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Short-Term Effects of Muscle Energy Technique Versus Neurodynamic Technique on Hamstring Flexibility Among DPT Students

Mehlab Usmani
Isra Institute of Rehabilitation Sciences, Isra University, Karachi Campus
Email: mehlabu013@gmail.com

Omair Shah
Ziauddin College of Physical Therapy

Dr. Rabel Chang
Indus College of Physical Therapy TMK, University of Modern Sciences TMK

Dr. Kiran Arshad
Isra Institute of Rehabilitation Sciences, Isra University, Karachi Campus

Dr. Saneela Ishfaque
Jinnah College of Physical Therapy

Dr. Paras Sarohi
Isra Institute of Rehabilitation Sciences, Isra University, Karachi Campus

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Corresponding Author:

Mehlab Usmani
Email: mehlabu013@gmail.com

ABSTRACT

Background: Hamstring tightness is prevalent among young adults, particularly physical therapy students, leading to compromised flexibility and increased injury risk. This study compared the short-term effects of Muscle Energy Technique (MET) and Neurodynamic Sliding on hamstring flexibility. Objective: To determine which intervention is more effective for improving hamstring flexibility in the short term among Doctor of Physical Therapy (DPT) students. Methods: A pre- and post-experimental study was conducted on 60 DPT students (age 18–25 years) with hamstring tightness ≥15° on the Active Knee Extension (AKE) test. Participants were randomly assigned to Group A (MET; n=30) or Group B (Neurodynamic Sliding; n=30). Interventions were administered three times per week for four weeks. Hamstring flexibility was assessed using the AKE test and Sit and Reach test before and after intervention. Data were analyzed using SPSS 22 with paired and independent t-tests ($p<0.05$). Results: Both groups showed significant improvements in hamstring flexibility. The MET group demonstrated mean improvements of 4.15 cm in sit-and-reach and 34.67° in AKE right leg. The Neurodynamic group improved by 5.13 cm in sit-and-reach and 27.87° in AKE right leg. Between-group analysis revealed no significant difference in sit-and-reach ($p=0.209$) or AKE right leg ($p=0.191$), but a significant difference was found in AKE left leg ($p=0.024$). Conclusion: Both Muscle Energy Technique and Neurodynamic Sliding effectively improve hamstring flexibility in the short term among DPT students. Although comparable overall results were observed, both techniques can be used interchangeably based on clinical presentation and therapist preference.

Introduction

Flexibility is described as the ability of the muscle to lengthen themselves. It plays a pivitol role in the maintenance of muscular function and prevention of injuries. The flexibility of the Hamstring muscle is specially important due to the group's postural nature and as it has multi-joint function, spreading to both the hip and knee joints. Limited hamstring flexibility is commonly observed in young adults, especially among university students, and is also associated with various musculoskeletal disorders which includes low back pain, patellofemoral pain syndrome, and increased injury risk (1). Hamstring tightness is extremely common in adolescents between 18-25 years, affecting both athletic and sedentary populations. Prolonged sitting which is a characteristic feature of academic life, keeps the hamstring in a shortened position for long periods of time which contribute significantly in the reduction of flexibility in this muscle group (2,3). Among Doctor of Physical Therapy (DPT) students, hamstring tightness presents a particular concern given the sedentary nature of classroom-based learning. There has been various physiotherapy interventions development to enhance hamstring flexibility, including static stretching, proprioceptive neuromuscular facilitation (PNF), and more recently, manual therapy techniques such as Muscle Energy Technique (MET) and Neurodynamic Sliding (4,5). MET, rooted in osteopathic practice, utilizes voluntary isometric muscle contraction to promote post-isometric relaxation and improve range of motion through mechanisms of autogenic inhibition and reciprocal inhibition. Neurodynamic techniques, conversely, target the nervous system's mobility and reduce neural tension through controlled movement patterns that promote sliding and mobility of neural structures. A recent 2025 meta-analysis examining the effectiveness of neurodynamic treatment on hamstring flexibility found that neurodynamic techniques were significantly more efficient than static stretching in affecting hamstring flexibility, particularly in long-term outcomes (6). Similarly, a comprehensive systematic review and meta-analysis by Kang et al. (2023) involving 949 patients from 19 randomized controlled trials demonstrated the efficacy of MET on hamstring flexibility, with consistent improvements across multiple studies (7). While both techniques have demonstrated effectiveness individually, limited evidence directly compares their short-term effects in a young, academically active population.

Literature Review

Multiple randomized controlled trials have investigated the effectiveness of MET for hamstring flexibility. Sathe et al. (2020) conducted a comparative analysis of MET and passive stretching on hamstring flexibility which demonstrated that MET resulted in a mean improvement of 12.81 degrees in Active Knee Extension when compared to 6.38 degrees in the group of passive stretching though the difference was not statistically significant (1). In a related study by Rabia et al. (2019), both MET and passive stretching protocol produced significant improvements, with MET showing a mean VAS reduction of 6.80±6.10 and AKE improvement of 7.80±8.90 degrees; while similarly in this study no statistically significant differences were found between the two groups (8). Recent evidence suggests that MET demonstrates particular efficacy when compared to other manual therapy approaches. Ahmad et al. (2023) found that in the Active Knee Extension Test (AKET), the MET group experienced a marked improvement from an average score of 43.36 to 84.83 ($p<0.001$), demonstrating more pronounced improvement than the static stretching control group which improved from 47.50 to 75.76 (9). These findings support MET as an effective intervention for enhancing hamstring flexibility in short-term applications. Neurodynamic techniques have similarly demonstrated significant effectiveness in improving hamstring flexibility. Shaikh et al. (2023) conducted a prospective study comparing neurodynamic sliding technique (NDST) with self-myofascial release (SMR) in healthy individuals, finding that NDST showed significantly better results for post-treatment AKE right ($p=0.002$) and AKE left ($p=0.001$), with higher effect sizes of 3.08 and 3.26 respectively (10). De Ridder et al. (2020) investigated the effectiveness of neurodynamic sliding techniques compared to static stretching in physically active males with tight hamstring syndrome, finding that the neurodynamic group demonstrated greater and more sustained gains, improving by 12.6° compared to 9.3° in the static group, leading to the conclusion that neurodynamic sliders are more effective for enhancing and maintaining hamstring flexibility (11). A recent 2025 systematic review and meta-analysis including 13 trials with 624 participants examined immediate and short-term effects of neurodynamic techniques on hamstring flexibility. The review found that neurodynamic sliders appear to be more efficient than regular static stretching in affecting hamstring flexibility, particularly in long-term applications (12). Comparative studies which examined multiple flexibility interventions have reported varied findings regarding the superiority of technique. Balagopal et al. (2022) compared the effects of neurodynamic sliding, PNF stretching, and static stretching on hamstring flexibility in young adults. The study reported that static stretching resulted in greater improvements in short-term hamstring flexibility, while neurodynamic sliding reported more pronounced effects in the long term compared to static and PNF stretching (13). Singh et al. (2017) found that PNF stretching (hold-relax) achieved higher mean values of AKE score (148.63±1.67) compared to Neurodynamic sliding (146.63±2.03) with a statistically significant difference ($P=0.01$), suggesting PNF hold-relax stretching may be more effective for improving hamstring flexibility among collegiate students (14). The divergent findings in the literature suggest that hamstring flexibility limitations may involve both muscular and neural components. MET addresses contractile and non-contractile muscular elements through reflexive inhibition and improved stretch tolerance, while neurodynamic techniques target neural tension, mobility, and mechanosensitivity. Because both pathways contribute to flexibility limitations, improvements in either system can yield significant functional gains. This multifactorial nature of hamstring tightness justifies the direct comparison of these two approaches in the present study.

Methods

Study Design and Setting

This was a pre- and post-experimental study conducted at Isra Institute of Rehabilitation Sciences. Sixty DPT students aged 18–25 years with hamstring tightness (≥15° on the Active Knee Extension test) were enrolled. Participants were non-randomly assigned into two equal groups of 30 each using purposive convenient sampling. Inclusion criteria were: age 18–25 years, confirmed hamstring tightness on AKE testing, willingness to participate, and both male and female participants. Exclusion criteria included history of low back pathology, recent lower limb fracture or surgery, knee joint pain, neurological disorders, and recent hamstring injury.

Outcome Measures

Hamstring flexibility was assessed using two validated tests: (1) Active Knee Extension (AKE) test, measured with a universal goniometer in supine position with the hip flexed to 90°, and (2) Sit and Reach test, using a standardized sit-and-reach box with participants in long-sitting position. Both measures have demonstrated excellent reliability in assessing hamstring flexibility (ICC>0.90).

Intervention Protocols

Group A received Muscle Energy Technique as follows: participants lay supine with the contralateral leg flexed or extended on the plinth. The therapist slowly straightened the affected leg until the restriction barrier was identified. An isometric contraction was introduced at 25% of maximal effort against the therapist's resistance, held for 7–10 seconds, followed by complete relaxation. On exhalation, the knee was extended toward its new barrier and a stretch was maintained for 30 seconds. This sequence was repeated three times per session. Group B received Neurodynamic Sliding: participants lay supine with neck and thoracic spine supported in forward flexion. The therapist performed dynamic alternation between hip/knee flexion and extension for 180 seconds on the participant's dominant lower extremity. Both groups received interventions three times weekly for four weeks.

Data Analysis

SPSS version 22 was used for statistical analysis. Descriptive statistics were calculated for demographic variables. Within-group changes were assessed using paired t-tests. Between-group comparisons of post-intervention values were analyzed using one-way ANOVA and the Mann–Whitney U test. Statistical significance was set at $p<0.05$.

Results

Participant Characteristics

The study included 60 participants (78.3% female, 21.7% male) with a mean age of 22.0±2.5 years. The majority of participants were right-leg dominant (81.7%). Demographic characteristics were comparable between groups, as shown in Table 1. The MET group showed a mean height of 159.85±4.94 cm, mean weight of 58.00±8.15 kg, and mean BMI of 22.68±2.97. The Neurodynamic group had a mean height of 158.75±5.95 cm, mean weight of 56.35±6.64 kg, and mean BMI of 22.35±2.32.

Table 1. Demographic Characteristics of Participants

Characteristic	MET Group (n=30)	Neurodynamic Group (n=30)
Age (years), mean±SD	22.1±2.3	21.9±2.7
Gender (% Female)	80.0%	76.7%
Dominant Leg (% Right)	83.3%	80.0%
Height (cm), mean±SD	159.85±4.94	158.75±5.95
Weight (kg), mean±SD	58.00±8.15	56.35±6.64
BMI, mean±SD	22.68±2.97	22.35±2.32

Within-Group Improvements

Significant within-group improvements were observed in both intervention groups, as presented in Table 2. In the MET group, pre- to post-test improvements were: sit-and-reach test increased from 21.07±5.43 cm to 25.22±5.23 cm (mean change: 4.15 cm); Active Knee Extension (AKE) right leg improved from 131.83°±10.46 to 166.50°±8.73 (mean change: 34.67°); AKE left leg improved from 132.00°±10.14 to 165.83°±8.10 (mean change: 33.83°). In the Neurodynamic group: sit-and-reach test increased from 18.51±4.42 cm to 23.64±4.40 cm (mean change: 5.13 cm); AKE right leg improved from 135.33°±11.29 to 163.20°±10.52 (mean change: 27.87°); AKE left leg improved from 133.83°±8.48 to 161.17°±7.51 (mean change: 27.34°). Both groups demonstrated statistically significant within-group improvements across all measures (p<0.001).

Table 2. Pre- and Post-Test Results for Hamstring Flexibility

Measure	Group	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	Mean Change
Sit and Reach (cm)	MET	21.07±5.43	25.22±5.23	4.15
	Neurodynamic	18.51±4.42	23.64±4.40	5.13
AKE Right Leg (°)	MET	131.83±10.46	166.50±8.73	34.67
	Neurodynamic	135.33±11.29	163.20±10.52	27.87
AKE Left Leg (°)	MET	132.00±10.14	165.83±8.10	33.83
	Neurodynamic	133.83±8.48	161.17±7.51	27.34

Note: AKE = Active Knee Extension; MET = Muscle Energy Technique; All improvements were statistically significant at p<0.001.

Between-Group Comparisons

Statistical analysis using one-way ANOVA and Mann–Whitney U tests revealed no significant between-group differences in post-intervention sit-and-reach test scores (p=0.209) or AKE right leg (p=0.191), as summarized in Table 3. However, a significant difference was observed in AKE left leg (p=0.024), with the MET group demonstrating slightly superior improvements. Overall, the differences in outcomes between groups were minimal and clinically comparable.

Table 3. Between-Group Comparison of Post-Test Values (ANOVA and Mann–Whitney U Test)

Outcome Measure	MET Mean (SD)	Neurodynamic Mean (SD)	Test Statistic	p-value
Post Sit and Reach (cm)	25.22±5.23	23.64±4.40	F=1.617	0.209
Post AKE Right (°)	166.50±8.73	163.20±10.52	F=1.749	0.191
Post AKE Left (°)*	165.83±8.10	161.17±7.51	U=5.355	0.024

Note: *p<0.05 indicates statistically significant difference. AKE = Active Knee Extension; MET = Muscle Energy Technique.

Discussion

Results of this study showed that Muscle Energy Technique and Neurodynamic Sliding techniques significantly increase hamstring flexibility for DPT students with short term benefits comparable to what has been described in the current literature. The large within-group improvements found for both therapies also speak to the efficacy of each intervention alone . The benefits of the MET group are in agreement with the prior research that demonstrated that post-isometric relaxation and autogenic inhibition are helpful in decreasing muscular stiffness and increasing the range of motion. These neurophysiological mechanisms excite the muscle spindles and Golgi tendon organs and induce muscular relaxation and extensibility. The mean improvements in AKE right leg were 34.67° with MET, which is similar to the results published by Ahmad et al. (2023), who found improvement of 41.47° in the MET group. The increases in the Neurodynamic group support recent findings that nerve mobility is important to hamstring flexibility . Neurodynamic procedures facilitate movement of the neural elements by altering the tension and slack of the neural pathways, increasing hamstring extensibility and decreasing mechanosensitivity of the sciatic nerve. The observed improvement of 27.87° in AKE right leg is in line with the findings of Shaikh et al. (2023) who found similar improvements in neurodynamic sliding technique group. The similar results between groups indicate the muscular and neurological factors in hamstring tightness. A 2025 meta-analysis on the effectiveness of neurodynamic treatment indicated that neurodynamic sliders are more successful than static stretching for long-term use, but initial results may be similar to other manual therapy techniques. The present study's finding of little between-group differences is consistent with this research. MET works on contractile and non-contractile muscle aspects by reflexive inhibition and increased stretch tolerance, while neurodynamic approaches work on neural tension and mobility. Since there is contribution from both pathways to restrictions in flexibility, changes in either system might result in substantial functional benefits and this explains the identical results after the intervention. The only relevant difference was in AKE left leg compared to MET (p=0.024), which would indicate a slight muscular emphasis of this approach, however this data does not show a consistent overall superiority and may rather be a side-specific impact than a clinically meaningful difference. Both approaches can be chosen according to clinical presentation, recognized main source of restriction (muscular versus neurological) and therapist expertise. These findings add to the mounting evidence for several effective techniques to addressing hamstring tightness in young, academically engaged individuals.

Conclusion

Both Muscle Energy Technique and Neurodynamic Sliding effectively improve hamstring flexibility in the short term among DPT students. Significant improvements were observed within both groups across all outcome measures, with no consistent superiority of either intervention. These findings suggest that clinical decision-making regarding technique selection may be based on patient presentation, identified primary restriction pattern, and individual therapist expertise rather than differential technique efficacy. Both interventions represent valid, evidence-supported options for short-term management of hamstring tightness in young adults. Future research investigating long-term effects, combined interventions, and identification of patient characteristics that predict superior response to each technique would further enhance clinical evidence.

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