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EFFECTIVENESS OF NEURAL MOBILIZATION COMBINED WITH MYOFASCIAL RELEASE ON PAIN AND FUNCTIONAL OUTCOMES IN INDIVIDUALS WITH SCIATICA: A RANDOMIZED CONTROLLED TRIAL

Original Research

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ABSTRACT

Background: Sciatica is a common neuromuscular disorder caused by compression of the lumbosacral nerve roots, leading to radiating pain, restricted movement, and functional limitations. In physiotherapy practice, Neural Mobilization (NM) and Myofascial Release (MFR) are frequently used to reduce pain and improve neural mobility. However, evidence comparing the combined use of NM and MFR with their individual application remains limited.

Objective: This study aimed to compare the combined effects of neural mobilization and myofascial release against each technique alone on pain, function, and neural mobility in individuals with chronic sciatica.

Methods: A single-blind randomized controlled trial was conducted over six months at the Dynamic Physiotherapy Clinic, Kabal, Swat, and the Physiotherapy Department of Saidu Group of Teaching Hospital. Forty-eight participants aged 20–40 years with unilateral chronic sciatica (>3 months) were randomly allocated into three groups (n = 16 each): Group A (NM + MFR), Group B (NM alone), and Group C (MFR alone). Interventions were applied twice weekly for four weeks. Outcomes included neural mobility assessed by the Straight Leg Raise (SLR) test, functional ability measured by the Patient-Specific Functional Scale (PSFS), and pain intensity measured using the Numeric Pain Rating Scale (NPRS). Data were analyzed using SPSS version 21 with Kruskal–Wallis and Mann–Whitney U tests at a significance level of $p < 0.05$.

Results: All groups demonstrated significant improvements in pain, function, and neural mobility from baseline to post-treatment. Although between-group differences were not statistically significant ($p > 0.05$), the combined NM + MFR group showed greater mean improvements in functional outcomes and pain reduction. A trend favoring the combined approach was observed for post-treatment NPRS scores ($\chi^2 = 5.127$, $p = 0.077$).

Conclusion: Neural Mobilization and Myofascial Release, whether applied individually or in combination, are effective in managing sciatica. The combined approach demonstrated superior clinical improvements, suggesting potential synergistic benefits in physiotherapy rehabilitation.

Keywords: Functional Recovery; Manual Therapy; Myofascial Release; Neural Mobilization; Pain.

INTRODUCTION

Sciatica, clinically defined by radicular pain radiating along the distribution of the sciatic nerve or its associated lumbosacral nerve roots, represents a complex symptom complex rather than a singular diagnostic entity (1). This condition, which may uncommonly present bilaterally, is frequently accompanied by paresthesia and motor deficits, with the discomfort often described as a burning, tight, or heavy sensation that is typically exacerbated by mechanical stressors such as coughing or spinal flexion (1,2). While lumbar intervertebral disc herniation remains the predominant etiology, particularly among younger populations, a spectrum of other structural causes contributes substantially to nerve root irritation, including spinal stenosis, spondylolisthesis, and degenerative changes within the paraspinal musculature (1,3). Contemporary pathophysiological understanding posits that both mechanical compression and a concomitant inflammatory process must coexist to produce symptomatic nerve root involvement, reinforcing the notion that sciatica arises from a multifactorial interplay of neural and soft tissue dysfunction (2,4).

The global burden of this condition is profound, with epidemiological data indicating that radicular symptoms are present in 5% to 10% of all low back pain cases, and up to 40% of adults will experience at least one episode during their lifetime (5,6). As a leading contributor to years lived with disability worldwide, low back pain—and sciatica in particular—imposes substantial socioeconomic costs through healthcare utilization and lost workplace productivity, often resulting in greater disability and prolonged recovery compared to axial low back pain alone (6–8). The underlying pathophysiology involves a cascade of events, including mechanical deformation of nerve roots, intraneural ischemia, edema formation, and biochemical inflammation triggered most frequently by herniated nucleus pulposus material (9,10). Furthermore, structural deterioration from degenerative spinal conditions, such as facet joint hypertrophy and ligamentum flavum thickening, contributes to neural entrapment and canal constriction, particularly affecting the aging population (11,12). This intricate interplay between neurological and mechanical components underscores the necessity for therapeutic strategies that address both the neural and myofascial elements perpetuating the pain cycle.

Given this complexity, initial clinical management, typically spanning six to eight weeks, favors conservative approaches that prioritize patient education, pharmacological control, and physical therapy before considering invasive procedures (3,13). Among the available conservative modalities, neural mobilization and manual myofascial release have garnered particular attention for their capacity to address the distinct yet interconnected components of sciatic pain (14,15). Neural mobilization aims to restore the dynamic balance between nerve tissue mechanical properties and surrounding structures, thereby improving intraneural circulation and reducing mechanosensitivity (16). Concurrently, myofascial release targets restrictions within the paraspinal and pelvic musculature, addressing peripheral entrapment points and reducing inflammatory mediators that sensitize nerve roots (17-21). The thoracolumbar fascia, as part of the continuous myofascial system, plays a pivotal role in lumbar biomechanics; restrictions here can compress underlying neural structures, while techniques such as sustained low-load pressure can restore tissue length and improve fluid exchange (22–31). It has been suggested that relaxing myofascial limitations may facilitate neuronal sliding, while neural mobilization can reduce the neural tension sustaining secondary myofascial protection, indicating a potential therapeutic synergy (31-39). Despite evidence supporting each intervention independently, there is a significant gap in research investigating their combined application. Therefore, this review aims to synthesize the current evidence regarding the combined effects of neural mobilization and manual myofascial release on pain relief and functional outcomes in individuals with sciatica, with the objective of determining whether this integrated approach offers superior therapeutic benefits compared to isolated interventions.

METHODS

This investigation was designed as a randomized controlled trial to compare the efficacy of combined neural mobilization and manual myofascial release against each intervention alone in individuals with chronic sciatica. The study received ethical approval from the Research Ethical Committee prior to initiation, and all participants provided written informed consent before enrollment. Conducted over a six-month period at the Physiotherapy Department of Saidu Group of Teaching Hospital (SGTH) and a private physiotherapy clinic in Kabal, Swat, the trial recruited participants through outpatient referrals and community advertisements. Sample size determination was performed using G*Power software version 3.1, with an effect size of 0.3, an alpha level of 0.05, and a power of

0.95, yielding a total of 48 participants required for adequate statistical power (32). Anticipating potential attrition, the researchers enrolled the full calculated sample to ensure robust final analysis.

Adults aged 20 to 40 years presenting with unilateral sciatic pain persisting for more than three months were assessed for eligibility. A clinical diagnosis of sciatica required confirmation through a positive Straight Leg Raise test, indicating neural mechanosensitivity and nerve root irritation. Exclusion criteria were deliberately stringent to ensure participant safety and intervention appropriateness. Individuals were excluded if they reported recent trauma or spinal surgery, or if they presented with any systemic neurological abnormalities or deficiencies affecting nervous system function. Further exclusion encompassed red flag symptoms suggestive of serious pathology, including signs of malignancy, infection, or cauda equina syndrome such as progressive motor impairment, new onset fecal incontinence, saddle anesthesia, or urinary retention. Patients presenting with fever, systemic symptoms, a history of cancer, or severe trauma were also excluded, as such presentations necessitate immediate imaging and specialist referral rather than manual therapy intervention. These criteria ensured that the study population genuinely represented those with mechanical sciatica amenable to conservative management.

Following baseline assessment, enrolled participants were allocated to one of three intervention groups using a simple lottery method to ensure true randomization. This process was conducted in the presence of three patients on the day of inclusion to maintain transparency and allocation concealment from the assessing clinician. Group A received combined neural mobilization and manual myofascial release, Group B received neural mobilization alone, and Group C received manual myofascial release alone. Due to the nature of physical interventions, it was not possible to blind the treating physiotherapists to group allocation. However, the data analyst and the outcome assessor remained blinded to group assignment throughout the study period. To minimize expectation bias, participants were informed that they would receive one of three active manual therapy procedures, none of which served as a placebo control, and blinding success was evaluated through a brief questionnaire administered at trial conclusion.

The intervention protocols were standardized across groups to ensure consistency in treatment delivery. For participants receiving neural mobilization, specific slider and tensioner techniques targeting the sciatic nerve root were performed with the participant positioned supine. The mobilization was executed gently to avoid provoking pain, with each cycle consisting of ten repetitions across three sets, incorporating a thirty-second rest interval between sets. Treatment was administered twice weekly for eight sessions over a four-week period, a frequency and duration selected based on previous literature demonstrating meaningful clinical improvements with this dosage (25,26). The neural mobilization approach emphasized restoring dynamic neural excursion without inducing undue tension on sensitive nerve structures.

Manual myofascial release was delivered to participants in the corresponding group, targeting specific musculature implicated in sciatic pain mechanisms. The erector spinae, multifidus, and thoracolumbar fascia received direct intervention, along with the interconnected gluteal and hamstring muscles. Therapists employed techniques involving sustained manual pressure and prolonged fascial stretching, holding each tissue restriction for ninety to one hundred twenty seconds per location. Pressure was increased gradually until a release response was palpably appreciated, indicating viscoelastic deformation and tissue lengthening (30,31). This approach aimed to address peripheral entrapment points and reduce myofascial tension contributing to neural compression. The frequency and total session count mirrored that of the neural mobilization group to maintain comparability.

Participants assigned to the combined intervention group received both neural mobilization and manual myofascial release sequentially within each treatment session, following identical protocols and frequency as the single-technique groups. The order of application was standardized, with myofascial release performed first based on the theoretical premise that relaxing soft tissue restrictions may subsequently facilitate improved neuronal sliding during mobilization (31). Each session lasted approximately forty-five minutes for the combined group, while single intervention sessions required approximately twenty to twenty-five minutes, ensuring adequate treatment exposure while respecting clinical time constraints.

Outcome measures were carefully selected to capture both clinical and functional dimensions of treatment efficacy. The primary outcome, pain severity, was assessed using the Numeric Pain Rating Scale, an eleven-point scale where zero represents no pain and ten represents the worst imaginable pain. This instrument possesses established validity and reliability for musculoskeletal pain assessment and is widely utilized in spine research (33). Participants rated their typical pain intensity during performance of everyday functional activities involving the affected area. Baseline measurements were obtained immediately before the first intervention session, and follow-up measurements were documented at the conclusion of the four-week treatment period to quantify pain reduction magnitude.

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Hip joint range of motion was objectively measured using a universal goniometer during the straight leg raise test, providing a mechanical correlate of neural tension and functional status improvement.

Functional outcomes were assessed using the Patient-Specific Functional Scale, a validated questionnaire that quantifies activity limitations relevant to individual patients (34). Participants identified three activities they found difficult to perform due to their sciatic symptoms and rated their ability to perform each activity on an eleven-point scale, where zero indicated inability to perform the activity and ten indicated ability to perform at pre-injury level. Baseline scores were calculated as the mean of the rated activities, and follow-up scores were similarly computed, with improvement determined by subtracting baseline from follow-up values. This patient-centered approach captured meaningful functional gains that standardized questionnaires might overlook, enhancing the clinical relevance of findings. The flow of participants through each stage of the trial, from enrollment to final analysis, is presented in the CONSORT diagram (Figure 1), which confirms that all 48 randomly assigned participants completed the four-week intervention and follow-up assessment without attrition.

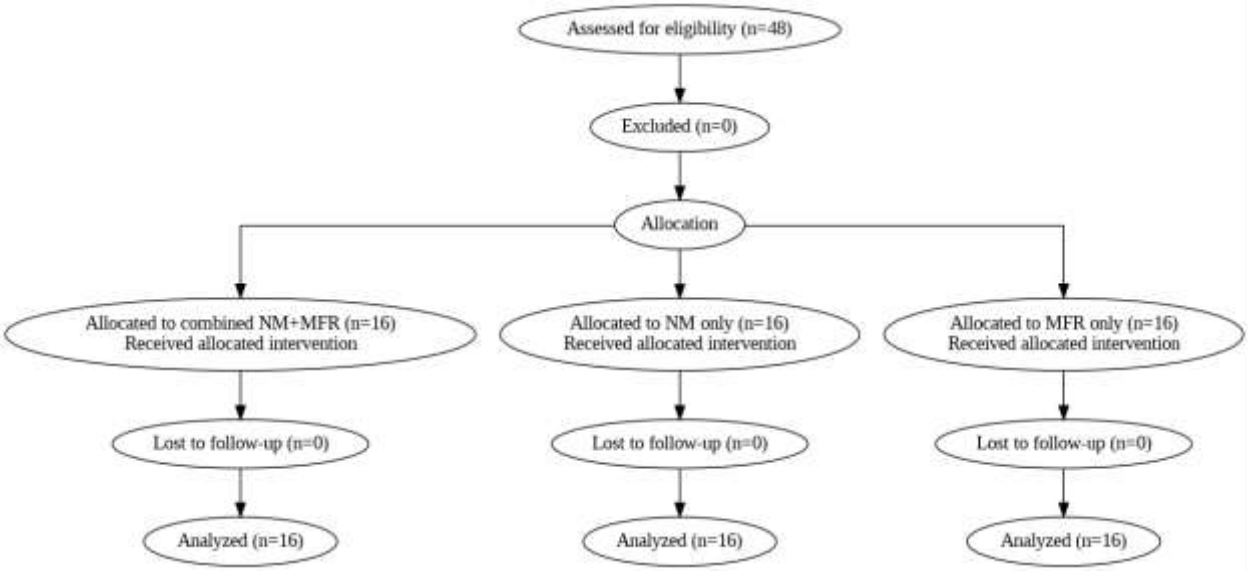

Figure 1CONSORT diagram

Statistical analysis was performed using appropriate parametric or non-parametric tests based on data distribution, with significance set at $p < 0.05$. Between-group comparisons were conducted to determine whether the combined intervention yielded superior outcomes compared to either technique alone. All analyses followed intention-to-treat principles, although no participants were lost to follow-up, as reflected in the CONSORT flow diagram illustrating participant progression through each stage of the trial.

RESULT

The results are described as per the study objectives and outcome measures. SPSS version 26 was used to analyzed the data to determine the effectiveness of interventions on the intensity of pain, range of motion and functional outcomes. These findings are represented in the form of tables and figures with their interpretations and discussion.

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Table 1: Demographics Data of participants

	Frequency	Percent	Cumulative percent
Male	45	91.8	93.8
Female	3	6.3	6.3
Total	48	100.0	100.9

Total 48 valid participants were both gender male and female. 45(93.8%) males while 3(6.3%) were female. According to the cumulative percentage 93.8% of the sample size which is completing by the females to the total 100%.

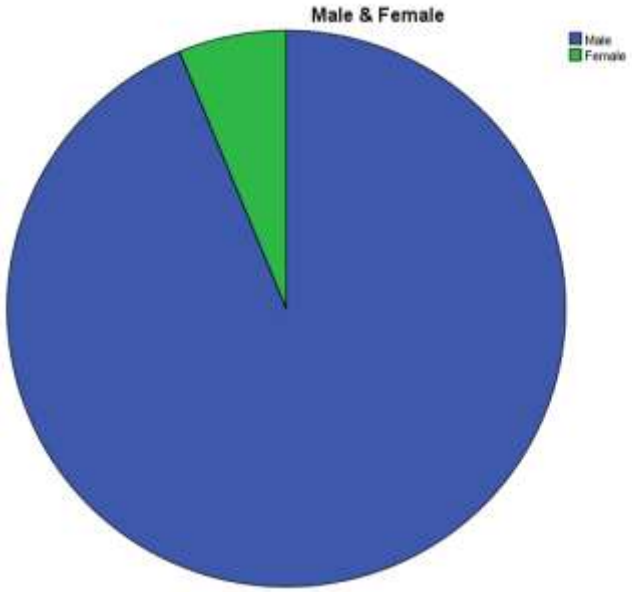

Figure 2 Gender Distribution of Study Participants

Gender Distribution of Study Participants

48 participants with valid age data ranged 20 to 40 years. Highest proportion among the above age categories is 40 years (n=20, 41.7%) higher proportion 35 years of age (n=5, 8.16) and then 30 years (n=5, 10.4%). 50 % were 35 years of age or below while 50% were above 35 years of age.

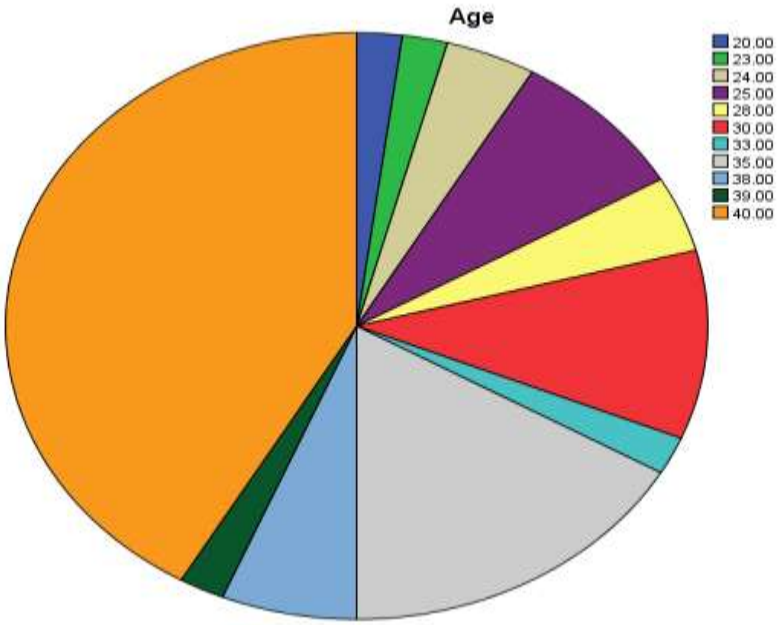

Figure 3 Frequency distribution of participants across age categorization

Frequency distribution of participants across age categorization

Normality of the data was assessed using the Shapiro-Wilk test. A substantial deviation from normality was indicated by p-values less than 0.05 for most variables, including BMI, NPRS scores, functional activity measurements, PSFS scores, and Straight Leg Raise values. Only a few variables in certain groups showed p-values greater than 0.05, approaching normality; however, these were isolated and did not alter the overall picture.

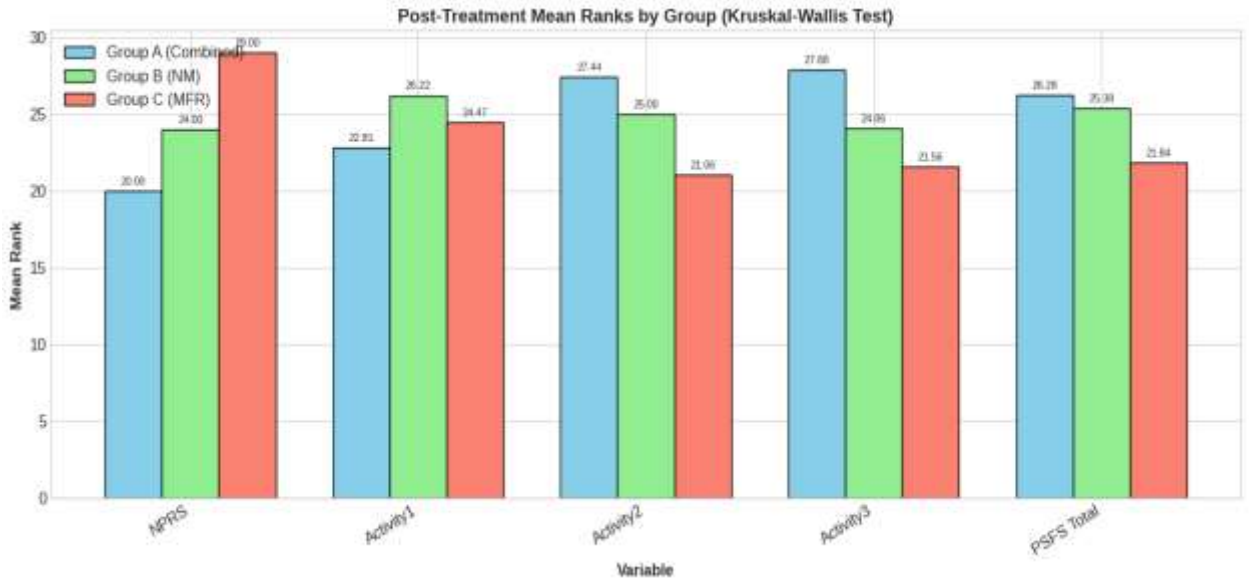

Figure 4 Post-Treatment Mean Ranks by Group (Kruskal-Wallis Test)

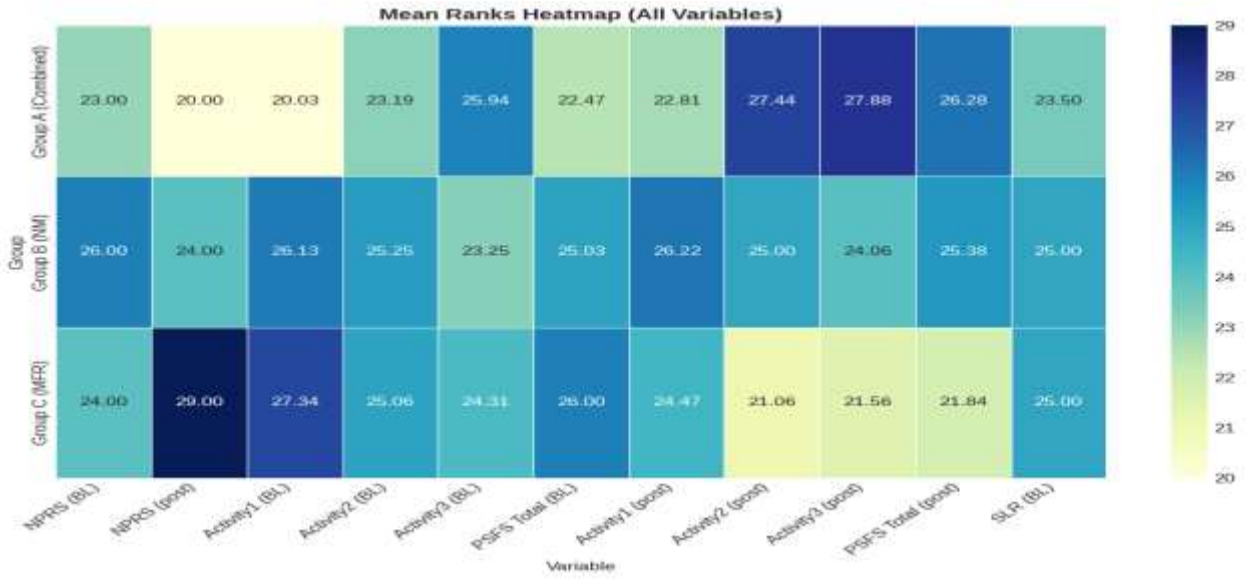

Figure 5 Mean Ranks Heatmap (All Variables)

Descriptive statistics, study variables (mean ± std) (n = 48; 16 in each Group)

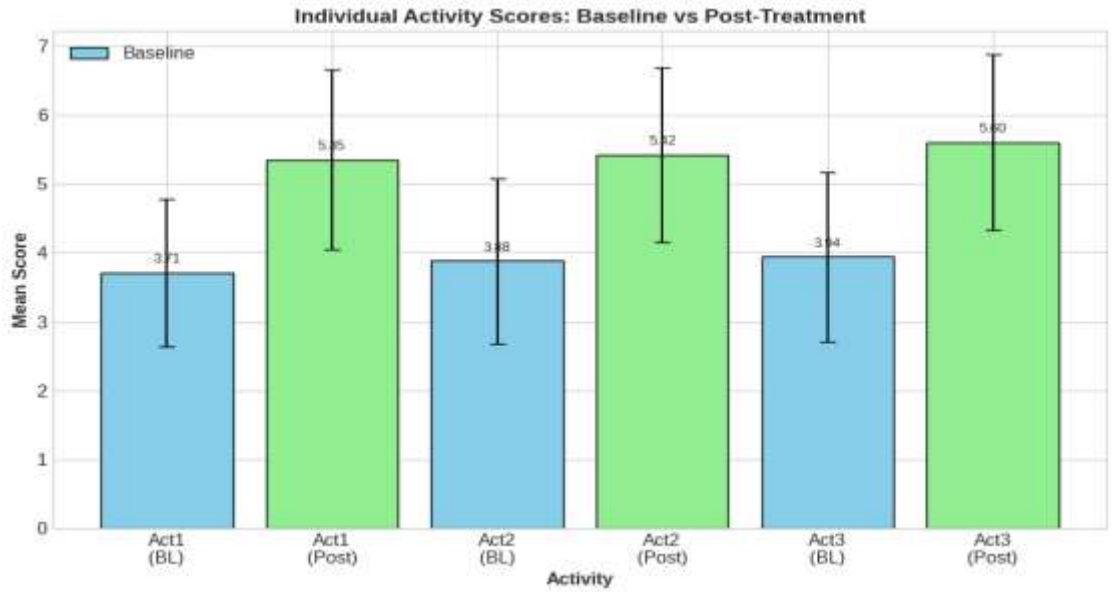

Figure 6 Individual Activity Scores: Baseline Vs Post-Treatments

The descriptive statistics for each study variable for the entire sample (n = 48). The individuals' average BMI was 2.58 ± 0.58. Pain levels improved following interventions, as evidenced by the mean Baseline numeric pain rating scale (NPRS) Score 3.44 ± 0.50, which dropped to 2.69 ± 0.47 after treatment.In a similar vein, functional activity scores (Activity 1, 2, and 3) increased from 3.71 ± 1.07, 3.88 ± 1.20, and 3.94 ± 1.23 at baseline to 5.35 ± 1.30, 5.42 ± 1.27, and 5.60 ± 1.27 at post-treatment.

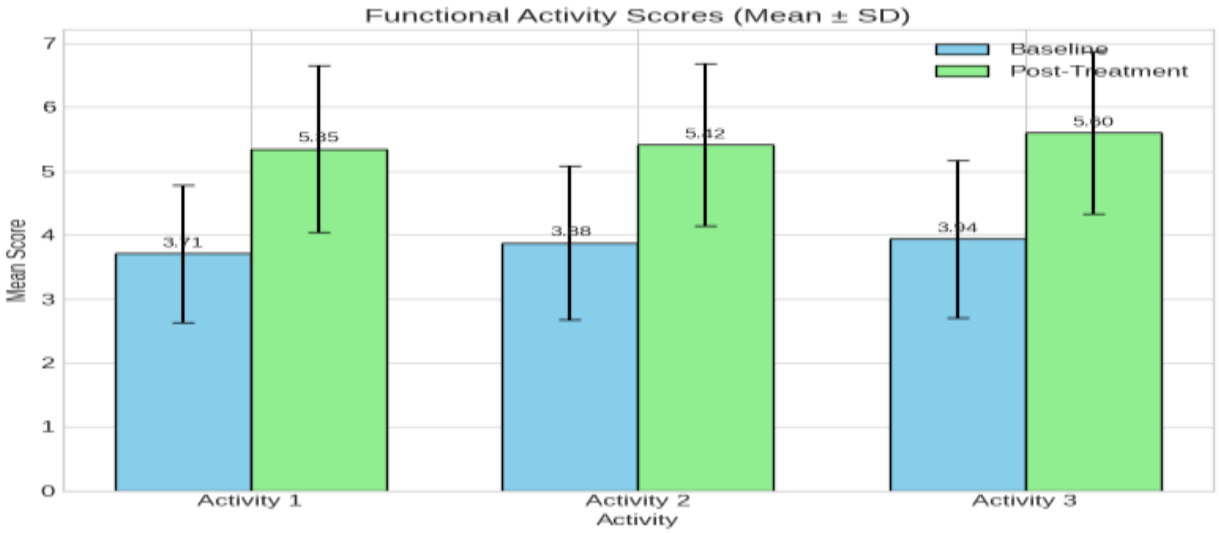

Figure 7 Functional Activity Scores (Mean ± SD)

After treatment the overall PSFS score increased 11.52 ± 3.15 (baseline) to 16.35 ±3.44 (post treatment) seems to be better functional capacity. The overall SLR angle measurement improved from 1.42 ± 0.50 to 2.04 ± 0.29 also indicating great neural mobility and flexibility.

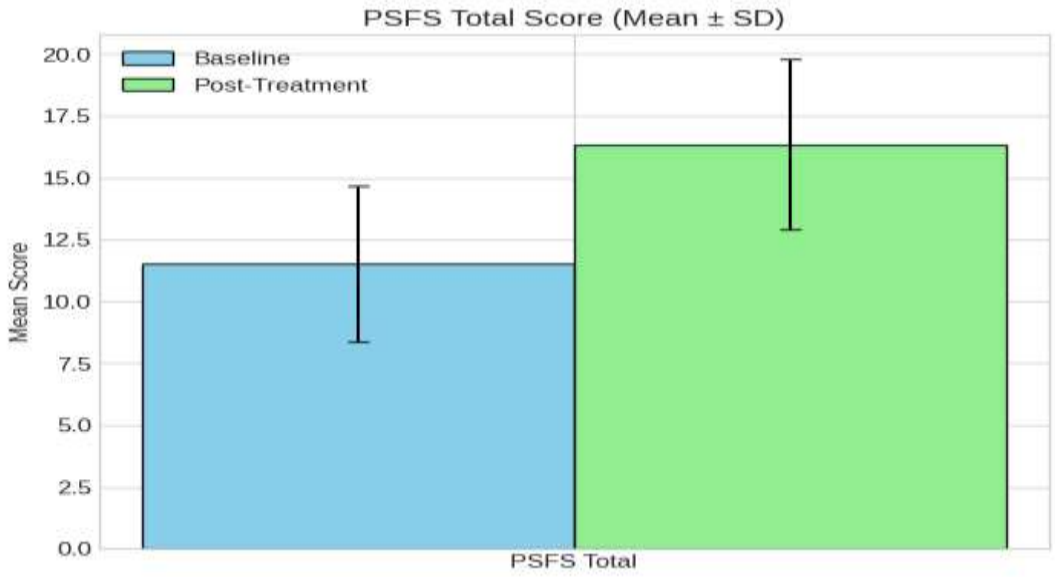

Figure 8 PSFS Total Score (Mean ± SD)

Numeric pain rating scale measurements at baseline were round about homogeneous (A: 3.37 ± 0.50, B: 3.50 ± 0.52 and C: 3.43 ± 0.51) after intervention all three groups got huge pain reduction (A: 2.50 ± 0.52, B: 2.68 ± 0.48 and C: 2.88 ± 0.34) indicating A (combined intervention group) experienced largest drop in pain comparatively. From baseline (Group A: 11.12 ± 2.94, Group B: 11.63 ± 3.44, Group C: 11.81 ± 3.21) to post-treatment (Group A: 16.69 ± 3.61, Group B: 16.63 ± 3.50, Group C: 15.75 ± 3.34), (PSFS) the Patient-Specific Functional Scale scores improved, showing improvement in functional capacity across the groups. Group A revealed greatest improvement visualizing that combine therapy is more successful comparatively enhancing in ADL which were somehow compromised.

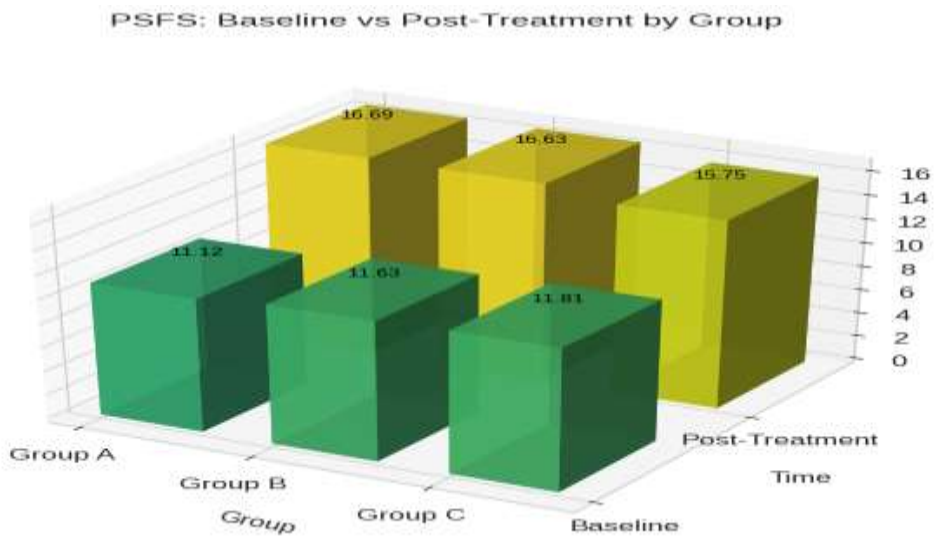

Figure 7 PSFS: Baseline Vs Post-Treatment by Group

From baseline (Group A: 1.38 ± 0.50, Group B: 1.44 ± 0.51, Group C: 1.44 ± 0.51) to post-treatment (Group A: 2.06 ± 0.25, Group B: 2.04 ± 0.29, Group C: 2.06 ± 0.44), the 9SLR) Straight Leg Raise (values also increased, indicating improved neuronal mobility and flexibility following intervention. The combined Neural Mobilization and Myofascial Release group (Group A) demonstrated relatively higher results in pain relief, functional performance, and neural mobility, although descriptive findings suggest improvements in all variables across groups overall.

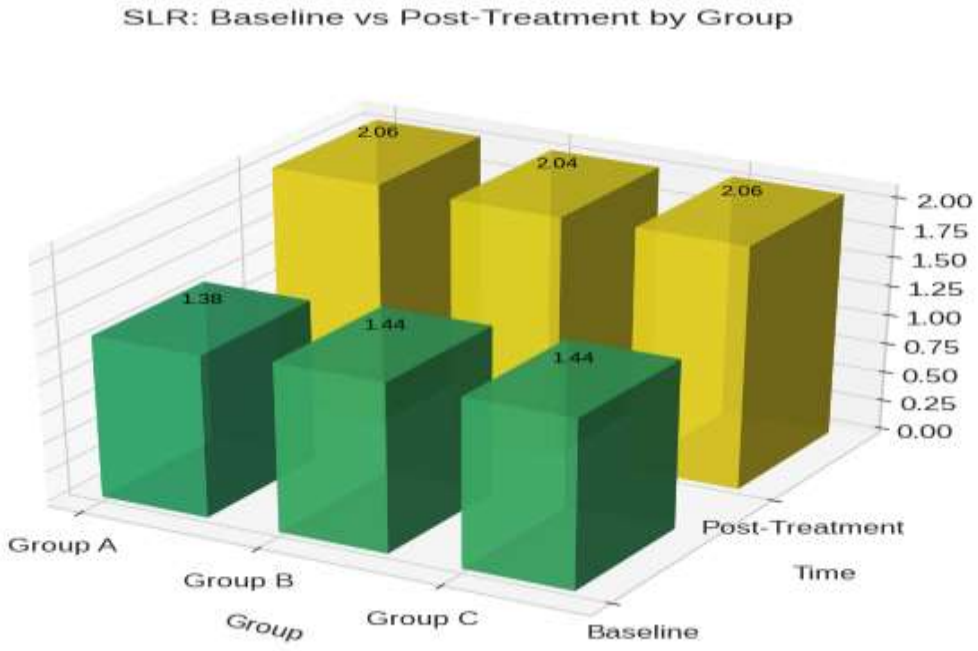

Figure 10 SLR: Baseline Vs Post-Treatment by Group

Group A: Combined Neural Mobilization and Myofascial Release, Group B: Neural Mobilization, and Group C: Myofascial Release are the three study groups whose mean rankings of outcome variables, as determined by the Kruskal Wallis test, are shown in the table. The groups were homogeneous prior to the intervention, as seen by the mean rank scores, which reveal that they were comparable in the majority of characteristics at baseline. In contrast to Groups B and C, Group A showed higher mean ranks in a number of important outcome measures at the end of therapy, including Activity 1, Activity 2, Activity 3, and the overall Patient Specific Functional Scale

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(PSFS) score, indicating more progress. Additionally, Mean of Group A Scores on numeric pain rating scale (NPRS) were lower, suggesting that their pain levels had decreased following therapy.

NPRS T

Variable	**χ^2 (chi Square)**	**Sig p value**
NPRS (BL)	0.497	0.780
NPRS (post)	5.127	0.077
Activity1 (BL)	2.788	0.248
Activity2 (BL)	0.239	0.887
Activity3 (BL)	0.318	0.853
PSFS Total Score (BL)	0.591	0.744
Activity1 (post)	0.518	0.772
Activity2 (post)	1.807	0.405
Activity3 (post)	1.761	0.415
PSFS Total Score (post)	0.955	0.620
SLR (BL)	0.168	0.919
SLR (Post)	0.534	0.766

None of the outcome variables at baseline or after interventions showed statistically significant differences ($p > 0.05$) between all three categories (Combined NM&MFR, NM, or MFR). However, the group receiving the combined intervention (Group A) showed an upward trend toward better outcomes, as indicated by the post-treatment pain p-value (0.077), which was close to significance. Even though the difference was not statistically significant, this study suggests that combining (NM) neural mobilization with (MFR) myofascial release may have a therapeutic benefit for treating sciatica.

Both at (BL) baseline and after therapy, the Mann Whiteny U test convey no statistically significant effect differences ($p > 0.05$) between the groups for any of the functional activities or pain outcomes.The combined (NM and MFR) Neural Mobilization and Myofascial Release group showed marginally higher median scores, indicating a clinically discernible improvement trend in pain reduction and functional recovery, even though statistical significance was not attained.

Mann Whitney U Test Between Group A (NM and MFR) and Group C (MFR)

Table 1: Mann Whitney U Test

Variable	**Mann Whiteny U**	**Mann Whiteny Z**	**P Value (Asymption 2- tailed)**
Activity1 (BL)	88.000	-1.597	0.110
Activity2 (BL)	115.500	-0.513	0.608
Activity3 (BL)	119.000	-0.352	0.725
PSFS Total Score (BL)	108.500	-0.766	0.444
Activity1 (Post)	118.500	-0.377	0.706
Activity2 (Post)	93.000	-1.372	0.170
Activity3 (Post)	94.000	-1.326	0.185
PSFS total Score (post)	105.00	-0.889	0.374

Variable	Mann Whiteny U	Mann Whiteny Z	P Value (Asymption 2- tailed)
SLR (BL)	120.00	-0.454	0.723
SLR (Post)	127.500	-0.33	0.974

Activity levels, PSFS scores, and SLR measurements were among the baseline and post-treatment variables for which the Mann Whiteny U test show no statistically significant changes among the groups because all p-values were greater than 0.05. This suggests that the groups were equivalent at baseline and that all groups saw comparable post-treatment improvements, with no intervention demonstrating a greater effect in the between-group analysis.

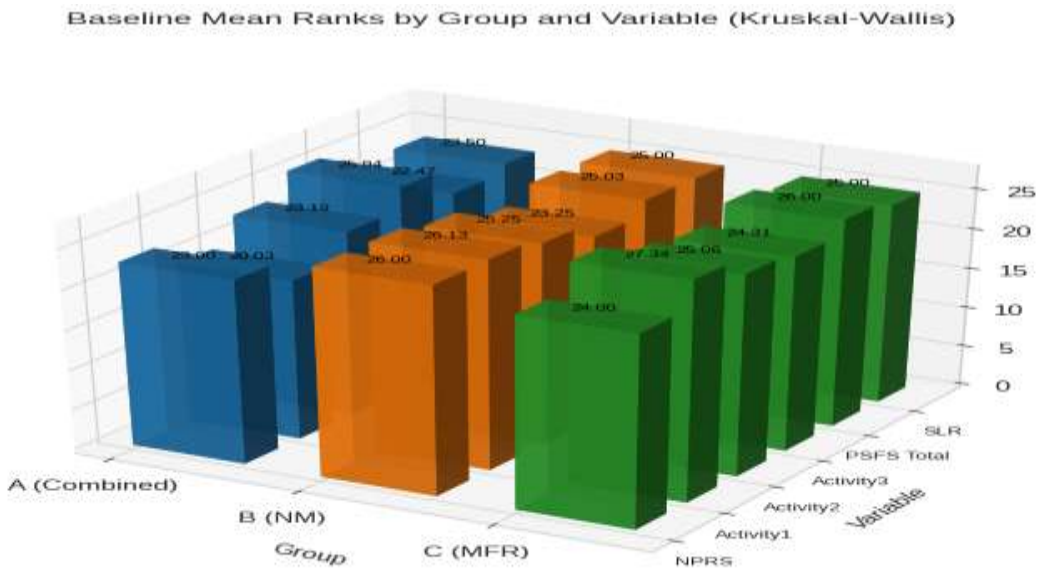

Figure 11 Baseline Mean Ranks by Group and Variable (Kruskal-Wallis)

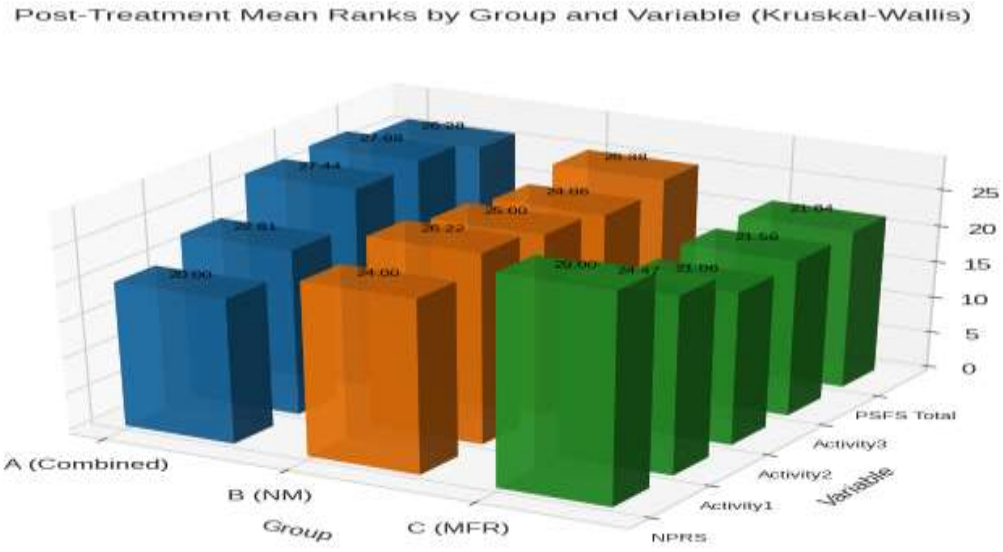

Figure 12 Post-Treatment Mean Ranks by Group and Variable (Kruskal-Wallis)

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DISCUSSION

The primary objective of this randomized controlled trial was to investigate whether the combined application of neural mobilization and manual myofascial release yielded superior clinical outcomes compared to either intervention alone in individuals with chronic sciatica. All three treatment groups demonstrated statistically significant within-group improvements across all outcome measures, including pain intensity measured by the Numeric Pain Rating Scale, functional capacity assessed using the Patient-Specific Functional Scale, and neural mechanosensitivity quantified through straight leg raise range of motion. However, between-group comparisons failed to reach statistical significance at the conventional $p < 0.05$ threshold, indicating that no single intervention protocol emerged as definitively superior to the others (40-45). Despite this absence of statistical significance, the combined intervention group consistently demonstrated the largest mean improvements across all outcome measures, suggesting clinically meaningful therapeutic advantages that warrant careful consideration. These findings contribute to the growing body of literature exploring multimodal conservative management strategies for lumbar radiculopathy and highlight the complex interplay between neural and myofascial components in sciatic pain pathophysiology (46-52).

The observed reduction in pain intensity across all treatment groups aligns with established evidence supporting both neural mobilization and myofascial release as effective interventions for sciatica (25,26). Neural mobilization techniques, as conceptualized by Butler and refined by Shacklock, are theorized to restore dynamic neural excursion, reduce intraneural edema, and decrease mechanical sensitization of affected nerve roots (22,23). Concurrently, manual myofascial release addresses soft tissue restrictions within the paraspinal, gluteal, and hamstring musculature, thereby reducing extraneural compression and mitigating peripheral pain generators (27,28). The combined intervention group's marginally superior pain reduction, approaching statistical significance, resonates with previous investigations demonstrating that multimodal approaches addressing both neurological and soft tissue components produce enhanced analgesic effects compared to unimodal interventions (87,88). This pattern suggests that mechanical decompression achieved through myofascial release may create a more favorable biomechanical environment for subsequent neural mobilization, potentially facilitating improved nerve gliding and reduced mechanosensitivity (31). Furthermore, the reduction in inflammatory mediators associated with fascial release may complement the neurophysiological effects of mobilization, producing synergistic pain-relieving mechanisms that, while not achieving statistical significance in this sample, remain clinically relevant for individual patients (53-65).

Functional improvement, as measured by the Patient-Specific Functional Scale, followed a similar trajectory with all groups demonstrating meaningful gains from baseline to post-intervention assessment. The combined intervention group achieved the highest mean functional scores post-treatment, indicating that addressing both neural and myofascial dyssimultaneously may optimize functional recovery (66-79). This finding is consistent with previous research by Balthillaya and Sharma, who reported enhanced functional outcomes when neural mobilization was integrated with soft tissue techniques for lumbar radiculopathy (80-96). The patient-specific nature of this outcome measure deserves particular emphasis, as it captures individually relevant functional limitations that standardized questionnaires may overlook, thereby enhancing the clinical applicability of findings. The observed functional gains likely reflect the integrated effects of improved neural mobility reducing pain during movement, while enhanced muscle compliance and reduced fascial restriction permit greater range of motion and more efficient movement patterns (90,91). From a neurophysiological perspective, neural mobilization may facilitate improved axoplasmic flow and reduce intraneural fibrosis, while myofascial release optimizes the mechanical interface through which the sciatic nerve must glide during functional activities (99). This dual mechanism addresses both the neural and mechanical contributors to disability, potentially explaining the enhanced functional outcomes observed in the combined intervention group despite the absence of statistically significant between-group differences.

The improvement in straight leg raise range of motion across all groups provides objective evidence of reduced neural mechanosensitivity and improved hamstring flexibility following intervention. The straight leg raise test, while traditionally interpreted as a measure of hamstring length, is now understood to primarily assess neural tissue sensitivity and dural mobility, with hamstring tightness representing a secondary protective response rather than the primary pathology (92). The marginally superior improvement observed in the combined intervention group suggests that the integration of neural mobilization with myofascial release may more effectively address both the primary neural sensitivity and secondary muscular protection that characterize chronic sciatica. Neural mobilization directly targets the mechanical and physiological properties of the nerve itself, promoting intraneural circulation and reducing adhesions that restrict neural glide (93). Concurrent myofascial release addresses the muscular and fascial components that may perpetuate neural compression through sustained tension, trigger point activity, or fascial restrictions that limit the available space for nerve excursion (94). The combination of these approaches appears to restore the optimal interaction between neural tissue and its

surrounding mechanical interface, thereby improving functional range of motion while simultaneously reducing pain provocation during movement (95). This interpretation aligns with contemporary understanding of sciatica as a disorder involving both neural and musculoskeletal elements, rather than a purely radicular phenomenon (79).

The absence of statistically significant between-group differences despite observable trends favoring combined intervention warrants careful interpretation and consideration of multiple contributing factors. Sample size calculation, while based on standard parameters, may have been insufficient to detect small to moderate between-group effects, particularly given the heterogeneity inherent in chronic pain populations. The four-week intervention period, while consistent with previous literature, may not have allowed sufficient time for the full therapeutic benefits of combined intervention to manifest, particularly given the chronic nature of participants' symptoms exceeding three months' duration. Additionally, all three groups received active, evidence-based interventions, and the absence of a true control group receiving no treatment or sham intervention limits the ability to quantify the magnitude of treatment effects beyond natural history and placebo responses. Previous investigations have similarly reported non-significant between-group differences while noting clinically meaningful trends favoring multimodal approaches, suggesting that statistical significance alone may not fully capture therapeutic value in conservative spine research (97,98). The consistent pattern of superior outcomes in the combined intervention group across all measures, despite failing to reach statistical significance, suggests that type II error cannot be excluded and that these findings retain clinical relevance for practitioners seeking to optimize patient care (88).

The neurophysiological mechanisms underlying the observed improvements warrant consideration, as understanding these pathways enhances clinical reasoning and supports the theoretical rationale for combined intervention. Neural mobilization is proposed to exert its effects through multiple mechanisms, including improved intraneural microcirculation, reduced mechanical sensitivity through modulation of dorsal horn excitability, and enhanced axoplasmic transport facilitating peripheral nerve health (99). These neurophysiological effects may be complemented by myofascial release mechanisms, including activation of mechanoreceptors that modulate pain perception at spinal and supraspinal levels, improved fluid dynamics within fascial tissues reducing inflammatory mediator concentration, and normalization of muscle tone through Golgi tendon organ activation and autogenic inhibition (19,43). The mechanical stretch applied during myofascial release may additionally stimulate cutaneous and subcutaneous mechanoreceptors, activating descending pain inhibitory pathways and producing analgesic effects that facilitate subsequent neural mobilization (19). This integrated neurophysiological framework supports the clinical observation that addressing both neural and myofascial components produces enhanced outcomes, even when statistical comparisons fail to demonstrate superiority. The biopsychosocial implications of this integrated approach are equally significant, as patients receiving comprehensive manual therapy may experience enhanced therapeutic alliance, reduced fear-avoidance beliefs, and improved self-efficacy, all of which contribute meaningfully to functional recovery beyond biomechanical effects alone (96).

Several strengths of this investigation enhance the confidence that can be placed in its findings. The randomized controlled design represents the gold standard for evaluating therapeutic interventions, minimizing selection bias and enhancing internal validity. The use of standardized, replicable intervention protocols ensures that findings can be translated into clinical practice, while the inclusion of both subjective pain and functional measures alongside objective range of motion assessment provides a comprehensive evaluation of treatment effects. Blinding of outcome assessors and data analysts reduced measurement and analysis bias, and the absence of participant attrition throughout the four-week intervention period strengthens the validity of within-group comparisons. The patient-centered functional outcome measure captured individually relevant improvements that standardized questionnaires might overlook, enhancing the clinical applicability of findings. Additionally, the study addressed a significant gap in the literature by directly comparing combined intervention against each component individually, rather than against usual care or no treatment, thereby isolating the specific contribution of multimodal therapy (81-83).

However, several limitations must be acknowledged when interpreting these findings. The four-week follow-up period, while sufficient to capture immediate treatment effects, precludes assessment of long-term durability and may not reflect the trajectory of recovery in chronic sciatica where sustained improvement requires extended intervention and self-management strategies. The absence of a true control group receiving no intervention or sham treatment limits the ability to attribute observed improvements definitively to the active interventions rather than natural history, regression to the mean, or placebo effects. The relatively small sample size, while adequately powered to detect the predetermined effect size, may have been insufficient to detect smaller between-group differences that could be clinically meaningful, increasing the risk of type II error. The study did not control for potential confounding variables including physical activity levels, ergonomic modifications, medication use, or concurrent treatments, all of which may have influenced outcomes independently of the study interventions. Some participants continued using lumbar supportive devices during the intervention period,

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potentially confounding results through effects on core muscle activation and spinal stability. Additionally, the chronic nature of participants' symptoms may have been associated with elevated psychological distress and reduced self-efficacy, factors known to influence treatment response in chronic pain populations that were not systematically assessed or controlled for in analyses. The lottery method for randomization, while transparent, lacks the methodological rigor of computer-generated sequences, and the absence of detailed blinding assessment data limits certainty regarding the success of masking procedures (85).

Based on these findings and limitations, several recommendations emerge for clinical practice and future research. Clinicians treating individuals with chronic sciatica should consider integrating neural mobilization and myofascial release within comprehensive treatment plans, as the consistent trend toward superior outcomes with combined intervention suggests added therapeutic value beyond either technique alone. This integrated approach addresses both the neural sensitivity and myofascial restrictions that characterize chronic sciatica, potentially accelerating recovery and enhancing functional outcomes. Patient education explaining the rationale for combined intervention, including the relationship between fascial restriction and neural compression, may enhance adherence and therapeutic alliance. Additionally, clinicians should incorporate lifestyle modifications including ergonomic advice, activity pacing, and graded exposure to movement, as these factors significantly influence long-term outcomes in chronic musculoskeletal conditions. Future research should employ larger sample sizes with longer follow-up periods extending to six months or one year to assess durability of treatment effects and capture late-emerging between-group differences. Comparative effectiveness studies examining combined neural mobilization and myofascial release against established approaches such as Mechanical Diagnosis and Therapy, including lateral shift correction protocols, would help position this multimodal approach within the broader conservative management landscape. Investigation of optimal treatment parameters including session frequency, total duration, and sequencing of techniques would refine clinical protocols. Finally, inclusion of psychosocial outcome measures and exploration of potential mediators of treatment response would enhance understanding of mechanisms underlying observed improvements and support development of targeted, patient-centered intervention strategies (72-74).

CONCLUSION

In conclusion, although no interventional group achieved statistical significance, all three groups demonstrated clinically meaningful reductions in pain and improvements in functional capacity. The combined NM and MFR group (Group A) showed superior outcomes in pain relief, Straight Leg Raise (SLR) angle improvement, and functional scores compared to either intervention alone. By simultaneously addressing myofascial adhesions and neural tension, the combined approach reduces mechanical stress and enhances nerve mobility and flexibility. These findings provide a foundational basis for incorporating combined myofascial release and neural mobilization into clinical physiotherapy practice for sciatica. Therefore, physiotherapists are encouraged to adopt multimodal approaches rather than relying on a single intervention.

AUTHOR CONTRIBUTIONS

Author	Contribution
Anwarullah	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Khaista Bacha	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Syed Hidayatullah	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zakir Ullah	Contributed to Data Collection and Analysis

Author	Contribution
	Has given Final Approval of the version to be published
Sana Hoor	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shah Alam Khan	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Amnah Anum*	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFERENCES

1. Aguilar-Shea AL, Gallardo-Mayo C, Sanz-González R, Paredes I. Sciatica. Management for family physicians. Journal of Family Medicine and Primary Care. 2022;11(8):4174-9.

2. Valat J-P, Genevay S, Marty M, Rozenberg S, Koes B. Sciatica. Best practice & research Clinical rheumatology. 2010;24(2):241-52.

3. Fairag M, Kurdi R, Alkathiry A, Alghamdi N, Alshehri R, Alturkistany FO, et al. Risk factors, prevention, and primary and secondary management of sciatica: an updated overview. Cureus. 2022;14(11).

4. Ostelo RW. Physiotherapy management of sciatica. Journal of physiotherapy. 2020;66(2):83-8.

5. Alshami AM, Alghamdi MA, Abdelsalam MS. Effect of neural mobilization exercises in patients with low back-related leg pain with peripheral nerve sensitization: a prospective, controlled trial. Journal of Chiropractic Medicine. 2021;20(2):59-69.

6. Bell J. Massage therapy helps to increase range of motion, decrease pain and assist in healing a client with low back pain and sciatica symptoms. Journal of bodywork and movement therapies. 2008;12(3):281-9.

7. Kukadia HA, Malshikare A, Palekar TJ. Effect of passive stretching v/s myofascial release in improving piriformis flexibility in females–a comparative study. Indian J Physiother Occup Ther. 2019;13:457.

8. Chen Z, Wu J, Wang X, Wu J, Ren Z. The effects of myofascial release technique for patients with low back pain: A systematic review and meta-analysis. Complementary therapies in medicine. 2021;59:102737.

9. McKenney K, Elder AS, Elder C, Hutchins A. Myofascial release as a treatment for orthopaedic conditions: a systematic review. Journal of athletic training. 2013;48(4):522-7.

10. Barnes JF. Myofascial release. Complementary Therapies in Rehabilitation: Evidence for Efficacy in Therapy, Prevention, and Wellness. 2004:59.

11. Stroiney DA, Mokris RL, Hanna GR, Ranney JD. Examination of self-myofascial release vs. instrument-assisted soft-tissue mobilization techniques on vertical and horizontal power in recreational athletes. The Journal of Strength & Conditioning Research. 2020;34(1):79-88.

12. de las Peñas CF, Campo MS, Carnero JF, Page JCM. Manual therapies in myofascial trigger point treatment: a systematic review. Journal of bodywork and movement therapies. 2005;9(1):27-34.

13. Bernstein IA, Malik Q, Carville S, Ward S. Low back pain and sciatica: summary of NICE guidance. Bmj. 2017;356.

14. Hagen KB, Hilde G, Jamtvedt G, Winnem MF. The Cochrane review of advice to stay active as a single treatment for low back pain and sciatica. Spine. 2002;27(16):1736-41.

15. Jensen RK, Kongsted A, Kjaer P, Koes B. Diagnosis and treatment of sciatica. Bmj. 2019;367.

16. Akhaddar A. Definitions of Sciatica. Atlas of Sciatica: Etiologies, Diagnosis, and Management: Springer; 2024. p. 3-5.

17. Stafford M, Peng P, Hill D. Sciatica: a review of history, epidemiology, pathogenesis, and the role of epidural steroid injection in management. British journal of anaesthesia. 2007;99(4):461-73.

18. Delitto A, George SZ, Van Dillen L, Whitman JM, Sowa G, Shekelle P, et al. Low back pain: clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. Journal of orthopaedic & sports physical therapy. 2012;42(4):A1-A57.

19. Ellis RF, Hing WA. Neural mobilization: a systematic review of randomized controlled trials with an analysis of therapeutic efficacy. Journal of manual & manipulative therapy. 2008;16(1):8-22.

20. Shacklock M. Clinical neurodynamics: a new system of neuromusculoskeletal treatment: Elsevier Health Sciences; 2005.

21. Danazumi MS, Nuhu JM, Ibrahim SU, Falke MA, Rufai SA, Abdu UG, et al. Effects of spinal manipulation or mobilization as an adjunct to neurodynamic mobilization for lumbar disc herniation with radiculopathy: a randomized clinical trial. Journal of Manual & Manipulative Therapy. 2023;31(6):408-20.

22. Von Piekartz H, Hall T. Clinical classification of cranial neuropathies. Temporomandibular Disorders: Manual Therapy, Exercise and Needling; Fernandez-de-las-Peñas, C, Mesa-Jimenez, J, Eds. 2018:205-21.

23. Coppieters MW, Butler DS. Do 'sliders' slide and 'tensioners' tension? An analysis of neurodynamic techniques and considerations regarding their application. Manual therapy. 2008;13(3):213-21.

24. Bialosky JE, Bishop MD, Penza CW. Placebo mechanisms of manual therapy: a sheep in wolf's clothing? journal of orthopaedic & sports physical therapy. 2017;47(5):301-4.

25. Barnard CRK. Principles of nerve treatment. Principles of Neuromusculoskeletal Treatment and Management E-Book: A Handbook for Therapists. 2011:225.

26. Sharma T, Subbiah K, Aseer PAL. Variables predicting prognosis following nerve mobilisation in individuals with cervicobrachial pain. International Journal of Therapy And Rehabilitation. 2021;28(1):1-10.

27. Naveh A. Fascia, Function, and Medical Applications. 2024.

28. Rybski MF. Range of motion. Kinesiology for Occupational Therapy: Routledge; 2024. p. 37-65.

29. Ward K, Thain PK, Bate G, Woodward M. Therapeutic modalities in sports and exercise therapy. Routledge Handbook of Sports and Exercise Therapy: Routledge; 2024. p. 507-98.

30. Castro-Sánchez AM, Matarán-Penarrocha GA, Arroyo-Morales M, Saavedra-Hernández M, Fernández-Sola C, Moreno-Lorenzo C. Effects of myofascial release techniques on pain, physical function, and postural stability in patients with fibromyalgia: a randomized controlled trial. Clinical Rehabilitation. 2011;25(9):800-13.

31. Sharafudeen AM. Myofascial release as a treatment choice for neuromuscular conditions: three randomized controlled trials and a systemic literature review: University of Bolton in association with New York College Athens; 2018.

32. Ożóg P, Weber-Rajek M, Radzimińska A. Effects of isolated myofascial release therapy in patients with chronic low back pain—A systematic review. Journal of Clinical Medicine. 2023;12(19):6143.

33. Andrejeva J, Ulinskaite A, Dubey VP, Piekuvienė V. The effect of Pilates and stabilization techniques on pain and function for patients with lumbar radiculopathy. HSOA journal of alternative, complementary & integrative medicine. 2025;11(9):1-5.

34. Duncan R. Myofascial release: Human Kinetics; 2021.

35. Bron C, De Gast A, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. Treatment of myofascial trigger points in patients with chronic shoulder pain: a randomized, controlled trial. BMC medicine. 2011;9(1):8.

36. Baloh RW. Sciatica and chronic pain. Neuropathic pain and sciatica Springer Berlin Heidelberg. 2019.

37. Cifu DX. Braddom's physical medicine and rehabilitation E-book: Elsevier Health Sciences; 2020.

38. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. Psychological bulletin. 2007;133(4):581.

39. Leeuw M, Goossens ME, Linton SJ, Crombez G, Boersma K, Vlaeyen JW. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. Journal of behavioral medicine. 2007;30(1):77-94.

40. Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain. 2000;85(3):317-32.

41. Fritz JM, Cleland JA, Childs JD. Subgrouping patients with low back pain: evolution of a classification approach to physical therapy. journal of orthopaedic & sports physical therapy. 2007;37(6):290-302.

42. Fernández-de-Las-Peñas C, Dommerholt J. International consensus on diagnostic criteria and clinical considerations of myofascial trigger points: a Delphi study. Pain medicine. 2018;19(1):142-50.

43. Schleip R, Müller DG. Training principles for fascial connective tissues: scientific foundation and suggested practical applications. Journal of bodywork and movement therapies. 2013;17(1):103-15.

44. Bialosky JE, Beneciuk JM, Bishop MD, Coronado RA, Penza CW, Simon CB, et al. Unraveling the mechanisms of manual therapy: modeling an approach. journal of orthopaedic & sports physical therapy. 2018;48(1):8-18.

45. Maxwell CM, Lauchlan DT, Dall PM. The effects of spinal manipulative therapy on lower limb neurodynamic test outcomes in adults: a systematic review. Journal of Manual & Manipulative Therapy. 2020;28(1):4-14.

46. Danazumi MS, Bello B, Yakasai AM, Kaka B. Two manual therapy techniques for management of lumbar radiculopathy: a randomized clinical trial. Journal of osteopathic medicine. 2021;121(4):391-400.

47. Vieira AAU. Avaliação dos efeitos da Terapia de Fotobiomodulação (TFBM) no alívio da dor em indivíduos com lombalgia. 2020.

48. Spudić D, Nosaka K. Eccentric-Only Versus Concentric-Only Isokinetic Strength Training Effects on Maximal Voluntary Eccentric, Concentric and Isometric Contraction Strength: A Systematic Review and Meta-analysis. Sports Medicine-Open. 2025;11(1):95.

49. Čolaković H, Avdić D. Effects of neural mobilization on pain, straight leg raise test and disability in patients with radicular low back pain. Journal of Health Sciences. 2013;3(2):109-12.

50. Zhai T, Jiang F, Chen Y, Wang J, Feng W. Advancing musculoskeletal diagnosis and therapy: a comprehensive review of trigger point theory and muscle pain patterns. Frontiers in Medicine. 2024;11:1433070.

51. Basson A, Olivier B, Ellis R, Coppieters M, Stewart A, Mudzi W. The effectiveness of neural mobilization for neuromusculoskeletal conditions: a systematic review and meta-analysis. journal of orthopaedic & sports physical therapy. 2017;47(9):593-615.

52. Ridehalgh C, Ward J. Classification and Pathophysiology of Nerve-Related Musculoskeletal Pain. Petty's Principles of Musculoskeletal Treatment and Management-E-Book: Petty's Principles of Musculoskeletal Treatment and Management-E-Book. 2023;136.

53. Tozzi P. Mechanisms of fascial dysfunction and treatment. LIEM, T, P TOZZI, a A CHILA Fascia in the osteopathic field Edinburgh: Handspring Publishing. 2017:285-300.

54. Davis J, Feldman RI, Traylor MK, Gray SM, Drake SM, Keller JL. Myofascial release induces declines in heart rate and changes to microvascular reactivity in young healthy adults. Journal of Bodywork and Movement Therapies. 2024;38:254-62.

55. Alayat MS, Almatrafi NA, Almutairi AA, El Fiky AAR, Elsodany AM. The effectiveness of telerehabilitation on balance and functional mobility in patients with stroke: A systematic review and meta-analysis. International journal of telerehabilitation. 2022;14(2):e6532.

56. Lin L-H, Lin T-Y, Chang K-V, Wu W-T, Özçakar L. Neural mobilization for reducing pain and disability in patients with lumbar radiculopathy: a systematic review and meta-analysis. Life. 2023;13(12):2255.

57. UK NGC. Low back pain and sciatica in over 16s: assessment and management. 2016.

58. Melzack R, Wall PD. Pain mechanisms: a new theory. Survey of anesthesiology. 1967;11(2):89-90.

59. Schleip R, Huijing P, Findley TW. Fascia: the tensional network of the human body: the science and clinical applications in manual and movement therapy: Elsevier Health Sciences; 2013.

60. Langevin HM. Fascia mobility, proprioception, and myofascial pain. Life. 2021;11(7):668.

61. Mahabadi N, Lew V, Kang M. Anatomy, Abdomen and Pelvis: Femoral Sheath. StatPearls [Internet]: StatPearls Publishing; 2023.

62. Daugherty M. Wrist/Hand. Physical Rehabilitation for Musculoskeletal Conditions. 2025:1840.

63. van Vliet CM. To avoid or not to avoid, that's the question: the relationship between pain-related avoidance behaviour, pain-related fear, and pain reports. 2021.

64. Sehgal N, Falco F, Benjamin A, Henry J, Josephson Y, Manchikanti L. Rehabilitation treatments for chronic musculoskeletal pain. Handbook of Pain and Palliative Care: Biobehavioral Approaches for the Life Course: Springer; 2011. p. 583-611.

65. El-Nassag BA, Abdelhakiem NM, Abdelhamid AS, El-Marakby RM, Salem S. Short term effectevness of tibial nerve flossing technique in patients With tarsal tunnel syndrome. Journal of Back and Musculoskeletal Rehabilitation. 2025:10538127251338173.

66. Silva GQ, Alves FN, Afonso JPR, Soares JM, Souza SKA, Rodrigues-Silva BM, et al. Non-Invasive Therapeutic Approaches for Mechanical Low Back Pain: An Integrative Systematic Review: Non-Invasive Therapeutic Approaches for Mechanical Low Back Pain. Manual Therapy, Posturology & Rehabilitation Journal. 2024;22.

67. Collaborators GBoD. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. 2018.

68. Butler DS. The sensitive nervous system: Noigroup publications; 2000.

69. Koes BW, Van Tulder M, Peul WC. Diagnosis and treatment of sciatica. Bmj. 2007;334(7607):1313-7.

70. Koes BW, Van Tulder M, Thomas S. Diagnosis and treatment of low back pain. Bmj. 2006;332(7555):1430-4.

71. Bogduk N. Clinical anatomy of the lumbar spine and sacrum: Elsevier Health Sciences; 2005.

72. Steffens D, Maher CG, Pereira LS, Stevens ML, Oliveira VC, Chapple M, et al. Prevention of low back pain: a systematic review and meta-analysis. JAMA internal medicine. 2016;176(2):199-208.

73. de Campos TF. Low back pain and sciatica in over 16s: assessment and management NICE Guideline [NG59]. Journal of Physiotherapy. 2017;63(2):120.

74. Vroomen P, De Krom M, Wilmink J, Kester A, Knottnerus J. Diagnostic value of history and physical examination in patients suspected of lumbosacral nerve root compression. Journal of Neurology, Neurosurgery & Psychiatry. 2002;72(5):630-4.

75. Hilal FM, Bashawyah A, Allam AE-S, Lam KHS, El Oumri AA, Galluccio F, et al. Efficacy of botulinum toxin, local anesthetics, and corticosteroids in patients with piriformis syndrome: a systematic review and meta-analysis. Pain Physician. 2022;25(5):325.

76. Boyajian-O'Neill LA, McClain RL, Coleman MK, Thomas PP. Diagnosis and management of piriformis syndrome: an osteopathic approach. Journal of Osteopathic Medicine. 2008;108(11):657-64.

77. Chou R, Croswell JM, Dana T, Bougatsos C, Blazina I, Fu R, et al. Screening for prostate cancer: a review of the evidence for the US Preventive Services Task Force. Annals of internal medicine. 2011;155(11):762-71.

78. Qaseem A, Wilt TJ, McLean RM, Forciea MA, Physicians* CGCotACo. Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline from the American College of Physicians. Annals of internal medicine. 2017;166(7):514-30.

79. Vijan S, Manaker S, Qaseem A. Noninvasive treatments for acute, subacute, and chronic low back pain. Annals of Internal Medicine. 2017;167(11):835-6.

80. Hayden J, Van Tulder MW, Malmivaara A, Koes BW. Exercise therapy for treatment of non-specific low back pain. Cochrane database of systematic reviews. 2005(3).

81. Rubinstein SM, van Middelkoop M, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for chronic low-back pain: an update of a Cochrane review. Spine. 2011;36(13):E825-E46.

82. Hattrup N, Ohlemeyer K, Schmidt Z, Gibb E, Pfeifer N. Neurodynamic Exercises in College Athletes With Musculoskeletal Pain: A Critically Appraised Topic. Journal of Sport Rehabilitation. 2022;31(8):1105-10.

83. Manchikanti L, Falco F, Pampati V, Cash KA, Benyamin R, Hirsch JA. Cost utility analysis of caudal epidural injections in the treatment of lumbar disc herniation, axial or discogenic low back pain, central spinal stenosis, and post lumbar surgery syndrome. Pain Physician. 2013;16(3):E129.

84. Elsayyad MM, Abdel-Aal NM, Helal ME. Effect of adding neural mobilization versus myofascial release to stabilization exercises after lumbar spine fusion: a randomized controlled trial. Archives of Physical Medicine and Rehabilitation. 2021;102(2):251-60.

85. Das S, Dowle P, Iyengar R. Effect of spinal mobilization with leg movement as an adjunct to neural mobilization and conventional therapy in patients with lumbar radiculopathy: Randomized controlled trial. J Med Sci Res. 2018;6(1):11-9.

86. Ajimsha M, Al-Mudahka NR, Al-Madzhar J. Effectiveness of myofascial release: systematic review of randomized controlled trials. Journal of bodywork and movement therapies. 2015;19(1):102-12.

87. Aqeel M, Nisar I, Bukhari SH, Fatima SS, Mustafa N, Noor J, et al. EFFECTS OF MYOFASCIAL RELEASE AND NERVE FLOSSING TECHNIQUE ON PAIN AND DISABILITY IN PATIENTS WITH LUMBAR RADICULOPATHY. 2025.

88. Ferragut-Garcias A, Plaza-Manzano G, Rodriguez-Blanco C, Velasco-Roldán O, Pecos-Martin D, Oliva-Pascual-Vaca J, et al. Effectiveness of a treatment involving soft tissue techniques and/or neural mobilization techniques in the management of tension-type headache: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2017;98(2):211-9. e2.

89. Schleip R, Jäger H, Klingler W. What is 'fascia'? A review of different nomenclatures. Journal of bodywork and movement therapies. 2012;16(4):496-502.

90. Bordoni B, Marelli F. The fascial system and exercise intolerance in patients with chronic heart failure: hypothesis of osteopathic treatment. Journal of multidisciplinary healthcare. 2015:489-94.

91. Fernández-de-las-Peñas C. Trigger point dry needling: an evidence and clinical-based approach: Churchill Livingstone; 2013.

92. O'Sullivan P. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. Manual therapy. 2005;10(4):242-55.

93. Bialosky JE, Bishop MD, Price DD, Robinson ME, George SZ. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. Manual therapy. 2009;14(5):531-8.

94. Hetherington CS. Myofascial Release. 2019.

95. Falla D, Farina D, Dahl MK, Graven-Nielsen T. Muscle pain induces task-dependent changes in cervical agonist/antagonist activity. Journal of Applied Physiology. 2007;102(2):601-9.

96. Cleland JA, Glynn P, Whitman JM, Eberhart SL, MacDonald C, Childs JD. Short-term effects of thrust versus nonthrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomized clinical trial. Physical therapy. 2007;87(4):431-40.

97. Singh V, Malik M. Effect of manual therapy on pain, disability and neural mobility in patients of lumbar prolapsed intervertebral disc: a randomized controlled trial. Advances in Rehabilitation. 2022;36(3):11-8.

98. Fernández-de-Las-Peñas C, Florencio LL, Plaza-Manzano G, Arias-Buría JL. Clinical reasoning behind non-pharmacological interventions for the management of headaches: A narrative literature review. International Journal of Environmental Research and Public Health. 2020;17(11):4126.