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Comparative Efficacy of Foam Roller and Static Stretching for Hamstring Tightness in Taekwondo Athletes

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ABSTRACT

Background: Hamstring tightness is a common issue among athletes, particularly those engaged in sports requiring high flexibility and dynamic lower-limb movements, such as taekwondo. Reduced hamstring flexibility can limit performance, restrict range of motion (ROM), and increase the risk of musculoskeletal injuries. Various interventions, including static stretching and foam rolling, have been widely used to improve flexibility, but their comparative effectiveness in taekwondo athletes remains unclear.

Methodology: A randomized clinical trial was conducted with 44 taekwondo athletes aged 12–18 years who practiced at least three times a week. The participants were randomly assigned to two groups

Group A: Foam rolling combined with conventional physiotherapy.

Group B: Static stretching combined with conventional physiotherapy. The intervention lasted for four weeks, with three sessions per week. Both groups performed strengthening exercises in addition to their respective interventions. Hamstring flexibility was assessed using the 9090 Straight Leg Raise (SLR) Test and the Active Knee Extension (AKE) Test before and after the intervention. Statistical analysis (paired and unpaired t-tests) was performed to evaluate changes in flexibility within and between groups.

Conclusion: Both foam rolling and static stretching significantly improved hamstring flexibility in taekwondo athletes. However, no statistically significant difference was observed between the two groups, indicating that both methods are equally effective in reducing hamstring tightness. Foam rolling may provide additional benefits in muscle recovery, whereas static stretching remains a widely used and effective technique for improving flexibility. These findings suggest that athletes and coaches can integrate either method based on individual preference, accessibility, and training needs.

Keywords: *Hamstring tightness, Taekwondo athletes, Foam rolling, Static stretching, Flexibility, Injury prevention, Range of motion (ROM), Myofascial release, Sports performance.*

1. INTRODUCTION

One popular traditional martial art style that originated in Korea is taekwondo (TKD). Both men and women participate in this fast-paced, highly enthusiastic activity. In the full contact sport of TKD, competitors are expected to kick their opponents with maximum force while adhering to the regulations. Athletes of all ages have participated in it, and its reputation and popularity have grown quickly since it was added to the Olympic program in 2000. Strong circular heading kicks and other

unusual double point scoring methods in taekwondo put athletes at lifelong risk of injury during practice and competition [1]. Hamstring is a 'mobilizer' muscle of hip and knee joint. It is a muscle group consisting of semitendinosus, semimembranosus, and the biceps femoris muscle [2].

The biceps femoris, semitendinosus, and semimembranosus are the three muscles that make up the hamstring muscle complex. Although the hamstring component of the adductor magnus muscle is a tendinous slip that originates from the inferomedial aspect of the ischial tuberosity, it will not be regarded as a part of the hamstring muscle complex for the purposes of this review.

Muscle tightness results from a reduction in the muscle's deformation capacity, which limits the range of motion at the joint where the muscle operates. The inability to extend the knee by more than 160° while maintaining a 90° flexion angle is regarded as hamstring tightness. The most frequent injury among athletes is a hamstring strain, which is caused by tight hamstrings. These injuries require a lot of medical care, take a long time to heal, and lower an athlete's performance level [3].

A reliable landmark for distinguishing between proximal and distal hamstring injuries is the femur, where the biceps femoris muscle originates. Both the short and long head origins of the musculotendinous junction (MTJ), which runs the length of the biceps femoris muscle aid in the development of the distal tendon insertions. The tibial section of the sciatic nerve innervates the long head, while the common peroneal portion innervates the short head (both L5, S1). It is hypothesized that the biceps femoris muscle's dual innervation may cause asynchrony in the two heads' coordination or stimulation intensity, which could explain why the biceps femoris muscle is the most frequently damaged muscle in the hamstring muscle complex [4].

Tight hamstring alters the biomechanical and postural changes and can lead to injury, and hence foam roller and static stretching can reduce tightness and increase flexibility [5].

The inferomedial side of the ischial tuberosity gives rise to the semitendinosus muscle, which is named for the length of its tendon. It forms a conjoint tendon with the long head of the biceps femoris muscle. The distal tendon's length may make the muscle more prone to rupturing. The gracilise muscle is then inserted into the upper portion of the medial surface of the tibia body at the Gerdy tubercle, behind the tendon of the sartorius, where it contributes to the pes anserine. It then curves around the medial condyle of the tibia and passes over the medial collateral ligament of the knee joint, from which it is separated by a bursa. It receives innervation from the tibial nerve via two separate branches (L5, S1, S2), with the lower branch meeting the nerve to the semimembranosus muscle [4]. A thick tendon from the superolateral portion of the ischial tuberosity, superior and lateral to the biceps femoris and semitendinosus, gives rise to the semimembranosus muscle, which gets its name from its membranous tendon of origin. Prior to the other hamstring tendons, the semimembranosus tendon runs medially [4]. Flexibility is the ability to rotate a single joint or series of joints smoothly and easily through an unrestricted pain free ROM [6]. An elongated structure called the proximal tendon grows into an aponeurosis that covers the upper portion of the muscle's anterior surface. Muscular fibres emerge from this aponeurosis, converge to another aponeurosis that covers the lower portion of the muscle's posterior surface, and contract into the tendon of insertion [4].

Improving athletic performance is a major goal of study by reducing risk of injury and proper flexibility training. As per previous studies conducted, athletes practicing martial arts have a prevalence of hamstring tightness of around 60 degrees [3]. Hamstring tightness leads to hamstring injuries. So, flexibility of muscle in lower limb plays a major role in preventing the injury to athletes. Tightness is a term used for shortened muscle [7]. Rehabilitation and injury prevention have a main essential component in common that is flexibility [8].

Because of the shortness of the hamstring muscles, complete flexion of the hip is impossible unless the knee joint is simultaneously flexed. The low incidence of hamstring injuries at this stage can be explained by the knee's passive flexion during the forward swing of the thigh in the gait cycle. When the knee is extended and the body's weight is moved forward during the foot strike, the hamstring muscles also help to slow down the tibia's forward translation during the heel strike. Thus, the anterior cruciate ligament (ACL) and the hamstring muscles work together to support anterior tibial translation both dynamically and statically [4].

The length of a musculotendinous unit can be increased using a variety of strategies. It is possible to use myofascial techniques like myofascial release or Rolfing, or more specifically, pre-contraction (proprioceptive neuromuscular facilitation [PNF] stretching, post isometric relaxation), static (active, passive), and dynamic (active, ballistic) stretches [9]. Foam rolling is one method of self-myofascial release. The foam roll is a solid foam cylinder that comes in a variety of sizes and hardness levels. Muscle tension is reduced, and the Golgi tendon unit is stimulated by the pressure applied by the foam roll. Squeezing soft tissue like a sponge while working causes it to get saturated with fluid, which enhances blood flow and temperature as well as the movement between the various fascial layers. Foam rolling is thought to decrease scar tissue and relieve facial adhesions. For this reason, incorrect posture and chronic myofascial pain syndrome can be avoided. The foam roll also speeds up muscle recovery and enhances muscle function [9].

Numerous stretching postures, methods, and durations seem to improve range of motion, according to the research. A tiny amount of motion is allowed when using the dynamic contract-relax PNF (CRPNF) method. Pre-contracting stretching

produces more rapid and more pronounced increases in range of motion than static stretching. Additionally, because it increases both active and passive flexibility, it is thought to be more functional. Investigating the training effect of foam rolls on hamstring muscular flexibility and contrasting them with CRPNF stretching were the goals of this study [9]. Foam roller is also known as Self Myofascial Release (SMR) technique. It is cylindrical in shape and designed with different densities and texture. The protocol used in this study is based on recommendations of Lukas. The foam roller is available in different degree of hardness and size [7]. Stretching is a general term used to describe any therapeutic maneuver designed to increase the extensibility of soft tissues, thereby improving flexibility by elongating

(lengthening) structures that have adaptively shortened and have become hypomobile over time. Types of stretching techniques are static, dynamic, proprioceptive neuromuscular facilitation, ballistic stretching. Out of all, static stretching is widely used and is effective Also easy to perform [6] [10].

Foam roller helps in releasing adhesions and scar tissues are also reduced [5]. For the assessment of the hamstring tightness we use active knee extension test and Straight leg raises test [11]. Taekwondo athletes need to have a great flexibility and extreme range of motion for the better performance in high kicks [12]. So, the hamstring flexibility is the important point in taekwondo athletes. The objective of the study was to understand the effectiveness of foam roller and static stretching for hamstring tightness in taekwondo athletes.

2. MATERIALS AND METHODS

The study protocol was presented for approval in from of institutional ethical committee and a Protocol committee of D Y Patil University Kolhapur, after that consulting subjects were selected from taekwondo academy according to inclusion criteria and explained about the study.

Inclusion Criteria:

All genders

Age – 12 to 18 years

Taekwondo athletes practicing thrice a week.

Exclusion Criteria:

History of recent fracture of lower limb.

Joints hypermobility already existing

History of lower limb surgeries in last 6 months.

The procedure was explained to the subject. A written consent was taken from the subjects who are willing to participate.

There were two groups each group consisting of 22 individuals. Group A, Group B.

Group A includes foam roller technique with conventional physiotherapy for hamstring tightness in taekwondo athletes.

Group B includes static stretching with conventional physiotherapy for hamstring tightness in taekwondo athletes.

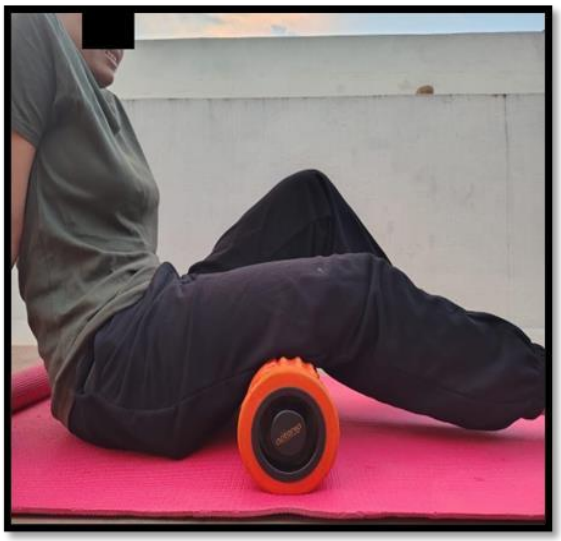
Demographic data details like age, gender, years of practicing taekwondo as per the data collection sheet and outcome measures. The subjects were assessed with the help of, 90-90 Straight Leg Raising Test, Active knee extension test, Goniometry for hip flexion.

The intervention consists of 3 training sessions every week for 4 continue weeks. All participants of both the groups was given strengthening exercises including Single leg pelvic bridging, Body weight squats, Lunges, Gluteal bridge/pelvic bridging and resistance band hamstring curls. The training lasted for 15 to 20 minutes each session has 3 sets and with 30-40 second roll in foam roller technique. The training for static stretching had 3 sets in 1 session with 30-60 seconds static stretch Statistical analysis was recorded and the results were obtained.

Group A:

Group A comprised of 22 individuals with treatment protocol of foam roller for hamstring tightness.

Treatment duration: The duration for intervention was 4 weeks for a total of a 20 minutes per session with 3 sessions per week. Session 1- Gluteal pelvic bridging and lunges, 2 sets for 12 repetitions. Session 2- Single leg pelvic bridging and body weight squats, 2 sets for 12 repetitions. Session 3- Resistant band hamstring curl, 2 sets for 12 repetitions. The individuals are taken in long sitting position and foam roller is placed below the thigh at the maximum pain threshold point in each repetition rolled the hamstring unilaterally for 30 to 40 seconds, with 60 sec rest period, repeat this with other leg also.

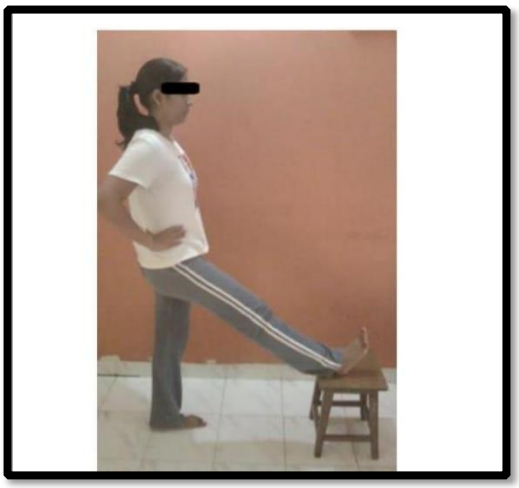


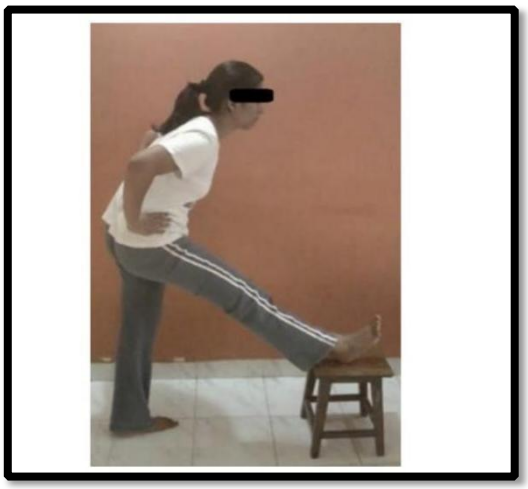
Starting position **End position**

Group B:

Group B comprised of 22 individuals with treatment protocol of static stretching for hamstring tightness.

Treatment duration: The duration of intervention lasted for 20 minutes in this 30 to 60 second. Session 1- Gluteal pelvic bridging and lunges 2 sets for 12 repetitions. Session 2- Single leg pelvic bridging and body weight squats, 2sets for 12 repetitions. Session 3- Resistance band hamstring curls, 2 sets for 12 repetitions. For static stretching hold stretch is given in standing position by placing a heel or feet over a 1 feet height table or ground or a basic heighted floor and apply a static stretch 1 session 3 repetitions do this for 3 sets.





Starting position **Ending position**

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	Session 1	Session 2	Session 3
Group A	Gluteal pelvic bridging and lunges, 2 sets for 12 repetitions. Foam roller for 30 to 40 seconds with 60 seconds rest period, in all for 15 minutes. **Total time duration: 20 minutes.**	Single leg pelvic bridging and body weight squats, 2 sets for 12 repetitions. Foam roller for 30 to 40 seconds with 60 seconds rest period, in all for 15 minutes. **Total time duration: 20 minutes.**	Resistance band hamstring curls, 2 sets for 12 repetitions. Foam roller for 30 to 40 seconds with 60 seconds rest period, in all for 15 minutes. **Total time duration: 20 minutes.**
Group B	Gluteal pelvic bridging and lunges, 2 sets for 12 repetitions. Three sets of static stretching with 3060 seconds hold, three repetitions, in all 15 minutes. **Total time duration: 20 minutes.**	Single leg pelvic bridging and body weight squats, 2 sets for 12 repetitions. Three sets of static stretching with 3060 seconds hold, three repetitions, in all 15 minutes. **Total time duration: 20 minutes.**	Resistance band hamstring curls, 2 sets for 12 repetitions. Three sets of static stretching with 30-60 seconds hold, three repetitions, in all 15 minutes. **Total time duration: 20 minutes.**

3. RESULTS

Variable	**Group A**		**Group B**	
	Mean	S.D.	Mean	S.D.
Months of training	48.55	22.75	42.18	22.79
Hours of practice/ day	1.95	0.38	1.95	0.21
Times/week	4.82	2.04	4.68	1.99

Table no. 1 Standard deviation

The average training duration for Group A was slightly higher than for Group B.

The training intensity (hours per day and times per week) was almost identical in both groups.

Group A Analysis (Paired t-test)

Table no. 2 Physiological Parameters

Variable	Time Point	Mean	S.D.	P-value
90-90 SLR test	pre	105.32	4.22	1.73E-16
	post	134.86	6.84	
Hip flexion ROM	pre	105.82	3.19	2.26E-09
	post	113.45	3.65	

Active Knee Extension Test Results:

Interpretation:

The 90-90 SLR test and Hip Flexion ROM significantly improved after training (p-values are extremely low).

Knee extension test shows that all subjects transitioned to a negative result post-training, indicating better knee extension control.

Table no.3 Active Knee Extension Test

Active Knee extension test	**Frequency n (%)**		**p-value**
	Pre	Post	
Negative	8 (36.36)	22 (100)	
Positive	14 (63.64)	0 (0)	
Total	22 (100)	22 (100)	< 0.001

Pre-Test: 36.36% negative, 63.64% positive Post-Test:

100% negative, 0% positive p-value: < 0.001 (statistically significant improvement)

Group B Analysis (Paired t-test)

Table no. 4 Physiological Parameters

Variable	Time Point	Mean	S.D.	P-value
90-90 SLR test	pre	105.09	3.89	2.80E-19
	post	134.27	5.29	
Hip flexion ROM	pre	106.27	3.43	9.21E-13
	post	112.18	3.36	

Pre-Test: 27.27% negative, 72.73% positive Post-Test: 100% negative, 0% positive p-value: < 0.001 (statistically significant improvement)

Interpretation:

Similar to Group A, Group B also showed a statistically significant improvement in all parameters post-training. The Knee extension test shows all subjects achieved a negative result after training.

Table no. 5 Active Knee extension test

Active Knee extension test	**Frequency n (%)**		**p-value**
	Pre	Post	
Negative	6 (27.27)	22 (100)	
Positive	16 (72.73)	0 (0)	
Total	22 (100)	22 (100)	< 0.001

Table no. 6 Group A vs. Group B (Unpaired t-test)

Variable	Time Point	Mean	S.D.	P-value
90-90 SLR test	Group A	134.86	6.84	0.3751
	Group B	134.27	5.29	
Hip flexion ROM	Group A	113.45	3.65	0.1177
	Group B	112.18	3.36	

Interpretation:

The differences between Group A and Group B are not statistically significant (p-values > 0.05).

This indicates that both groups improved similarly after training.

4. DISCUSSION

The above study aimed to compare the effectiveness of foam rolling and static stretching in improving hamstring flexibility among taekwondo athletes. While previous research has established the benefits of both techniques, a direct comparison in the context of taekwondo training has been limited. The study findings indicate that both foam rolling and static stretching significantly improved flexibility, with no statistically significant difference between the two methods.

In the above study,

In the foam rolling group (Group A):

The 90-90 Straight Leg Raise (SLR) test showed a significant improvement from 105.32° (pretest) to 134.86° (post-test) ($p < 0.001$).

The Active Knee Extension (AKE) test results indicated enhanced knee extension post-intervention.

These findings are consistent with Junker & Stöggl (2015) [7] , who found foam rolling to be an effective method for increasing hamstring flexibility.

Advantages of Foam Rolling

Time-efficient: Takes less than 5 minutes per session.

Self-administered: Does not require a partner or external assistance, reduces muscle soreness, beneficial for post-training recovery.

Limitations of Foam Rolling are discomfort during use, especially for beginners, short term effects, requires consistent practice for long-term benefits, limited studies on long-term flexibility improvements compared to stretching.

Mechanism of Static Stretching: Static stretching involves holding a stretch for a sustained duration, gradually lengthening muscle fibers. The key mechanisms include: Increase in Muscle Compliance, reduces passive resistance to elongation, reduced neuromuscular activity, lowers muscle spindle excitability, allowing deeper stretch, tensile adaptation, promotes collagen remodelling in tendons and fascia.

Findings in Study: In the static stretching group (Group B): The 90-90 SLR test improved from 105.09° (pre-test) to 134.27° (post-test) ($p < 0.001$).

Similar significant improvements were observed in hip flexion ROM and AKE test results. These findings align with Davis et al. (2005) [11], who reported that consistent static stretching increases hamstring length over time.

Advantages of Static Stretching are that no equipment is required (accessible for all athletes). It is proven to have long-term benefits in flexibility improvement. It reduces muscle stiffness, lowering injury risks.

Limitations of Static Stretching are that it requires longer duration for effectiveness. It is less effective for muscle recovery compared to foam rolling. It can cause temporary performance reduction if performed immediately before training.

Comparative Analysis: Foam Rolling vs. Static Stretching

Statistical Comparison:

Despite differences in mechanisms, both methods resulted in statistically significant improvements, with no significant difference between the two groups ($p > 0.05$). This suggests: Both foam rolling and static stretching are effective in improving hamstring flexibility. Athletes can choose either method based on personal preference, convenience, and training structure.

Which Method is Better for Taekwondo Athletes?

Factor	Foam Rolling	Static Stretching
Equipment Needed	Foam roller	None
Ease of Use	Moderate	Easy
Effectiveness	High	High
Muscle Recovery	Better	Limited
Risk of Overstretching	Low	Moderate

Practical Recommendations

Foam rolling may be more beneficial post-training for muscle recovery. Static stretching can be incorporated into warm-ups and cooldowns. A combination of both methods may yield the best results.

5. CONCLUSION

The above study confirms that both foam rolling and static stretching effectively improve hamstring flexibility in taekwondo athletes.

While foam rolling is superior for muscle recovery, static stretching is more accessible and widely used. Athletes and coaches should incorporate flexibility training tailored to individual needs, ensuring optimal performance and injury prevention. By integrating both foam rolling and static stretching, athletes can maximize flexibility, reduce injuries, and enhance movement efficiency, contributing to higher performance levels in taekwondo.

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