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Immediate Effect of Static Versus Dynamic Stretching on Calf Muscle Flexibility in Healthy Young Adults

Dr. Mariyam M Darbar[1], Dr. Bhavika P Gohel[2], Dr. Reji K Samuel[3]

[1]M.P.T. in Musculoskeletal condition, [2]M.P.T. Sports,
Assistant Professor, C U Shah Physiotherapy College, Surendranagar, Gujarat, India.
[3]M.P.T. Orthopaedics, Principal, C U Shah Physiotherapy College, Surendranagar

Corresponding Author: Dr. Mariyam M Darbar

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ABSTRACT

Introduction: The calf muscle, comprising the larger gastrocnemius behind the knee and the smaller soleus beneath it, functions as a powerful plantar flexor connecting to the ankle. Calf muscle tightness, characterized by reduced flexibility or increased stiffness, is associated with decreased ankle dorsiflexion and several disorders, including shin splints, Achilles tendinitis, plantar fasciitis, and muscle or joint sprains. Stretching is a term used to describe any therapeutic manoeuvre designed to lengthen pathologically shortened soft tissue and thereby to increase range of motion.
Objective: To examine the immediate effect of static stretching (SS) and dynamic stretching (DS) on flexibility of the calf muscle as measured by active ankle Dorsiflexion Range of Motion (ADFROM) in healthy adults.
Design: An Interventional Study
Materials & Methods: Thirty participants with calf muscle tightness were selected by convenience sampling and randomly assigned to two groups: Group A (n=15) received static stretching, and Group B (n=15) received dynamic stretching. Active ankle dorsiflexion range of motion (ADFROM) was measured before and after stretching.
Result: A statistically significant improvement in ADFROM was observed in both the groups. There was no statistically significant difference in ADFROM was observed between groups.
Conclusion: Both intervention groups demonstrated significant improvements in ADFROM, with no statistically significant difference observed between the two stretching techniques. These findings suggest that both SS and DS are effective strategies for enhancing calf muscle flexibility in healthy individuals.

Keywords: Calf Flexibility, Static Stretching, Dynamic Stretching, Range of Motion.

INTRODUCTION

The calf muscle, comprising the larger gastrocnemius behind the knee and the smaller soleus beneath it, functions as a powerful plantar flexor connecting to the ankle. Calf muscle tightness, characterized by reduced flexibility or increased stiffness, is associated with decreased ankle dorsiflexion and several disorders, including shin splints, Achilles tendinitis, plantar

fasciitis, and muscle or joint sprains. Reduced ankle dorsiflexion range of motion (ADFROM) can impact gait, physical activity, and increase the risk of falls. Kinematic analyses of normal gait indicate that 5 to 10 degrees of ankle dorsiflexion is necessary to transition from mid-stance to terminal stance. Higher ranges of motion (ROM) are required for dynamic activities like running and jumping, where ankle dorsiflexion peaks at around 20 degrees during mid-stance. As a result, limited dorsiflexion restricts the ability to transition smoothly from mid-stance to terminal stance, leading to shorter stride length, reduced gait speed, and unsteadiness. These gait changes may also result in compensatory adaptations, such as increased pronation or early heel rise. Because of this, identifying successful physical therapy interventions to improve ankle ROM is important.[1,2]

Stretching is a term used to describe any therapeutic manoeuvre designed to lengthen pathologically shortened soft tissue and thereby to increase range of motion. Static stretching involves the elongation of a muscle to its tolerance and maintaining the position for a set period, making it the gold standard for flexibility training. Dynamic stretching focuses on lengthening the muscle through controlled body movements, progressively increasing the range, reach, and speed of motion.[3-5]

Trent J. Herda et al. (2011) examined constant-angle (CA) and constant-torque (CT) static stretching, finding that both improved peak torque (PT), EMG RMS, passive range of motion (PROM), and passive torque (PASTQ), but only CT reduced musculotendinous stiffness (MTS). Wei-Cheng Lin et al. (2020) studied dynamic stretching (DS) with or without vibration foam rolling (VFR) in badminton athletes, reporting significant improvements in range of motion (ROM), countermovement jump height, and agility.[5,6]

The purpose of the present study was to examine the immediate effect of static stretching (SS) and dynamic stretching (DS) on flexibility of the calf muscle as measured by active ankle Dorsiflexion Range of Motion (ADFROM) in an interventional study in healthy adults. We had 2 hypotheses: there would be no statistically significant difference in effect of both interventions and there would be a statistically significant difference in effect of both interventions.

MATERIALS & METHODS

This interventional study was conducted in the musculoskeletal outpatient department of C. U. Shah Physiotherapy College, Surendranagar. All participants received comprehensive information about the study and provided informed consent before participating. Participants who met the selection criteria were randomly assigned to groups by the primary investigator, a postgraduate student specializing in Musculoskeletal Physiotherapy. The outcome measure was assessed by the same postgraduate student both before and immediately after the stretching protocol to evaluate the intervention's effects.

Selection Criteria: The inclusion criteria for the study consisted of participants of either gender, aged 18 to 35 years, presenting with calf muscle tightness (ADFROM < 20°), and those willing to participate. Exclusion criteria were participants with lower limb injuries, metal implants, a history of fractures, or joint and muscular conditions arising from other underlying disorders. Participants with unstable cardiovascular conditions, as determined by a physician or those diagnosed with organ failure (lung, heart, kidney, or liver) or limb amputations were also excluded. Additionally, participants who had engaged in physical activities, such as aerobics, running, or exercise, within four hours prior to testing were excluded from the study.[1,2]

PROCEDURE

Prior consent was taken from all the individuals to fulfill the selection criteria and individuals willing to participate in the study. The Sample Population was randomly allocated in 2 groups: Group A – received Static Stretching & Group B – received Dynamic Stretching. Individual's Active ADFROM were evaluated Pre and Post Stretching with the use of Goniometer.

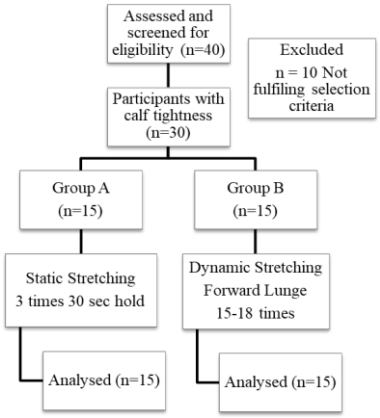


Figure 1: Allocation Chart

Intervention:

Static Stretching: The participants were positioned in a supine lying position. The therapist held the patient's heel with one hand, ensuring the subtalar joint remained in a neutral position, while placing their forearm along the plantar surface of the foot. With the other hand, the therapist stabilized the anterior aspect of the tibia. To dorsiflex the talocrural joint, the therapist pulled the calcaneus downward with the thumb and fingers, while applying gentle upward pressure just above the metatarsal heads using the forearm. The stretch was held for 30 seconds and repeated three times.[7]

Dynamic Stretching: The participant stepped forward with one leg while keeping the back heel flat on the ground and the knee flexed. Simultaneously, they moved forward to the point of a mild stretch in the back calf muscle and then immediately released the stretch, performing a forward lunge. This movement was repeated 15 to 18 times.[8]

Outcome Measures:

The subject was seated with the knee flexed to 90 degrees and the foot at 0 degrees of inversion and eversion. The tibia and fibula were stabilized to prevent movement. The goniometer's fulcrum was placed over the lateral malleolus, the proximal arm aligned with the fibula's lateral midline, and the distal arm parallel to the fifth metatarsal. The participant then performed active ankle dorsiflexion. The Universal Goniometer is a valid and reliable tool, with ICCs of 0.50 for dorsiflexion and 0.72 for plantar flexion.[9,10]

Picture 1: Static Stretching

Picture 2: Dynamic Stretching

RESULT

The data analysis was conducted using SPSS (Version 26). As the data was not following normal distribution, non-parametric tests were employed. Intra-group comparisons were performed using the Wilcoxon signed-rank test, while inter-group differences were assessed using the Mann-Whitney U test. A 95% confidence interval was applied, with statistical significance set at $p < 0.05$.

GROUPS	GROUP A	GROUP B	p-value	INFERENCE
AGE	20.87 ± 1.598	20.67 ± 1.496	0.806	NOT SIGNIFICANT
GENDER (Female: Male)	14:1	13:2		

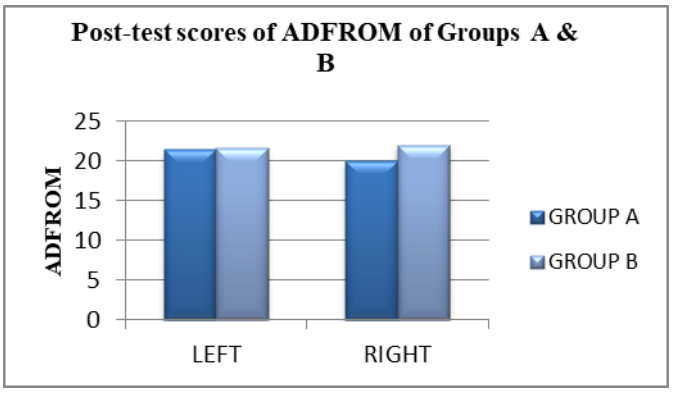
TABLE 1: Baseline demographic data of both the groups.

GROUPS	Side	Pre-treatment scores of ADFROM		Post-treatment scores of ADFROM		*p*-value	Z-value
		Mean	± SD	Mean	± SD		
GROUP A	Left	16.15	±2.410	21.46	±2.989	0.001	3.190
	Right	16.77	±1.589	20.08	±3.013	0.001	3.192
GROUP B	Left	16.23	±1.589	21.62	±2.256	0.001	3.194
	Right	17.00	±1.528	22.00	±1.958	0.001	3.194

TABLE 2: Intra group comparison of pre & post-test scores of ADFROM in Groups A & B (Wilcoxon signed-rank test)

OUTCOME	GROUP A		GROUP B		*p*-value	Z-value
ADFROM	MEAN	± SD	MEAN	± SD		
Left	21.46	±2.989	21.62	±2.256	0.139	1.526
Right	20.08	±3.013	22.00	±1.958	0.920	0.130

TABLE 3: Inter group comparison of post-test scores of ADFROM of Groups A & B (Mann-Whitney U test)



GRAPH 1: Inter group comparison of post-test scores of ADFROM of Groups A & B

Table 1 shows the mean age and gender of participants in Group-A & Group-B. No statistically significant difference was found between the ages and gender of participants in both groups, proving that the groups are homogenous in terms of demographic details. Table 2 shows the Intragroup comparison of pre and post treatment ADFROM in Groups A & B where the *p*-value is <0.05. A statistically significant difference was found between the pre and post treatment ADFROM with a significant reduction in ADFROM after treatment. This comparison was done using Wilcoxon signed-rank test. Table 3 & Graph 1 shows the intergroup comparison of mean difference ADFROM of Group A & Group B. No statistically significant difference in ADFROM was found between groups A and B. This comparison was done using Mann-Whitney U test.

DISCUSSION

This study examined the immediate impact of SS and DS on calf muscle flexibility, evaluated through active ADFROM. The analysis demonstrated that both SS and DS led to comparable improvements in calf muscle flexibility, with no statistically significant differences between the two interventions. Therefore, the first hypothesis, which proposed that SS and DS are equally effective in enhancing calf muscle flexibility as measured by ADFROM, was supported.

SS has been established as an effective means to increase ROM around the ankle joint and muscle flexibility. This prolonged stretching increases muscle flexibility thus allowing the muscle spindle to adapt over time and stop firing. Sustained passive stretching takes advantage of the inverse myotatic reflex, which promotes muscle relaxation, and hence allows further stretching and ROM.[2]

DS of the plantar flexors was considered an effective means of lengthening the tendon tissues. DS consists of performing movements that take the limb through range of motion (ROM) by contracting the agonist muscles, which allows the antagonist muscles to relax and elongate due to reciprocal inhibition.[11]

The findings of this study align with those of Wenqing Wang, who examined the effects of static and dynamic stretching on lower extremity joint ROM, static balance, and dynamic balance. Wang's study showed that all interventions (static stretching, dynamic stretching, and control) significantly improved lower extremity joint ROM (hip flexion, knee extension, and ankle dorsiflexion), indicating that the observed ROM changes were independent of the type of stretching intervention used.[12]

The findings of this study align with the conclusions of a systematic review and meta-analysis conducted by Behm DG et al., which found that a single stretching session can lead to acute, modest improvements in range of motion (ROM) across various assessments. These improvements were shown to be consistent regardless of factors such as stretch intensity, the participant's training background, stretching method, or sex, suggesting that these variables do not significantly influence the observed ROM gains.[13]

CONCLUSION

This study investigated the immediate effects of static stretching (SS) and dynamic stretching (DS) on calf muscle flexibility, as measured by active ankle dorsiflexion range of motion (ADFROM) in a sample of healthy adults. Both intervention groups demonstrated significant improvements in ADFROM, with no statistically significant difference observed between the two stretching techniques. These findings suggest that both SS and DS are effective strategies for enhancing calf muscle flexibility in healthy individuals.

CLINICAL IMPLICATIONS

This study suggests that either stretching technique can be integrated into warm-up routines or flexibility training, allowing flexibility based on individual preference or specific activity requirements. These findings can be applied to rehabilitation and sports training, as improved ADFROM and calf muscle flexibility are essential for movements requiring ankle mobility, such as walking, running, and jumping.

Declaration by Authors

Ethical Approval: Ethical committee approval was taken prior to the study.
Acknowledgement: None
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Conflict of Interest: The authors declare no conflict of interest.

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