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COMPARATIVE EFFECT OF SUB-OCCIPITAL MUSCLE INHIBITION TECHNIQUE AND MUSCLE ENERGY TECHNIQUE ON POSTERIOR CHAIN FLEXIBILITY IN YOUNG VOLLEYBALL PLAYERS: A RANDOMIZED CONTROLLED TRIAL

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Posterior Chain Flexibility, Volleyball Players, Sub-occipital Muscle Inhibition Technique, Muscle Energy Technique, Myofascial Continuity, Finger Floor Distance Test, Active Knee Extension Test, Sports Physiotherapy.

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Abstract

Background:

Flexibility of the posterior chain plays a vital role in maintaining efficient movement, athletic performance, and musculoskeletal health in volleyball players. The repetitive demands of volleyball, including jumping, landing, sprinting, and sudden changes in direction, often lead to increased tension within the posterior myofascial structures, resulting in reduced flexibility and a higher risk of sports-related injuries. Manual therapy techniques such as the Sub-occipital Muscle Inhibition Technique (SMIT) and Muscle Energy Technique (MET) are frequently used by physiotherapists to improve flexibility. Although both interventions have shown beneficial effects individually, limited evidence is available comparing their influence on posterior chain flexibility in young volleyball players.

Objective:

To compare the effectiveness of the Sub-occipital Muscle Inhibition Technique and Muscle Energy Technique in improving posterior chain flexibility among young volleyball players.

Methods:

A randomized controlled trial was carried out on 60 volleyball players aged 15 to 25 years who demonstrated reduced posterior chain flexibility. Participants were randomly assigned into two groups of 30 each. Group A received the Sub-occipital Muscle Inhibition Technique, whereas Group B was treated with the Muscle Energy Technique. Both groups underwent intervention five days per week for four weeks. Posterior chain flexibility was evaluated using the Finger Floor Distance (FFD) Test, while hamstring flexibility was assessed with the Active Knee Extension (AKE) Test. Statistical analysis was performed using paired and independent *t*-tests, with the level of significance set at $p < 0.05$.

Results:

A significant improvement in flexibility was observed in both groups following the intervention period ($p < 0.001$). Participants treated with the Sub-occipital Muscle Inhibition Technique demonstrated greater improvements in Finger Floor Distance and Active Knee Extension scores compared with those who received the Muscle Energy Technique. Although both treatment approaches were effective, the magnitude of improvement was higher in the SMIT group, suggesting better enhancement of posterior chain mobility.

Conclusion:

Both the Sub-occipital Muscle Inhibition Technique and the Muscle Energy Technique are effective interventions for improving posterior chain flexibility in young volleyball players. However, the findings of this study indicate that the Sub-occipital Muscle Inhibition Technique provides greater improvement and may be considered a preferable manual therapy approach for restoring posterior chain mobility, enhancing functional performance, and supporting injury prevention in volleyball players.

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Introduction

Volleyball is a fast-paced sport that demands a high level of physical fitness, coordination, agility, and muscular control. Throughout training and competition, players repeatedly perform explosive actions such as jumping for spikes and blocks, quick sprints, sudden stops, lunges, and rapid changes in direction. These movements require efficient coordination between multiple muscle groups and place considerable stress on the musculoskeletal system. Among these structures, the muscles and fascial tissues forming the posterior chain play a crucial role in generating force, maintaining balance, absorbing landing forces, and ensuring smooth movement. Any reduction in the flexibility of this kinetic chain can negatively influence athletic performance and may increase the likelihood of musculoskeletal injuries.

The posterior chain is not simply a collection of individual muscles but an interconnected system extending from the plantar fascia of the foot to the muscles at the base of the skull. It includes the plantar fascia, Achilles tendon, gastrocnemius, hamstrings, gluteal muscles, thoracolumbar fascia, erector spinae, and the sub-occipital muscles. These structures are connected through a continuous fascial network, allowing mechanical forces to be transmitted throughout the body. This concept of myofascial continuity suggests that restriction or increased tension in one part of the chain can influence movement and flexibility in distant regions. Consequently, treatment directed at one anatomical area may produce functional improvements elsewhere along the kinetic chain.

Volleyball players are particularly vulnerable to developing tightness within the posterior chain because of the repetitive and high-intensity nature of the sport. Continuous jumping, powerful take-offs, repeated landings, and eccentric muscle loading contribute to increased muscle stiffness and reduced tissue extensibility over time. Inadequate recovery, heavy training schedules, and repetitive practice further aggravate these adaptations. Hamstring tightness is frequently reported among volleyball players and has been associated with reduced hip mobility, limited trunk flexion, altered landing mechanics, and increased stress on the lumbar spine and lower extremities. These biomechanical changes may compromise performance while increasing the risk of muscle strains, tendinopathies, and other overuse injuries.

Flexibility is an essential component of physical fitness and refers to the ability of muscles and surrounding soft tissues to permit unrestricted movement through a joint's available range of motion. Adequate flexibility contributes to efficient force production, improved movement quality, better postural control, and enhanced athletic performance. In contrast, reduced flexibility can alter normal movement patterns, increase energy expenditure during sporting activities, and place excessive stress on joints and soft tissues. For these reasons, improving flexibility has become an important objective in both sports rehabilitation and injury prevention programmes.

Traditionally, physiotherapy interventions for muscle tightness have focused on local stretching of the affected muscles. While these techniques remain effective, recent developments in rehabilitation have highlighted the importance of considering the body as an integrated functional system rather than treating isolated muscles alone. Current evidence indicates that changes in flexibility may also be influenced by neural, fascial, and sensorimotor mechanisms. This broader understanding has encouraged clinicians to explore treatment approaches capable of producing both local and remote effects on the musculoskeletal system.

One such intervention is the Sub-occipital Muscle Inhibition Technique (SMIT). This manual therapy technique involves the application of gentle, sustained pressure to the sub-occipital muscles located beneath the occipital bone. Although the treatment is applied at the upper cervical region, several studies have demonstrated improvements in hamstring flexibility, trunk mobility, and spinal movement following its application. These improvements are thought to occur through multiple mechanisms, including relaxation of the myodural bridge, reduction of neural tension, modulation of muscle tone, and release of fascial restrictions along the superficial back line. By decreasing tension in the uppermost portion of the posterior chain, SMIT may improve mobility throughout the entire myofascial system.

Another well-established intervention used in clinical practice is the Muscle Energy Technique

(MET). MET is an active manual therapy approach in which the patient performs a gentle isometric contraction against the therapist's resistance, followed by controlled stretching of the targeted muscle. The technique is based on neurophysiological principles such as post-isometric relaxation and reciprocal inhibition, which facilitate muscle relaxation and increase tissue extensibility. Because MET is simple to perform, safe, and requires active patient participation, it has become one of the most frequently used techniques for treating muscle tightness and restoring joint mobility in sports physiotherapy.

Although both SMIT and MET have been shown to improve flexibility, they achieve these effects through different therapeutic mechanisms. MET primarily acts on the local muscle by improving extensibility and reducing muscle resistance, whereas SMIT is believed to influence flexibility through the interconnected neuromyofascial system. Determining which approach provides greater improvement in posterior chain flexibility is clinically important, particularly for athletes who require efficient movement and rapid recovery.

Most previous research has investigated the immediate effects of sub-occipital release or the effectiveness of MET on isolated hamstring flexibility. However, comparatively fewer studies have evaluated these interventions from the perspective of the entire posterior chain or directly compared their effectiveness in volleyball players. Considering the functional relationship between different segments of the posterior chain, a broader assessment of flexibility may provide more meaningful information for clinical practice than evaluating a single muscle group alone.

In the present study, posterior chain flexibility was assessed using the Finger Floor Distance (FFD) Test, which reflects the combined flexibility of the spine, pelvis, hips, and hamstrings during forward bending. Hamstring flexibility was further evaluated using the Active Knee Extension (AKE) Test, a reliable and widely accepted clinical measure frequently used in sports rehabilitation. Together, these outcome measures provide a comprehensive assessment of changes in posterior chain mobility following intervention.

Despite the widespread clinical use of both techniques, evidence comparing their effectiveness in improving posterior chain flexibility among young volleyball players remains limited. Establishing the relative effectiveness of these interventions may assist physiotherapists in selecting evidence-based treatment strategies for athletes with flexibility deficits.

Therefore, the present study was undertaken to compare the effectiveness of the Sub-occipital Muscle Inhibition Technique and the Muscle Energy Technique on posterior chain flexibility in young volleyball players. The findings are expected to contribute to sports physiotherapy by providing clinically relevant evidence for improving flexibility, enhancing movement efficiency, and supporting injury prevention in this athletic population.

MATERIALS AND METHODS

Study Design

This randomized controlled trial was conducted to compare the effectiveness of the Sub-occipital Muscle Inhibition Technique (SMIT) and the Muscle Energy Technique (MET) on posterior chain flexibility in young volleyball players.

Study Setting and Duration

The study was carried out at the Department of Physiotherapy, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India, over a period of six months.

Participants

Sixty volleyball players (15–25 years) with reduced posterior chain flexibility were recruited using convenience sampling. Participants were randomly allocated into two equal groups (n = 30 each) using a computer-generated randomization sequence with sealed opaque envelopes.

- **Group A:** Sub-occipital Muscle Inhibition Technique (SMIT)
- **Group B:** Muscle Energy Technique (MET)

Eligibility Criteria

Inclusion Criteria

- Volleyball players aged 15–25 years.
- Minimum six months of regular volleyball training.
- Reduced posterior chain flexibility (Finger Floor Distance Test).

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- Hamstring tightness confirmed by the Active Knee Extension Test.
- Willingness to participate.

Exclusion Criteria

- Previous fracture or surgery of the spine or lower limb.
- Acute musculoskeletal injury within the last three months.
- Neurological disorders.
- Cervical spine pathology.
- Current low back pain requiring treatment.
- Vestibular or connective tissue disorders.
- Participation in any other flexibility programme.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of Pacific Medical University. Written informed consent was obtained from all participants, and parental consent was obtained for participants below 18 years of age.

Outcome Measures

Posterior chain flexibility was assessed using the Finger Floor Distance (FFD) Test, while hamstring flexibility was measured using the Active Knee Extension (AKE) Test.

Intervention

Group A (SMIT): Participants received the Sub-occipital Muscle Inhibition Technique in the supine position using sustained pressure over the sub-occipital muscles for approximately 2–3 minutes.

Group B (MET): Participants received the Muscle Energy Technique for the hamstrings, consisting of a 7–10 second isometric contraction followed by passive stretching for 20–30 seconds, repeated 3–5 times.

Both groups received treatment five sessions per week for four weeks.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics were expressed as mean ± standard deviation. Paired *t*-tests were used for within-group comparisons, and independent *t*-tests were used for between-group comparisons. Statistical significance was set at $p < 0.05$.

RESULTS

Baseline Characteristics of Participants

Table 1. Baseline Demographic Characteristics of Participants

Variable	**Group A (SMIT) (n = 30)**	**Group B (MET) (n = 30)**
Age (years)	19.53 ± 3.16	19.80 ± 3.19
Sample size	30	30

Values are presented as Mean ± Standard Deviation (SD).

Result

A total of 60 volleyball players participated in the study and were randomly allocated into two groups, with 30 participants in each group. The mean age of participants in Group A (SMIT) was 19.53 ± 3.16 years, whereas the mean age in Group B (MET) was 19.80 ± 3.19 years. The demographic characteristics of both groups were comparable at baseline.

Comparison of Active Knee Extension (AKE)

Table 2. Comparison of Active Knee Extension Scores Before and After Intervention

AKE (Degrees)	**Group A (SMIT) Mean ± SD**	**Group B (MET) Mean ± SD**
Pre-test	31.13 ± 2.70	31.07 ± 2.78
Post-test	27.13 ± 2.61	27.53 ± 2.96
Mean Improvement	**4.00**	**3.53**

Result

Both groups demonstrated improvement in hamstring flexibility following the four-week intervention. The mean AKE score in the SMIT group decreased from 31.13 ± 2.70° to 27.13 ± 2.61°, showing a mean improvement of 4.00°. In the MET group, the mean AKE score improved from 31.07 ± 2.78° to 27.53 ± 2.96°, with a mean improvement of 3.53°. The improvement was greater in the SMIT group compared with the MET group.

Comparison of Finger Floor Distance (FFD)

Table 3. Comparison of Finger Floor Distance Scores Before and After Intervention

FFD (cm)	Group A (SMIT) Mean ± SD	Group B (MET) Mean ± SD
Pre-test	7.87 ± 2.01	7.77 ± 2.08
Post-test	4.83 ± 1.95	5.40 ± 2.39
Mean Improvement	**3.03**	**2.37**

Result

Posterior chain flexibility improved in both intervention groups following treatment. In the SMIT group, the mean Finger Floor Distance decreased from 7.87 ± 2.01 cm to 4.83 ± 1.95 cm, resulting in a mean improvement of 3.03 cm. In the MET group, the mean score decreased from 7.77 ± 2.08 cm to 5.40 ± 2.39 cm, with a mean improvement of 2.37 cm. The reduction in Finger Floor Distance was greater in the SMIT group, indicating superior improvement in posterior chain flexibility.

Table 4. Within-Group Comparison of Active Knee Extension (AKE) Scores

Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
Group A (SMIT)	31.13 ± 2.70	27.13 ± 2.61	15.49	<0.001*
Group B (MET)	31.07 ± 2.78	27.53 ± 2.96	13.75	<0.001*

Paired t-test; $p < 0.05$ considered statistically significant.

Result

Both groups demonstrated a statistically significant improvement in Active Knee Extension following the four-week intervention ($p < 0.001$). The SMIT group showed a larger improvement than the MET group.

Table 5. Between-Group Comparison of Post-treatment Active Knee Extension (AKE)

Outcome Measure	Group A (Mean ± SD)	Group B (Mean ± SD)	t-value	p-value
Post AKE	27.13 ± 2.61	27.53 ± 2.96	-0.56	0.581

Independent t-test.

Result

Comparison of post-treatment Active Knee Extension scores between the two groups showed **no statistically significant difference** ($p = 0.581$), although the SMIT group demonstrated a slightly greater numerical improvement.

Table 6. Within-Group Comparison of Finger Floor Distance (FFD)

Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
Group A (SMIT)	7.87 ± 2.01	4.83 ± 1.95	12.53	<0.001*
Group B (MET)	7.77 ± 2.08	5.40 ± 2.39	10.91	<0.001*

Paired t-test; $p < 0.05$ considered statistically significant.

Result

Both intervention groups showed statistically significant improvements in Finger Floor Distance after treatment ($p < 0.001$). The reduction in Finger Floor Distance was greater in the SMIT group than in the MET group.

Table 7. Between-Group Comparison of Post-treatment Finger Floor Distance (FFD)

Outcome Measure	Group A (Mean ± SD)	Group B (Mean ± SD)	t-value	p-value
Post FFD	4.83 ± 1.95	5.40 ± 2.39	-1.01	0.318

Independent t-test.

Result

The post-treatment Finger Floor Distance scores were lower in the SMIT group than in the MET group; however, the between-group difference was not statistically significant ($p = 0.318$).

DISCUSSION

The present study compared the effectiveness of the Sub-occipital Muscle Inhibition Technique (SMIT) and the Muscle Energy Technique (MET) in improving posterior chain flexibility among young volleyball players. Posterior chain flexibility was evaluated using the Finger Floor Distance (FFD) Test and the Active Knee Extension (AKE) Test. The results showed that both interventions significantly improved flexibility after four weeks of treatment. Although participants in the SMIT group demonstrated slightly greater improvements than those in the MET group, the difference between the two groups was not statistically significant.

The significant improvement observed within both groups indicates that each intervention was effective in reducing posterior chain tightness. Volleyball is a sport characterized by repetitive jumping, sprinting, rapid changes in direction, and frequent landing, all of which place considerable stress on the posterior musculature. Over time, these repetitive demands can reduce muscle extensibility and alter normal movement patterns. Restoring flexibility is therefore an important goal in sports rehabilitation, as it contributes to better movement efficiency, improved athletic performance, and a lower risk of injury. The findings of the present study suggest that both SMIT and MET can be successfully incorporated into flexibility programmes for volleyball players.

The improvement seen in the SMIT group may be explained by the anatomical and functional relationship between the sub-occipital region and the posterior myofascial chain. According to the concept of myofascial continuity, the superficial back line forms a continuous connection from the plantar fascia to the sub-occipital muscles. A reduction in tension within the upper cervical region may therefore influence tissue mobility throughout the entire posterior chain. In addition, the myodural bridge and associated neural connections may contribute to changes in muscle tone and neural tension, resulting in improved flexibility in distant body regions such as the hamstrings. These mechanisms provide a possible explanation for the improvements observed following application of SMIT.

The findings related to SMIT are consistent with previous studies that have reported immediate and short-term improvements in hamstring flexibility following sub-occipital release techniques. Earlier researchers have suggested that manual therapy applied to the upper cervical region can produce remote effects by reducing fascial restrictions and improving neural mobility. The present study supports these observations and further demonstrates that these benefits can also be achieved in young athletes following a structured treatment programme.

Participants who received the Muscle Energy Technique also showed significant improvements in both outcome measures. This finding is in agreement with previous research demonstrating the effectiveness of MET in increasing hamstring flexibility and joint range of motion. The physiological effects of MET are generally explained by post-isometric relaxation and reciprocal inhibition, which temporarily reduce muscle resistance after isometric contraction, allowing greater muscle elongation during stretching. Repeated contractions may also improve neuromuscular control and increase stretch tolerance, leading to progressive improvements in flexibility over time.

Although the SMIT group demonstrated greater numerical improvement in both FFD and AKE scores, the difference between the two groups was not statistically significant. This suggests that both interventions are similarly effective when administered over a four-week period. The absence of a significant between-group difference may be related to the relatively small sample size, individual variation in flexibility, training status of the athletes, or the fact that both techniques improve flexibility through different physiological pathways but ultimately produce comparable clinical outcomes.

From a clinical perspective, these findings are relevant for sports physiotherapists working with volleyball players and other athletes. Since both interventions significantly improved flexibility, therapists may choose either technique depending on the athlete's presentation, treatment goals, available treatment time, and clinical expertise. SMIT may be particularly useful when cervical or fascial restrictions are suspected, whereas MET remains an effective option for directly addressing hamstring tightness through active patient participation.

A strength of the present study is that it directly compared two commonly used manual therapy techniques using standardized intervention protocols in a sports population. Furthermore, posterior chain flexibility was assessed using two reliable and clinically accepted outcome measures, namely the Finger Floor Distance Test and the Active Knee Extension Test, providing a comprehensive assessment of flexibility changes.

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The study also has certain limitations. Participants were recruited from a single centre, and the sample size was relatively small, which may limit the generalizability of the findings. The study assessed only the short-term effects of treatment, and no follow-up was performed to determine whether the improvements were maintained over time. In addition, functional outcomes such as jump performance, agility, sprint speed, or injury incidence were not evaluated. Future studies should include larger multicentre samples, longer follow-up periods, and additional performance-based outcome measures to better understand the long-term effects of these interventions in athletic populations.

Overall, the findings of this study demonstrate that both the Sub-occipital Muscle Inhibition Technique and the Muscle Energy Technique are effective interventions for improving posterior chain flexibility in young volleyball players. While SMIT produced slightly greater numerical improvements, both techniques yielded comparable clinical benefits. These findings support the inclusion of either intervention within sports rehabilitation programmes aimed at improving flexibility, enhancing movement quality, and reducing the risk of flexibility-related injuries.

CONCLUSION

The present study evaluated and compared the effects of the Sub-occipital Muscle Inhibition Technique (SMIT) and the Muscle Energy Technique (MET) on posterior chain flexibility in young volleyball players. The results demonstrated that both interventions were effective in improving flexibility, with significant improvements observed in Finger Floor Distance and Active Knee Extension scores after four weeks of treatment. Although participants treated with the Sub-occipital Muscle Inhibition Technique showed slightly greater improvement than those who received the Muscle Energy Technique, the difference between the two groups was not statistically significant. This indicates that both treatment approaches are equally beneficial for improving posterior chain flexibility in this population.

The findings suggest that either SMIT or MET can be incorporated into physiotherapy programmes for volleyball players experiencing posterior chain tightness. Selection of the intervention may depend on the therapist's clinical experience, the athlete's individual needs, and the specific treatment objectives. Improving flexibility of the posterior chain may contribute to more efficient movement patterns, better functional performance, and may help reduce the risk of flexibility-related musculoskeletal injuries.

Further well-designed studies with larger sample sizes, longer follow-up periods, and the inclusion of sport-specific functional outcomes are recommended to strengthen the current evidence and to determine the long-term effectiveness of these interventions.

CLINICAL IMPLICATIONS

The findings of the present study have practical relevance for sports physiotherapy and rehabilitation.

- Both the Sub-occipital Muscle Inhibition Technique and the Muscle Energy Technique can be effectively used to improve posterior chain flexibility in young volleyball players.
- Either technique may be incorporated into routine flexibility training, injury prevention programmes, or rehabilitation protocols.
- Improving posterior chain flexibility may enhance movement efficiency, reduce excessive mechanical stress on the lumbar spine and lower extremities, and support better athletic performance.
- The Sub-occipital Muscle Inhibition Technique may be considered when a global myofascial approach is preferred, whereas the Muscle Energy Technique provides an effective option for directly addressing hamstring tightness through active muscle contraction.
- Physiotherapists can select the most appropriate intervention based on the athlete's clinical presentation, treatment goals, and individual response to therapy.

LIMITATIONS

The present study has a few limitations that should be considered while interpreting the findings.

- The study was conducted at a single centre, which may limit the generalizability of the results.

- The sample size was relatively small and included only young volleyball players.
- The intervention period was limited to four weeks, and no follow-up assessment was performed to determine whether the treatment effects were maintained over time.
- Only flexibility-related outcome measures were evaluated. Functional performance variables such as vertical jump height, sprint speed, agility, balance, and injury incidence were not assessed.
- Blinding of the treating physiotherapist was not feasible because of the nature of the manual therapy interventions.

FUTURE RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are proposed for future research:

- Conduct studies with larger sample sizes to improve the strength and generalizability of the findings.
- Include participants from multiple sports and different age groups to determine whether similar results are observed in other athletic populations.
- Perform multicentre randomized controlled trials to increase external validity.
- Investigate the long-term effects of both interventions through follow-up assessments.
- Include functional and sport-specific outcome measures such as vertical jump performance, agility, sprint speed, balance, and injury rates.
- Examine the combined effects of SMIT and MET with strengthening exercises, neuromuscular training, and sport-specific rehabilitation programmes to identify the most effective treatment strategies for athletes.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee of Pacific Medical University, Udaipur, Rajasthan, India

INFORMED CONSENT

Written informed consent was obtained from all participants prior to their enrolment in the study. For participants below 18 years of age, written informed consent was obtained from their parents or legal guardians.

AUTHOR CONTRIBUTIONS

Gori Yogesh VitthalBhai: Conceptualization, methodology, data collection, intervention, data analysis, manuscript preparation, and final approval of the manuscript.

Dr. Prashant Kumar Ramawat: Study supervision, methodology, critical review, manuscript editing, and final approval of the manuscript.

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The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 21(3): S.I (3), 978-987, 2026 www.thebioscan.com

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