

RESEARCH ARTICLE

Comparative Effectiveness of Muscle Energy Technique Combined with Ultrasonic Therapy versus Myofascial Release Combined with Transcutaneous Electrical Nerve Stimulation in Sciatic Nerve Pain due to Prolapsed Intervertebral Disc: A Randomized Controlled Trial

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ABSTRACT

Background: Sciatic nerve pain due to Prolapsed Intervertebral Disc (PIVD) is a common cause of radiating low back pain, reduced mobility, neural tension, and functional disability. Muscle Energy Technique (MET), Myofascial Release (MFR), Ultrasonic Therapy (UST), and Transcutaneous Electrical Nerve Stimulation (TENS) are each individually supported by evidence, but comparative evidence on combined manual-therapy-plus-electrotherapy protocols for PIVD-related sciatica remains limited.

Objective: To compare the effectiveness of Muscle Energy Technique combined with Ultrasonic Therapy (Group A) against Myofascial Release combined with TENS (Group B) on pain intensity, functional disability, neural mobility, and lumbar range of motion in patients with sciatic nerve pain due to PIVD.

Methods: In this randomized controlled trial, 60 participants aged 40–55 years with MRI-confirmed PIVD (4–8 mm disc protrusion) and clinical sciatica were randomly allocated in a 1:1 ratio to Group A (MET + UST, n = 30) or Group B (MFR + TENS, n = 30). Both groups received treatment three sessions per week for 4 weeks. Outcomes were assessed using the Visual Analogue Scale (VAS), the Oswestry Disability Index (ODI), the Straight Leg Raise (SLR) Test, and lumbar Range of Motion (ROM) at baseline and after 4 weeks.

Results: Both groups improved significantly on all outcome measures from baseline to post-treatment (all $p < 0.05$). Group A showed significantly greater improvement than Group B on VAS, ODI, SLR, and ROM at post-treatment (all $p < 0.05$), with large between-group effect sizes ($d = 0.88$ to 1.49).

Conclusion: Muscle Energy Technique combined with Ultrasonic Therapy produced significantly greater improvement in pain, functional disability, neural mobility, and lumbar range of motion than Myofascial Release combined with TENS, in patients with sciatic nerve pain due to PIVD, over a 4-week period. These findings support MET plus UST as a preferred first-line conservative combination, pending confirmation in a larger, multi-centre, blinded trial.

Trial registration: This trial was not prospectively registered in a clinical trials registry; this is noted as a limitation of reporting.

Keywords: sciatica; PIVD; muscle energy technique; myofascial release; ultrasonic therapy; TENS; low back pain; lumbar radiculopathy; randomized controlled trial

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1. INTRODUCTION

Low back pain with radiating symptoms into the lower limb is one of the most commonly encountered musculoskeletal complaints in physiotherapy practice, and sciatic nerve pain due to Prolapsed Intervertebral Disc (PIVD) is among the leading causes of disability in the adult population, affecting functional independence, occupational activity, sleep, and quality of life. Sciatica is generally described as pain radiating along the sciatic nerve distribution from the lower back toward the buttock and lower extremity, most commonly arising from compression or irritation of the lumbar nerve roots at the L4–L5 and L5–S1 levels, as the nucleus pulposus protrudes through the annulus fibrosus and mechanically and chemically irritates adjacent neural structures. The pathology may develop gradually through degenerative change, or follow repetitive stress, poor posture, heavy lifting, or prolonged sitting, and is frequently associated with muscle spasm, restricted lumbar mobility, altered biomechanics, and reduced soft-tissue flexibility.

Changing lifestyle patterns, reduced physical activity, and prolonged sitting have contributed to a growing incidence of low back pain and sciatic symptoms among middle-aged individuals. Conservative management remains the primary treatment approach for most patients with PIVD-related sciatica unless a severe neurological deficit or surgical emergency is present, and physiotherapy intervention has repeatedly been shown to reduce pain, improve mobility, restore function, and help prevent recurrence. Current evidence favours a multimodal approach, combining manual therapy, electrotherapy, stretching, neural mobilization, and stabilization exercise, over isolated interventions in the management of lumbar radiculopathy, although variability persists in which specific combination of techniques clinicians select.

Muscle Energy Technique (MET) is an active manual therapy technique in which the patient performs a voluntary isometric contraction against therapist-applied resistance, working through post-isometric relaxation and reciprocal inhibition to reduce muscle tightness and restore joint mobility. In sciatic nerve pain, shortened hamstrings, piriformis tightness, and gluteal dysfunction can increase mechanical stress on the lumbar spine and sciatic nerve, and MET has been shown to improve muscle extensibility, correct biomechanical imbalance, and reduce pain. Myofascial Release (MFR) instead applies sustained pressure and stretch to restricted fascial tissue to improve tissue mobility and circulation, and has been reported to reduce pain and improve function in musculoskeletal disorders involving soft-tissue restriction and trigger points.

Alongside manual therapy, electrotherapy modalities are commonly incorporated for pain reduction and

tissue healing. Ultrasonic Therapy (UST) produces thermal and non-thermal effects that improve local circulation, reduce muscle spasm, enhance collagen extensibility, and promote tissue repair, potentially reducing inflammation and tissue tightness around the affected nerve root. Transcutaneous Electrical Nerve Stimulation (TENS) instead provides analgesia by stimulating sensory nerve fibres and modulating pain transmission through the gate-control mechanism, and is widely used for its non-invasive application and short-term pain relief.

Although MET, MFR, UST, and TENS have each independently demonstrated benefit in reducing musculoskeletal pain and disability, limited literature directly compares combined manual-therapy-plus-electrotherapy protocols in patients with sciatic nerve pain due to PIVD; most available studies evaluate isolated interventions rather than multimodal combinations, leaving clinicians to rely on preference and experience when selecting a treatment approach for lumbar radiculopathy. The present study was therefore undertaken to compare the effectiveness of Muscle Energy Technique combined with Ultrasonic Therapy against Myofascial Release combined with Transcutaneous Electrical Nerve Stimulation in patients with sciatic nerve pain due to PIVD, to help inform evidence-based selection between these two commonly used conservative combinations.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This study was a randomized controlled trial comparing Muscle Energy Technique combined with Ultrasonic Therapy (Group A) against Myofascial Release combined with Transcutaneous Electrical Nerve Stimulation (Group B) in patients with sciatic nerve pain due to PIVD. The trial was conducted in the outpatient Department of Physiotherapy at the Institute of Applied Medicines and Research (IAMR), Ghaziabad, and at Maharaja Agrasen Hospital, Dwarka, Sector 1, New Delhi. Patients attending these physiotherapy departments with low back pain radiating to the lower limb were screened for eligibility.

2.2 Participants

Eligible participants were men and women aged 40–55 years with clinically and radiologically confirmed sciatic nerve pain due to PIVD. Diagnosis required MRI evidence of disc protrusion between 4–8 mm at the L4–L5 or L5–S1 level, classified as moderate protrusion (4–5 mm, with nerve root contact or irritation, radiating pain into the buttock or posterior thigh, and SLR positive between 40–70°) or large protrusion (6–8 mm, with evident nerve root

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compression, radicular pain below the knee, dermatomal sensory involvement, and SLR positive between 30–50°); symptom duration of 4–12 weeks; VAS pain score of 4/10 or greater; measurable disability on the ODI; and a positive Straight Leg Raise test. This protrusion range was chosen because moderate-to-large protrusions commonly present with symptomatic radiculopathy while remaining appropriate for conservative physiotherapy management, whereas minimal bulges (non-radicular back pain) and severe extrusions (potential surgical candidates) were excluded.

Participants were excluded if they had prior lumbar spine surgery; severe neurological deficit or bowel/bladder involvement; spinal fracture, tumour, infection, or inflammatory spinal disorder; were pregnant; had a pacemaker or other implanted electrical device; had malignancy near the treatment area; had open wounds, severe sensory loss, or active skin infection; had uncontrolled systemic disease such as diabetes mellitus or severe osteoporosis; or were receiving any other physiotherapy treatment for the same condition during the study period. These contraindications to electrotherapy and manual therapy were applied to ensure participant safety.

2.3 Sample Size

A total of 60 participants were included, determined on the basis of previous comparable literature and feasibility considerations to ensure adequate statistical power to detect clinically significant between-group differences. Participants were randomly allocated into two equal groups of 30 each.

2.4 Randomization, Allocation Concealment, and Blinding

Participants were allocated to Group A or Group B using simple random sampling with a computer-generated random number table. Allocation concealment was maintained using sealed opaque envelopes to prevent selection bias. The assessor

conducting outcome measurements was blinded to group allocation to reduce measurement bias.

2.5 Interventions

Group A: MET + UST (n = 30). Muscle Energy Technique was applied to the hamstrings, piriformis, and gluteus maximus using post-isometric relaxation: isometric contraction for 5–7 seconds followed by a 20–30 second relaxation phase, 3–5 repetitions per muscle group, with repetitions and stretch intensity progressed over the 4 weeks according to tolerance. Ultrasonic Therapy was delivered at 1 MHz, continuous mode, 1.5 W/cm², for 7 minutes over the lumbar paraspinal region and sciatic notch. A phase-wise home exercise component accompanied treatment: pelvic tilting, ankle pumping, and gentle hamstring stretching in Week 1; knee-to-chest, piriformis stretching, and partial bridging in Week 2; bridging, pain-free straight leg raise exercises, and lumbar stabilization in Week 3; and advanced core strengthening, functional lumbar mobility exercises, and home exercise education in Week 4 (Table 1).

Group B: MFR + TENS (n = 30). Myofascial Release was applied over the lumbar fascia, piriformis, and hamstring muscles using sustained deep pressure and stretching for 2–3 minutes per restricted area, with duration and depth progressed over the 4 weeks according to tolerance. TENS was delivered at 80–100 Hz, 150 µs pulse width, for 15 minutes over the lumbar and gluteal region. The accompanying home exercise component progressed from pelvic tilting and gentle lumbar flexion in Week 1, through piriformis stretching and knee-to-chest exercises in Week 2, lumbar stabilization and hamstring stretching in Week 3, to core strengthening and functional movement training in Week 4 (Table 2).

Both groups received treatment three sessions per week for 4 weeks, with each session lasting approximately 20–40 minutes.

Table 1. Week-Wise Intervention Protocol – Group A (MET + UST)

Week	MET / UST parameters	Accompanying exercise
1	MET: post-isometric relaxation, hamstrings/piriformis/gluteus maximus, 5–7 s contraction + 20–30 s relaxation, 3–5 reps. UST: 1 MHz, continuous, 1.5 W/cm ² , 7 min, lumbar/sciatic notch.	Pelvic tilting, ankle pumping, gentle hamstring stretching
2	MET continued with gradual increase in stretch intensity; UST parameters maintained.	Knee-to-chest, piriformis stretching, partial bridging

Week	MET / UST parameters	Accompanying exercise
3	MET repetitions increased per tolerance; UST continued.	Bridging, pain-free SLR exercises, lumbar stabilization
4	MET focused on end-range mobility/flexibility; UST continued as required.	Advanced core strengthening, functional lumbar mobility, home exercise education

Table 2. Week-Wise Intervention Protocol – Group B (MFR + TENS)

Week	MFR / TENS parameters	Accompanying exercise
1	MFR: sustained pressure/stretch, lumbar fascia/piriformis/hamstrings, 2–3 min/area. TENS: 80–100 Hz, 150 μ s, 15 min, lumbar/gluteal region.	Pelvic tilting, gentle lumbar flexion
2	MFR duration/intensity increased per tolerance; TENS parameters unchanged.	Piriformis stretching, knee-to-chest exercises
3	Deeper MFR over restricted fascial tissue; TENS continued.	Lumbar stabilization, hamstring stretching
4	Maintenance MFR continued; TENS applied as required for pain relief.	Core strengthening, functional movement training, home exercise instruction

2.6 Outcome Measures

Pain intensity (VAS, 0–10) and functional disability (ODI, 0–100%) were assessed alongside neural mobility (Straight Leg Raise Test, degrees) and lumbar Range of Motion (ROM, measured with a universal goniometer). All outcomes were assessed at baseline and again after completion of the 4-week intervention, administered by a trained assessor blinded to group allocation.

2.7 Statistical Analysis

Data were tabulated and analysed using appropriate statistical methods. Mean and standard deviation were calculated for all outcome measures. Paired t-test was used for within-group (pre- to post-treatment) comparison, and independent-samples t-test was used for between-group comparison of post-treatment scores. The level of significance was set at $p < 0.05$.

2.8 Ethical Considerations

The study protocol, entitled “Comparative approach of muscle energy technique and ultrasonic therapy vs

myofascial release and TENS in sciatic nerve pain due to PIVD,” was reviewed and unanimously approved on both scientific and ethical grounds by the Institutional Ethics Committee of the Institute of Applied Medicines and Research (IAMR), Ghaziabad, affiliated with Atal Bihari Vajpayee Medical University (ABVMU), Lucknow, at a meeting held on 14 July 2025. Written informed consent was obtained from all participants before enrolment. Confidentiality of participant data was maintained throughout the study, and participants retained the right to withdraw at any time without consequence to their ongoing treatment.

3. RESULTS

3.1 Participant Characteristics

A total of 60 participants meeting the eligibility criteria were randomly allocated in a 1:1 ratio to Group A ($n = 30$) or Group B ($n = 30$). Both groups were comparably distributed by age (majority aged 40–50 years in both groups), by sex (15 male and 15 female in each group), and by symptom duration (majority 4–6 weeks in both groups), summarized in Table 3.

Table 3. Baseline Demographic Distribution

Characteristic	Group A (n=30)	Group B (n=30)	Total
Age 40–45 y	12	11	23
Age 46–50 y	11	12	23
Age 51–55 y	7	7	14
Male	15	15	30
Female	15	15	30
Symptoms 4–6 wk	16	16	32
Symptoms 7–8 wk	10	10	20
Symptoms 9–10 wk	4	4	8

Values are number of participants.

3.2 Within-Group Change from Baseline to Post-Treatment

Both groups improved significantly on all four outcome measures from baseline to post-treatment (all $p < 0.05$; Table 4). Group A's mean VAS fell from 7.47 ± 1.02 to 2.57 ± 0.77 , a numerically larger

reduction than Group B's (7.47 ± 1.02 to 3.37 ± 1.03). A similar pattern was observed for ODI, SLR, and ROM, with consistently larger within-group gains in Group A.

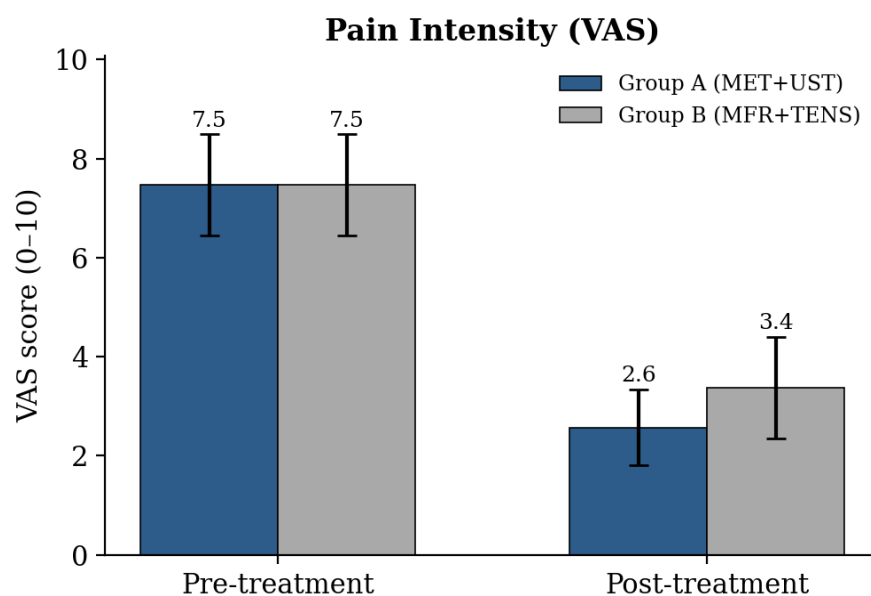


Figure 1. Pain intensity (VAS) before and after treatment (mean $\pm$ SD).

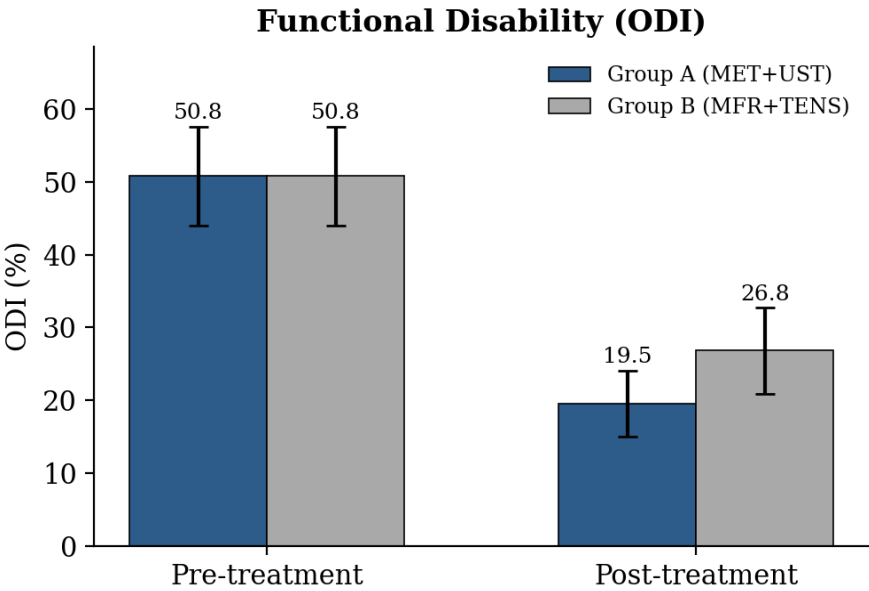


Figure 2. Functional disability (ODI) before and after treatment (mean ± SD).

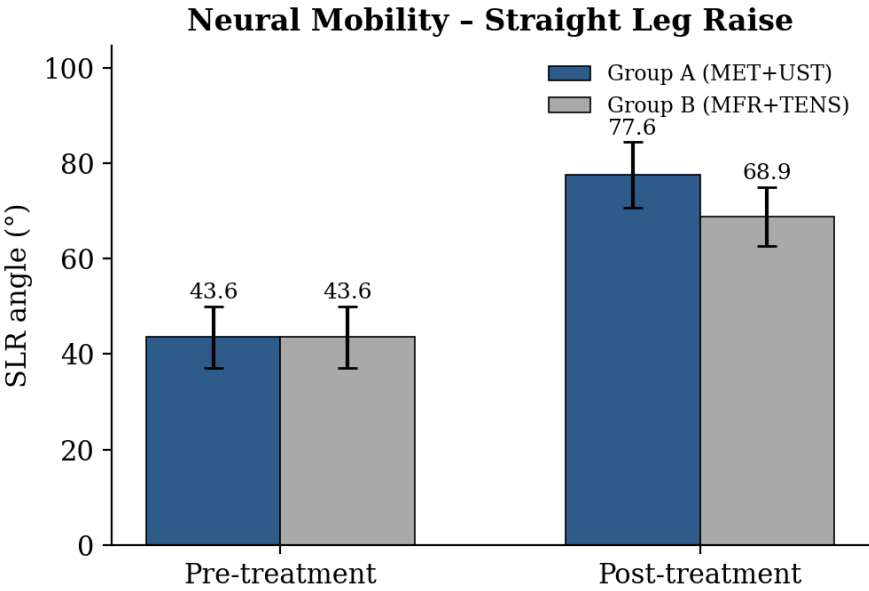


Figure 3. Straight Leg Raise angle before and after treatment (mean ± SD).

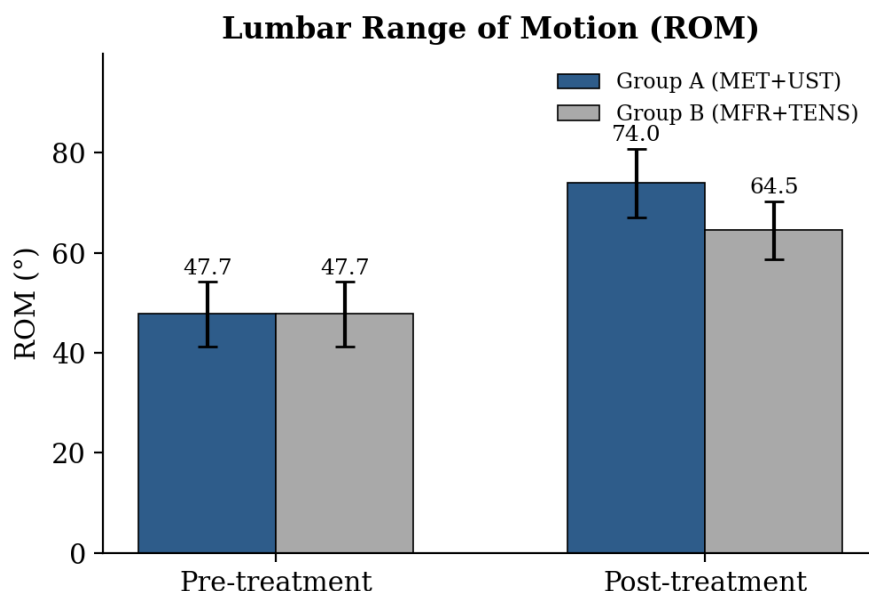


Figure 4. Lumbar range of motion before and after treatment (mean ± SD).

Table 4. Within-Group Comparison, Pre- to Post-Treatment (Paired t-test)

Outcome	Group	Pre-treatment	Post-treatment	t	p
VAS (0–10)	A (MET+UST)	7.47 ± 1.02	2.57 ± 0.77	18.24	<0.05*
	B (MFR+TENS)	7.47 ± 1.02	3.37 ± 1.03	14.16	<0.05*
ODI (%)	A (MET+UST)	50.83 ± 6.78	19.53 ± 4.56	19.42	<0.05*
	B (MFR+TENS)	50.83 ± 6.78	26.80 ± 5.94	15.86	<0.05*
SLR (°)	A (MET+UST)	43.63 ± 6.45	77.63 ± 6.88	17.82	<0.05*
	B (MFR+TENS)	43.63 ± 6.45	68.87 ± 6.21	14.94	<0.05*
ROM (°)	A (MET+UST)	47.73 ± 6.52	73.97 ± 6.84	18.67	<0.05*
	B (MFR+TENS)	47.73 ± 6.52	64.50 ± 5.82	15.21	<0.05*

Values are mean ± SD. * $p < 0.05$. Baseline VAS/ODI/SLR/ROM values were reported as common pre-treatment values across both groups in the source data.

3.3 Between-Group Comparison of Post-Treatment Outcomes

At post-treatment, Group A showed significantly better scores than Group B on all four outcome

measures (all $p < 0.05$; Table 5), with effect sizes in the medium-to-large range (Cohen's $d = 0.88$ to 1.49 ; Figure 5).

Table 5. Between-Group Comparison of Post-Treatment Scores

Outcome	Group A (n=30)	Group B (n=30)	t	p	d
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Outcome	Group A (n=30)	Group B (n=30)	t	p	d
VAS (0–10)	2.57 ± 0.77	3.37 ± 1.03	3.42	<0.05*	–0.88
ODI (%)	19.53 ± 4.56	26.80 ± 5.94	4.18	<0.05*	–1.37
SLR (°)	77.63 ± 6.88	68.87 ± 6.21	3.96	<0.05*	1.34
ROM (°)	73.97 ± 6.84	64.50 ± 5.82	4.11	<0.05*	1.49

Values are mean ± SD. * $p < 0.05$. Cohen's d computed from raw post-treatment scores with pooled SD.

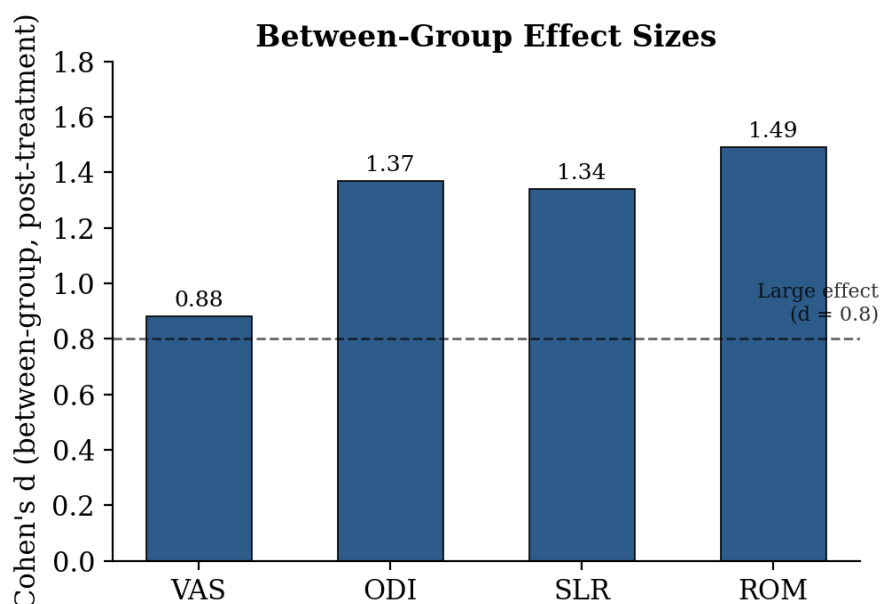


Figure 5. Between-group effect sizes (Cohen's d) on post-treatment scores.

4. DISCUSSION

This randomized controlled trial compared Muscle Energy Technique combined with Ultrasonic Therapy (Group A) against Myofascial Release combined with TENS (Group B) in patients with sciatic nerve pain due to PIVD. Both groups improved significantly on all four outcome measures from baseline to post-treatment; however, Group A improved significantly more than Group B on pain intensity (VAS), functional disability (ODI), neural mobility (SLR), and lumbar range of motion (ROM) at post-treatment (all $p < 0.05$), with medium-to-large between-group effect sizes ($d = 0.88$ to 1.49).

4.1 Pain Intensity (VAS)

Group A's mean VAS fell from 7.47 to 2.57, a larger reduction than Group B's fall from 7.47 to 3.37. This is consistent with prior reports that Muscle Energy Technique reduces pain intensity and disability in

chronic low back pain and more broadly improves musculoskeletal pain and mobility. Ultrasonic Therapy further contributes through increased local circulation and tissue healing, and the combined mechanical and thermal effects of MET and UST likely explain the greater pain reduction observed in Group A. Group B's improvement is consistent with reports that Myofascial Release reduces pain via reduced fascial tightness and that TENS provides analgesia through sensory nerve modulation; the smaller magnitude of improvement in Group B may reflect the more localized, passive nature of these modalities relative to the active, muscle-lengthening mechanism of MET combined with a deeper thermal effect from UST.

4.2 Functional Disability (ODI)

Group A's ODI improved from 50.83% to 19.53%, compared with Group B's improvement from 50.83% to 26.80%. As pain decreases and flexibility improves, patients are typically able to perform

activities such as walking, sitting, bending, and standing with less difficulty, consistent with prior findings that MET improves function, flexibility, and mobility in musculoskeletal disorders and that manual therapy combined with electrotherapy reduces disability in lumbar radiculopathy. Group B's improvement is consistent with reports that Myofascial Release improves fascial mobility and reduces tissue restriction, though the present results suggest this mechanism produced a smaller functional gain than the combined MET and UST protocol over the same 4-week period.

4.3 Neural Mobility (SLR) and Range of Motion (ROM)

SLR angle improved from 43.63° to 77.63° in Group A and to 68.87° in Group B, while ROM improved from 47.73° to 73.97° in Group A and to 64.50° in Group B. Improvement in SLR reflects reduced neural tension and improved flexibility, consistent with reports that MET improves hamstring flexibility and outperforms Myofascial Release specifically on flexibility outcomes, and more broadly improves range of motion in musculoskeletal disorders. Group B's improvement in SLR and ROM is consistent with Myofascial Release's role in releasing fascial adhesions and improving tissue extensibility; nonetheless, the larger gains in Group A across both neurodynamic and mobility measures suggest that combining an active, muscle-lengthening manual technique with a thermal modality may more effectively reduce mechanical stress on the sciatic nerve than a passive fascial technique combined with an electro-analgesic modality alone.

4.4 Interpretation and Clinical Relevance

Across all four outcome measures, Group A demonstrated consistently greater improvement than Group B, with medium-to-large effect sizes ($d = 0.88$ to 1.49). This pattern supports a plausible dual mechanism: Muscle Energy Technique addresses muscular and biomechanical contributors to sciatic nerve compression — hamstring, piriformis, and gluteal tightness — while Ultrasonic Therapy contributes thermal and circulatory effects that promote soft-tissue healing and reduce inflammation around the affected nerve root. Myofascial Release and TENS, while each independently effective, may act through comparatively more localized or passive mechanisms, which could explain the smaller, though still statistically significant, improvement observed in Group B. These findings support the role of physiotherapy, and specifically a combined active manual therapy and thermal electrotherapy approach, in the conservative management of PIVD-related sciatica, with early intervention potentially helping to reduce pain, restore mobility, and improve functional independence.

4.5 Limitations

- Baseline (pre-treatment) VAS, ODI, SLR, and ROM values were reported as common values across both groups in the source data, rather than as separately verified per-group baseline means with a formal baseline-comparability test; this limits confidence that the two groups were equivalent at study entry on these measures.
- Outcomes were assessed only at baseline and after 4 weeks, without longer-term follow-up to determine whether the between-group differences were maintained after treatment ended.
- The trial did not report a formal a priori sample-size calculation with target effect size, power, and alpha; the sample of 60 was based on prior literature and feasibility rather than a pre-specified power calculation.
- Home exercise components accompanied both protocols but adherence to these exercises was not formally tracked or reported.
- Participants were recruited from two centres by non-probability sampling, which may limit generalizability to other populations and settings.

5. CONCLUSION

Within the limits of this 4-week randomized controlled trial, both Muscle Energy Technique combined with Ultrasonic Therapy and Myofascial Release combined with TENS produced statistically significant improvement in pain intensity, functional disability, neural mobility, and lumbar range of motion in patients with sciatic nerve pain due to PIVD (all $p < 0.05$ within-group). However, Muscle Energy Technique combined with Ultrasonic Therapy produced significantly greater improvement than Myofascial Release combined with TENS on every outcome measure at post-treatment (all $p < 0.05$), with medium-to-large between-group effect sizes ($d = 0.88$ to 1.49). These results support Muscle Energy Technique combined with Ultrasonic Therapy as a more effective conservative physiotherapy combination for PIVD-related sciatica in this population, and, given the modest sample size, single comparative time point, and reporting limitations noted above, warrant confirmation in a larger, multi-centre trial with longer follow-up before broader clinical adoption as a preferred first-line protocol.

6. DECLARATIONS

Ethics Approval and Consent to Participate

The study protocol was reviewed and unanimously approved, on both scientific and ethical grounds, by the Institutional Ethics Committee of the Institute of Applied Medicines and Research (IAMR), Ghaziabad, affiliated with Atal Bihari Vajpayee Medical University (ABVMU), Lucknow, at a meeting held on 14 July 2025. Written informed consent was obtained from all participants prior to enrolment.

Consent for Publication

Not applicable (no individual participant data or identifying images are included).

Availability of Data and Materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

PC: conceptualization, data collection, intervention delivery, formal analysis, writing – original draft. MS: supervision, methodology, review and editing. LY: co-supervision, methodology review, review and editing. All authors read and approved the final manuscript.

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