Section: Miscellaneous

Original Research Article

EFFECTS OF MUSCLE ENERGY TECHNIQUE ON LENGTH OF HAMSTRING MUSCLE AND KNEE ROM OF FEMALES AGEING 25 -50 YEARS – AN EXPERIMENTAL STUDY

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ABSTRACT

Background: Hamstring tightness is a common musculoskeletal issue that can reduce flexibility, limit knee range of motion (ROM), and predispose individuals to injury. Muscle Energy Technique (MET) is a manual therapy intervention aimed at improving muscle length and flexibility. **Aim:** To evaluate the effectiveness of Muscle Energy Technique (MET) on hamstring muscle length and knee ROM in females aged 25 to 50 years.

Materials and Methods: An experimental, interventional, comparative study with a pre-test and post-test design was conducted on 90 female participants with clinically diagnosed hamstring tightness. Participants were randomly allocated into two groups: Group A received MET, while Group B underwent conventional treatment comprising moist heat application and static stretching. Hamstring flexibility was assessed using the Active Knee Extension (AKE) Test, and data were analyzed using paired and unpaired t-tests with significance set at $p < 0.05$.

Results: Both groups showed significant within-group improvements in hamstring flexibility and knee ROM ($p < 0.001$). Group A's mean muscle length reduced from 27.40 ± 3.27 to 26.26 ± 2.93 units, and Group B from 28.11 ± 2.98 to 25.68 ± 2.96 units. AKE test scores improved significantly in both groups, with Group A increasing from 47.33 ± 6.80 to 54.56 ± 7.42 units and Group B from 48.47 ± 10.42 to 66.04 ± 10.15 units. Intergroup comparison revealed a statistically significant difference in AKE Test scores favoring Group B ($p < 0.001$).

Conclusion: Both MET and conventional interventions effectively improved hamstring flexibility and knee ROM. However, MET demonstrated superior functional outcomes, highlighting its potential as a preferred intervention for managing hamstring tightness in females aged 25 to 50 years.

Keywords: Muscle Energy Technique, Hamstring Tightness, Knee ROM, Flexibility, Active Knee Extension Test.

INTRODUCTION

Flexibility is an imperative component of physical fitness and conditioning programs. It allows tissues, including muscles, tendons, and ligaments, to adapt efficiently to mechanical stress, to dissipate shock impacts, and to enhance the overall effectiveness of bodily movements, thereby minimizing or preventing injury[1]. Flexibility ensures that the musculoskeletal system can function optimally during both routine and complex movements, contributing significantly to athletic performance and daily living tasks[1]. An optimal level of flexibility reduces the strain on muscles and joints, promoting efficiency, stability, and coordination in movement patterns,[1]

In recent years, various therapeutic and preventive strategies have been implemented to improve flexibility, mobility, and muscular health. Among these, commonly used techniques include the spray and stretch method, soft tissue mobilization, static stretching, ballistic stretching, proprioceptive neuromuscular facilitation (PNF), and muscle energy techniques (MET).[2-4] Each of these methods has shown efficacy in promoting muscle extensibility, improving joint range of motion (ROM), and preventing musculoskeletal injuries. The correct application of these techniques can be beneficial in rehabilitation programs, sports performance enhancement, and injury prevention protocols.[2-4]

The hamstring muscles, consisting of the biceps femoris, semitendinosus, and semimembranosus, play a vital role in lower limb mechanics, particularly during gait, running, and dynamic movements. Hamstring flexibility is critical for maintaining efficient biomechanical function of the pelvis, hip, and knee joints. Reduced hamstring flexibility has been associated with an increased risk of lower extremity injuries, including muscle strains, ligament sprains, and overuse injuries. Research has demonstrated that targeted hamstring stretching exercises can significantly improve muscle extensibility, decrease injury risk, and enhance lower limb function, as observed in studies involving military trainees where structured stretching programs yielded notable improvements in flexibility compared to control groups.[5]

Muscle flexibility exercises are essential components of rehabilitation programs and sports training routines, designed to minimize injury risks, alleviate muscle discomfort, and enhance muscular performance. Adequate flexibility allows for a more balanced distribution of muscular forces during movement, reducing the risk of muscle imbalances, postural abnormalities, and compensatory movement patterns. These exercises play a preventive and corrective role, addressing tightness, stiffness, and restrictions that can limit mobility and functional capacity.[6]

Muscle flexibility is defined as the ability of a muscle to lengthen, enabling one joint or a sequence of joints to move freely through their intended range of motion[7]. This characteristic is essential for both static postures and dynamic movements, facilitating smooth, efficient motion without undue resistance. A lack of muscle flexibility not only impairs movement efficiency but also places excessive strain on other structures, leading to musculoskeletal dysfunction and increased injury susceptibility.[7]

In particular, the degree of flexibility within the hamstring and quadriceps muscle groups has a direct impact on knee joint mechanics and lower limb function.[8] The coordinated function of these muscle groups ensures a smooth, controlled, and efficient ambulatory pattern, essential for both everyday activities and athletic performance[8]. When hamstring flexibility is compromised, it can lead to altered gait patterns, restricted knee extension, compensatory movements at the pelvis or lumbar spine, and overall limitations in functional mobility.[8]

Inadequate flexibility of the hamstring muscles predisposes individuals to a range of musculoskeletal disorders, including lower back pain, postural deviations, and increased susceptibility to acute or chronic injuries[9]. Reduced hamstring extensibility has been linked to decreased stride length, impaired postural control, and inefficient movement patterns, which collectively can significantly impair an individual's functional capacity and quality of life.[9]

Women aged 25 to 50 years represent a demographic commonly affected by reduced flexibility and muscle tightness, often influenced by factors such as sedentary lifestyles, occupational demands, hormonal changes, and the natural aging process. Within this population, restricted hamstring flexibility can contribute to limitations in physical function, reduced athletic performance, and a higher risk of musculoskeletal injuries. Maintaining optimal hamstring flexibility and knee ROM is therefore essential to preserve mobility, prevent injuries, and enhance overall musculoskeletal health in this group,[9]

The muscle energy technique (MET) is a widely recognized therapeutic intervention employed to improve muscle length, flexibility, and joint ROM. MET involves the use of voluntary muscle contractions performed by the patient against a controlled resistance provided by the therapist, followed by a period of relaxation and passive stretching. This technique is based on physiological principles such as post-isometric relaxation and reciprocal inhibition, facilitating muscle elongation and neuromuscular re-education.[9] MET is considered safe, non-invasive, and effective for addressing muscle tightness, reducing spasm, and enhancing flexibility, making it particularly suitable for individuals within the 25 to 50-year age group experiencing musculoskeletal limitations.

Despite the recognized benefits of MET, there remains a need for further empirical investigation into its specific effects on hamstring muscle length and knee ROM among females within this age range. Understanding the efficacy of MET in improving flexibility and joint mobility in this population is essential for developing targeted interventions that promote musculoskeletal health, enhance functional performance, and prevent injury.[9]

This experimental study aims to explore the effects of muscle energy technique on the length of the hamstring muscle and knee ROM in females aged 25 to 50 years, contributing to the existing body of knowledge on flexibility enhancement and injury prevention strategies in this population.

MATERIALS AND METHODS

The present research was conducted as an experimental interventional comparative study using a pre-test and post-test design, to investigate the effectiveness of Muscle Energy Technique (MET) in improving hamstring muscle length and knee range of motion (ROM) among females aged 25 to 50 years. The study received ethical approval from the Research Committee of Singhania University, ensuring adherence to institutional and ethical standards.

Participants

Young female participants with clinically diagnosed hamstring tightness, defined as an extension deficit of 20 degrees or more in the popliteal angle, confirmed through the Active Knee Extension (AKE) Test, were recruited for the study. A total of 116 participants were enrolled, and they were randomly allocated into two groups, namely the Experimental group and the Control group, with 58 subjects in each group, using a random sampling method to avoid selection bias. Prior to participation, all subjects were provided with detailed information regarding the study objectives, procedures, and potential risks, after which written informed consent was obtained from each participant. The age range of the participants was between 25 to 50 years, and all subjects were female college students.

Inclusion and Exclusion Criteria

Participants who met the inclusion criteria were selected for the study. The inclusion criteria required participants to have clinically diagnosed hamstring tightness, defined as knee extension of less than 160 degrees with the hip positioned at 90 degrees of flexion. Additionally, participants were required to exhibit a reduced range of motion at the knee joint, decreased performance in the Straight Leg Raise (SLR) test, and complaints of pain in the posterior compartment of the thigh. Only females aged between 25 and 50 years were considered eligible for participation in the study.

Participants were excluded from the study if they had a history of acute or chronic hamstring injury, the presence of neurological disorders, or if they were currently using muscle relaxant medications. Those undergoing physiotherapy for any musculoskeletal conditions, as well as individuals with a history of hip or knee joint pathology, lower limb fractures, dislocations, or subluxations, were also excluded. Furthermore, participants showing any signs of swelling or inflammation in the hamstring region were not considered for inclusion in the study.

Procedures

A total of 90 female participants meeting the inclusion criteria were selected and randomly divided into two groups:

- **Group A (Experimental Group, n = 45):** Received Muscle Energy Technique (MET).
- **Group B (Control Group, n = 45):** Received conventional intervention.

Hamstring muscle tightness was assessed using the Active Knee Extension (AKE) Test, which measures the popliteal angle. Baseline assessments were conducted for all participants prior to intervention, with follow-up assessments conducted after four weeks.

Intervention Details

Muscle Energy Technique (Experimental Group)

Participants allocated to the Experimental Group received treatment through the Post-Isometric Relaxation (PIR) Method, a specific form of Muscle Energy Technique (MET) as described by Lewit. To perform the intervention, each participant was positioned in a supine position on the plinth, with the hips flexed to 90 degrees to isolate the hamstring muscles. The therapist then passively extended the participant’s knee until the initial point of tissue restriction was encountered, indicating the muscle’s resistance barrier. At this point, the participant was instructed to perform an isometric contraction of the hamstring muscles by attempting to flex the knee joint. This contraction was executed at approximately 75% of the participant's maximum voluntary contraction capacity and maintained for a duration of 7 to 10 seconds while the therapist provided counter-resistance. Following the isometric contraction phase, the participant relaxed, and the therapist passively extended the knee further to increase the muscle's length, holding this newly achieved range of motion for 10 seconds. This sequence of contraction and stretch was repeated as per the intervention protocol throughout the treatment period to effectively enhance hamstring flexibility.

Conventional Intervention (Control Group)

Participants assigned to the Control Group underwent a conventional treatment protocol that combined moist heat application and static hamstring stretching exercises. Initially, moist heat was applied to the posterior aspect of the thigh, targeting the hamstring muscle region to facilitate muscle relaxation and prepare the tissues for stretching. Following the heat application, participants performed static hamstring stretching exercises, which involved passively elongating the hamstring muscles and holding each stretch for 30 seconds. This routine was repeated for three repetitions during each session. The stretching protocol was consistently performed over a period of four weeks, with the duration and frequency based on time frames established in previous scientific research to ensure the effectiveness and standardization of the intervention.

Outcome Measures

The primary outcome measure used in this study to evaluate the effectiveness of both intervention protocols was the Popliteal Angle, assessed using the Active Knee Extension (AKE) Test. This test is a widely accepted and reliable clinical method for quantifying hamstring muscle length and flexibility. During the assessment, the participant lay supine with the hip flexed to 90 degrees, and the knee was actively extended as far as possible. The angle formed at the knee joint was measured to determine hamstring flexibility. Baseline measurements were recorded for all participants before the interventions commenced, and follow-up assessments were conducted at the end of the four-week intervention period. The pre- and post-intervention data were compared to assess improvements in hamstring muscle length and knee joint range of motion, thereby determining the effectiveness of the applied techniques.

Statistical Analysis: The data collected in this study were analyzed using IBM SPSS version 23.0, applying both descriptive and inferential statistical methods to evaluate the outcomes within and between the groups. Descriptive statistics were used to summarize the data, where categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean values with standard deviations to represent variability. Inferential statistics included the use of the Chi-Square test to assess associations between categorical variables, while the unpaired t-test compared the means of independent groups to detect significant differences. Additionally, the paired t-test was applied to evaluate pre- and post-intervention changes within the same group. For more complex analyses, Multivariate Analysis of Variance (MANOVA) was performed to analyze multiple dependent variables simultaneously, and a Multivariate Regression Model was used to explore the relationship between several independent predictors and dependent variables collectively. A p-value of less than 0.05 was considered statistically significant for all tests.

RESULTS

The table 1 presents a descriptive summary of the age distribution among the two study groups, Group A (Experimental Group) and Group B (Control Group). The mean age of participants in Group A was 38.00 years, with a standard deviation (SD) of 4.63, indicating moderate variability in age within the group. In comparison, Group B reported a slightly lower mean age of 36.89 years, accompanied by a higher standard deviation of 6.05, reflecting greater age variability among participants in this group. An unpaired t-test was conducted to compare the mean ages between the two groups. The calculated t-value was 0.97, which suggests only a small difference between the groups in terms of age. The corresponding p-value was 0.336, which is greater than the conventional significance threshold of 0.05. Therefore, this result indicates that there is no statistically significant difference in the mean ages between Group A and Group B.

Table 2 presents the comparison of muscle length between Group A and Group B, both before and after the intervention, as well as within-group changes over time. The pre-test results showed that Group A had a mean muscle length of 27.40 units with a standard deviation (SD) of 3.27, while Group B had a slightly higher mean of 28.11 units and an SD of 2.98. The unpaired t-test revealed a t-value of -1.08 and a p-value of 0.283, indicating that the difference between groups at baseline was not statistically significant.

Following the intervention, the post-test results showed a mean muscle length of 26.26 units for Group A (SD = 2.93) and 25.68 units for Group B (SD = 2.96). The t-test comparing these groups yielded a t-value of 0.93 and a p-value of 0.357, again indicating no significant difference between the groups after the intervention period.

However, within-group comparisons from pre-test to post-test revealed statistically significant changes in both groups. In Group A, the change in muscle length was significant, with a t-value of 7.21 and $p < 0.001$, while Group B also demonstrated a significant change with a t-value of 14.62 and $p < 0.001$. These results suggest that both interventions effectively reduced muscle length over time, even though there were no significant differences between the groups when compared directly.

Table 3 illustrates the comparison of Active Knee Extension Test scores between Group A and Group B, as well as within-group changes before and after the intervention. At the pre-test stage, Group A recorded a mean AKE test score of 47.33 units with an SD of 6.80, while Group B had a mean score of 48.47 units with a higher SD of 10.42. The calculated t-value of -0.61 and p-value of 0.544 indicate no significant difference in AKE test scores between the two groups at baseline.

Post-test results revealed marked improvements in both groups, with Group A showing a mean AKE test score of 54.56 units (SD = 7.42) and Group B displaying a substantially higher mean score of 66.04 units (SD = 10.15). The intergroup comparison yielded a t-value of -6.08 and a p-value of < 0.001, demonstrating a highly statistically significant difference between the two groups, favoring Group B.

Within-group analysis also showed significant improvements from pre-test to post-test. In Group A, the increase in AKE test scores was statistically significant, with a t-value of 8.72 and $p < 0.001$. Similarly, Group B exhibited a significant enhancement with a t-value of 24.06 and $p < 0.001$. These findings suggest that although both groups experienced significant improvements in AKE test scores over time, the intervention applied in Group B was more effective in enhancing knee extension performance.

Table 1: Age According to Groups

Group	Mean Age (years)	Standard Deviation (SD)	t-value	p-value
Group A	38.00	4.63	0.97	0.336
Group B	36.89	6.05		

Table 2: Intergroup and Intragroup Comparison of Length of Muscle Parameter

Length of Muscle	Group A	Group B	Unpaired t-test
	Mean	SD	Mean
Pre-test	27.40	3.27	28.11
Post-test	26.26	2.93	25.68
Pre to Post (within-group)	t = 7.21, p < 0.001	t = 14.62, p < 0.001	

Table 3: Intergroup and Intragroup Comparison of Active Knee Extension Test Parameter

AKE Test (Units)	Group A	Group B	Unpaired t-test
	Mean	SD	Mean
Pre-test	47.33	6.80	48.47
Post-test	54.56	7.42	66.04
Pre to Post (within-group)	t = 8.72, p < 0.001	t = 24.06, p < 0.001	

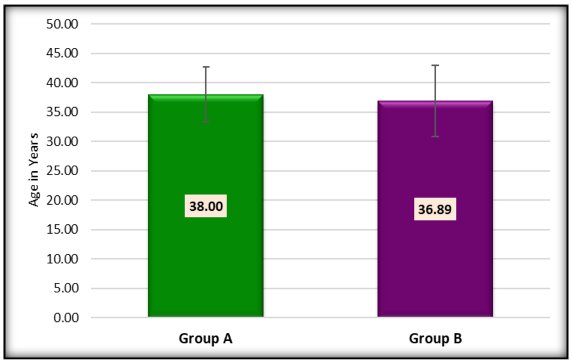

Figure 1: Age According to Groups

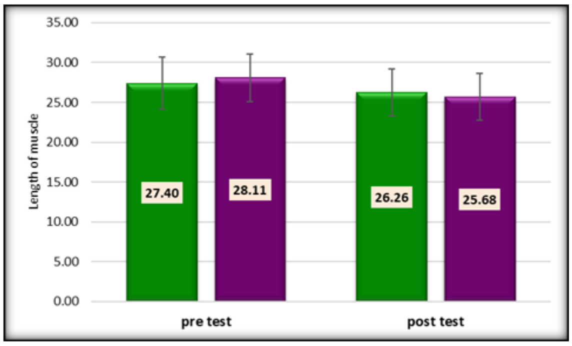

Figure 2: Intergroup and Intragroup Comparison of Length of Muscle Parameter

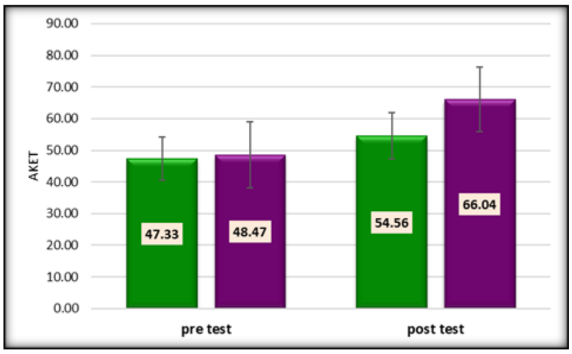

Figure 3: Intergroup and Intragroup Comparison of Active Knee Extension Test Parameter

DISCUSSION

The present study aimed to investigate the effectiveness of Muscle Energy Technique (MET) on hamstring flexibility and knee range of motion (ROM) among females aged 25 to 50 years. In this study, both groups were demographically comparable at baseline, ensuring that the observed changes in outcomes could be attributed primarily to the interventions applied rather than participant characteristics such as age.

In terms of muscle length, the pre-test mean for Group A (MET group) was 27.40 ± 3.27 units, and for Group B (conventional group) was 28.11 ± 2.98 units, with no statistically significant difference between groups. Post-intervention, Group A showed a reduction in muscle length to 26.26 ± 2.93 units, while Group B demonstrated a reduction to 25.68 ± 2.96 units. Although both groups showed improvements, the intergroup difference remained statistically insignificant ($p > 0.05$). However, within-group comparisons revealed significant improvements in both groups, with Group A showing a t-value of 7.21 ($p < 0.001$) and Group B showing a t-value of 14.62 ($p < 0.001$).

These results align with the findings of Azizi et al. (2018),[9] who reported immediate and significant improvements in hamstring flexibility and stiffness reduction after MET application in healthy young females. Similarly, Pathan and Doijad (2020),[10] demonstrated that MET significantly reduces hamstring tightness, particularly in females, supporting the within-group improvements observed in the present study. Furthermore, Ballantyne et al. (2003),[11] explained that MET improves flexibility by enhancing neuromuscular control and altering muscle viscoelastic properties, a theory consistent with the current improvements in muscle length across both groups. Additionally, Bose and Dusad (2018),[12] confirmed that both post-isometric relaxation and reciprocal inhibition techniques—forms of MET—significantly improve muscle length, which is reflected in the present findings.

Interestingly, the conventional group also demonstrated significant improvements, indicating that static stretching combined with moist heat provides measurable flexibility benefits. This is in agreement with Newell (2011),[13] who emphasized the role of consistent stretching and thermal interventions in improving muscle extensibility, particularly for the hamstrings.

Active Knee Extension Test served as a functional indicator of hamstring flexibility. Pre-test AKE test scores for Group A and Group B were 47.33 ± 6.80 units and 48.47 ± 10.42 units, respectively, with no significant baseline differences. Post-intervention, Group A achieved an improved AKE test score of 54.56 ± 7.42 units, while Group B demonstrated a more substantial improvement to 66.04 ± 10.15 units, with the intergroup difference reaching statistical significance ($t = -6.08$, $p < 0.001$). Within-group improvements were also significant, with Group A showing a t-value of 8.72 ($p < 0.001$) and Group B demonstrating a t-value of 24.06 ($p < 0.001$).

The greater improvement in AKE test scores within Group B suggests superior functional gains with MET, consistent with the findings of Smith and Fryer (2008),[14] who reported that MET techniques produce greater improvements in flexibility compared to conventional stretching. Furthermore, Albertin et al. (2020),[15] emphasized the effectiveness of advanced soft tissue methods like the Primal Reflex Release Technique™ in improving hamstring strain symptoms and enhancing lower limb function, which aligns with the functional improvements seen in Group B.

The observed within-group improvements in both groups are consistent with Waseem et al. (2009),[16] who demonstrated significant hamstring flexibility gains following MET in collegiate males. Moreover, Azizi et al. (2018),[9] reported reductions in muscle stiffness and significant flexibility enhancements following MET, reinforcing the current findings.

The physiological basis for these improvements is supported by Ballantyne et al. (2003),[11] who proposed that MET utilizes post-isometric relaxation to facilitate neuromuscular resetting and improved muscle elasticity, enabling better ROM. Similarly, Bose and Dusad (2018),[12] emphasized that MET, including both post-isometric relaxation and reciprocal inhibition techniques, effectively enhances muscle length, which is reflected in the significant changes observed in this study.

Overall, the findings of this study align with the existing literature, confirming MET as an effective intervention for improving hamstring flexibility and functional movement. The significant superiority observed in AKE test outcomes for the experimental group indicates that MET offers greater benefits than conventional stretching and heat application alone. Additionally, as suggested by Albertin et al. (2020),[16] combining MET with advanced soft tissue techniques may further enhance flexibility and functional improvements, a direction that future research may explore.

CONCLUSION

The present study concludes that both Muscle Energy Technique (MET) and conventional stretching interventions significantly improve hamstring flexibility and knee range of motion in females aged 25 to 50 years. However, MET demonstrated superior improvements in functional outcomes, as reflected by greater gains in Active Knee Extension Test scores. These findings support the effectiveness of MET as a reliable technique for enhancing muscle flexibility and joint mobility, suggesting its inclusion in rehabilitation and preventive physiotherapy programs targeting hamstring tightness.

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