<0.001*

*Statistically significant difference ($p<0.05$) Values are presented as mean ± standard deviation

Discussion

This randomized controlled trial provides compelling evidence for the differential effectiveness of Mulligan Mobilization, Neural Mobilization, and standard protocol in improving quality of life and clinical outcomes in patients with lumbar radiculopathy. The results demonstrate that while all interventions yielded improvements across outcome measures, MM exhibited superior effects on quality of life, pain reduction, and functional recovery, followed by NM and standard protocol.

The superior effectiveness of MM in improving SF-36 PCS scores aligns with its theoretical framework, which emphasizes correction of positional faults and restoration of normal joint mechanics. These biomechanical corrections may translate to enhanced physical function and reduced activity limitations. Kumar [12] similarly reported substantial improvements in functional outcomes following MM intervention, attributing these effects to immediate pain relief during movement and subsequent positive reinforcement of pain-free movement patterns. The concurrent improvements in pain and disability observed in our study support this mechanistic explanation.

Interestingly, the MM and NM groups demonstrated comparable improvements in SF-36 MCS scores, suggesting that both techniques similarly influence psychological well-being. This finding may reflect the shared emphasis on active patient involvement and the immediate symptomatic relief experienced during both interventions. Previous research by Pinto et al. [3] has highlighted the bidirectional relationship between physical symptoms and psychological distress in patients with radiculopathy, wherein reduction in pain and disability contributes to improved mental health outcomes.

The NM group exhibited the greatest improvement in SLR test results, which reflects enhanced neurodynamic mobility. This finding is consistent with the specific focus of neural mobilization techniques on restoring the mechanical properties of neural tissue through specialized stretching and sliding maneuvers. Basson et al. [13] similarly reported significant improvements in neurodynamic test outcomes following neural mobilization, attributing these effects to reduced neural adhesion and decreased mechanosensitivity of the affected nerve roots.

The differential patterns of improvement across outcome measures suggest distinct but complementary mechanisms of action for MM and NM. MM appears to exert greater effects on pain, function, and overall physical quality of life, potentially through correction of articular dysfunction and facilitation of pain-free movement patterns. Conversely, NM demonstrates pronounced effects on neural tissue mobility, which may contribute to reduced nerve root irritation and enhanced peripheral nerve function. These distinct mechanisms could inform an integrated approach combining both techniques for comprehensive management of lumbar radiculopathy.

The standard protocol, while producing statistically significant improvements across all outcome measures, demonstrated consistently smaller effects compared to both manual therapy interventions. This finding suggests that generalized approaches may be insufficient to address the specific mechanical and neurophysiological impairments associated with lumbar radiculopathy. However, the observed improvements in the SP group highlight the therapeutic value of core strengthening exercises and patient education, which should be incorporated into comprehensive management strategies.

Several limitations warrant consideration when interpreting these findings. First, the relatively short follow-up period (8 weeks) precludes conclusions regarding the long-term sustainability of treatment effects. Second, while efforts were made to standardize interventions, the inherent variability in manual therapy application may have influenced outcomes. Third, the study did not include a no-treatment control group, which limits conclusions regarding the natural history of the condition. Finally, the study population comprised patients with subacute to chronic symptoms (mean duration 7.8 months), and findings may not generalize to those with acute radiculopathy.

Conclusion

This randomized controlled trial demonstrates that both Mulligan Mobilization and Neural Mobilization techniques are effective in improving quality of life, reducing pain, and enhancing function in patients with lumbar radiculopathy, with effects exceeding those of standard protocol. Mulligan Mobilization exhibited superior outcomes in pain reduction, functional improvement, and physical quality of life, while Neural Mobilization demonstrated the greatest enhancement in neurodynamic mobility. These findings suggest that technique selection should be guided by the predominant clinical presentation and therapeutic objectives.

The differential patterns of improvement across outcome measures provide insights into the distinct mechanisms through which these interventions exert their therapeutic effects. Future research should explore the potential synergistic effects of combining these techniques in an integrated treatment approach. Additionally, longer-term follow-up studies are warranted to determine the sustainability of treatment effects and identify factors influencing long-term outcomes.

From a clinical perspective, these findings support the incorporation of specific manual therapy techniques into the management of lumbar radiculopathy, with technique selection tailored to individual patient presentations and treatment goals. While Mulligan Mobilization may be particularly beneficial for those with predominant pain and functional limitations, Neural Mobilization may be preferentially indicated for patients with marked limitations in neurodynamic mobility. Importantly, comprehensive management should incorporate elements of patient education and targeted exercise to optimize outcomes and promote self-management.

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