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THE EFFECTIVENESS OF ECCENTRIC EXERCISE AND STATIC STRETCHING IN IMPROVING THE CALF MUSCLE FLEXIBILITY IN UNIVERSITY MALE STUDENTS - A COMPARATIVE STUDY

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Abstract:

Background: This study endeavoured to find the effectiveness of static stretching and eccentric training for the improvement of calf muscle flexibility in university students. **Methodology:** Forty university male students between the age group of 18-25 years volunteered to participate in the study. Anthropometric variables, i.e. height, weight, and Body Mass Index (BMI) measured. **Result & Conclusion:** Statistical analyses of data performed using the Statistical Package for the Social Sciences (SPSS) version 21.0. The level of significance was set at 0.05. The eccentric training group showed statistically significant improvements in active and passive calf muscle flexibility when compared to the static stretching group.

Keywords: eccentric training, calf muscle flexibility, stretching, proprioception

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1. Introduction

Muscular flexibility is an important aspect of normal human function. Adequate flexibility is important to maintain balance, agility, and musculoskeletal function. Joint stiffness and muscle tightness decrease athletic performance and increase musculoskeletal injuries. Flexibility helps to improve performance in general and athletic areas (Sudhakar S. et al., 2016).

The calf muscle is composed of the gastrocnemius and the soleus muscle that attach to the strong calcaneal (Achilles) tendon (Biel and Dorn, 2005). It plays an important role in postural control and gait. Calf muscle tightness (i.e., decreased flexibility or increased stiffness) is associated with a decrease in ankle dorsiflexion as well as many disorders such as shin splints, Achilles tendinitis, plantar fasciitis, and muscle and joint sprains (Middleton and Kolodin, 1992).

Stretching interventions for increasing calf muscle flexibility included static stretching (SS), ballistic stretching, proprioceptive neuromuscular facilitation, eccentric training (ET), and balance board training (Samukawa et al., 2001).

The study was to find the effectiveness of static stretching and eccentric training for the improvement of calf muscle flexibility in university students.

2. Materials and Methods

Forty university male students between the age group of 18-25 years volunteered to participate in the study. This study was randomized experimental trial. Total 40 number of subjects, confirmed by the subject specialist selected based on exclusion and inclusion criteria. Subjects had signed the consent form and agreed to participate in three testing sessions separated by two weeks.

2.1 Outcome Measures

Ankle active dorsiflexion range of motion and ankle passive dorsiflexion range of motion were the outcome measures of this study.

2.2 Instruments Used

Anthropometric rod as a tool for measuring height, weighing machine for measurement of body weight, universal goniometer for joint range of motion and hand-held dynamometer for clinical quantification of joint strength at a fixed static position have been used in the study.

3. Procedure

3.1 Ankle Dorsiflexion Range of Motion Measurements (DFROM)

Ankle DFROM defined as the angle between the proximal axis (from the head of the fibula to the lateral malleolus) and the distal axis (from the base to the head of the fifth metatarsal). Calf muscle flexibility, as determined by ankle passive dorsiflexion range of motion (PDFROM) and active dorsiflexion range of motion (ADFROM) had been measured in the intervention ankle, assigned in random order. Subjects were positioned supine on a treatment table with their knees fully extended. The researcher secured the tibia and fibula of the lower extremity using 10cm wide straps to prevent knee motion. The intervention ankle was maintained in a subtalar joint neutral position during the measurements and subjects were instructed not to provide active assistance. Initially, the subjects flexed the calf muscles as far as possible. Next, the researchers pushed back with sufficient strength to encounter notable tension in the calf muscle. Each measurement was repeated three times, and the mean was used for statistical analyses. All pre-post intervention universal goniometric measurements were taken from the intervention ankle by the same tester, to provide good intra-tester reliability for ankle DFROM. In addition, a hand-held dynamometer (Dualer IQ the smarter inclinometer; JTECH Medical, Salt Lake City, USA) was applied to maintain a constant resistance at the maximum height range in front of the sole of the foot.

The testers undertaking the measurements were blinded to the purpose of the study; the testers had high reliability. All the subjects received two interventions with the same leg, applied in a random order: static stretching and eccentric training.

Each intervention had a break of at least 24 hours in between to minimize any carryover effect. Two types of stretching were used on each intervention: the calf muscle stretched and both knees straight, and bending the knee slightly to maximize the activation of the soleus muscle. All three interventions were performed for 200 secs (total stretch time: 150 sec, total rest time: 50 sec).

Group A (Static Stretching)

Static stretching elongates the muscle to tolerance and sustains the position for a length of time (Nelson RT & William D. Bandy, 2004). Two types of static stretching were used. The subject was standing with one leg in front of the intervention leg, placing the hand against the wall, and slowly moving towards the wall by bending the front leg further whilst keeping the knee on the intervention leg straight with the heel pressed on the floor. The subjects hold the maximally stretched calf muscle in each position for 30 seconds followed by a 10-seconds rest interval. The stretch was repeated 5 times.

Group B (Eccentric Exercise)

Eccentric exercise is defined as a slow movement; the treatment progressed by adding load not speed (R. Bahr, 2007). The intervention starts from an upright body position, and standing with whole body weight on the anterior half-part of the foot, with the ankle joint in plantar flexion lifting by the non-intervention leg. Then the ankle of the intervention leg is lowered to full dorsiflexion and returned to its original position with the assistance of the non-intervention leg. Loading of the calf muscle of the intervention leg was done eccentrically. The training was of 15 repetitions over 50-seconds in 3 sets (3 x 15 repetitions).

4. Statistical Analysis

Descriptive statistics (mean ± standard deviation) were determined for the directly measured and derived variables. Student's t-test (independent t-test) was applied to compare the data between the two groups. All the data were determined using SPSS (Statistical Package for Social Science) version 21.0. A 5% ($p<0.05$) level of probability was used to indicate statistical significance.

5. Results, Analysis and Tables

Table 1 shows the descriptive statistics of anthropometric variables and outcome measure variables in calf muscle flexibility. This table highlights the (mean± SD), t-value, and p-value between Group A and Group B which are as follows. Group B has higher mean values in age (23.6±2.16), height (169.7±4.03), weight (70.8±4.83), and BMI (24.5±1.43) as compared to Group A's age (23.7±2.36), height (169.6±4.66), weight (69.8±6.69), BMI (24.2±2.20) respectively. Statistically significant differences were noted in age t=0.07, height t= 0.18, weight t= 0.51 and BMI t= 0.55.

Table 1: The descriptive statistics of anthropometric variables and outcome measure variables in calf muscle flexibility

Variables	Group A (Static Stretching)		Group B (Eccentric Exercise)		t-value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation		
Age	23.70	2.364	23.65	2.16	.070	.945
Height	169.68	4.66	169.70	4.031	-.018	.986
Weight	69.83	6.691	70.80	4.830	-.512	.611
BMI	24.26	2.20	24.58	1.43	-.550	.585

Table 2: The descriptive analysis for active dorsiflexion

Variables	Group A (Static Stretching)		Group B (Eccentric Exercise)		t-value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation		
ADFROM 1 Day	6.80	1.056	7.35	1.089	-1.62	.113
ADFROM 2 Week	8.15	1.040	9.45	1.28	-3.53	**.001**
ADFROM 4 Week	9.85	1.268	11.70	1.42	-4.35	**.001**

Table 3: The descriptive analysis for passive dorsiflexion

Variables	Group A (Static Stretching)		Group B (Eccentric Exercise)		t-value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation		
PDFROM 1 Day	8.30	.865	8.80	1.005	-1.69	.100
PDFROM 2 Week	10.40	1.142	11.30	1.13	-2.51	**.017**
PDFROM 4 Week	11.90	1.165	13.50	1.24	-4.21	**.001**

6. Discussion and Conclusion

The result of the study elicits that Group A, i.e. static stretching exercises, showed statistically significant improvements in active and passive calf muscle flexibility in within-group analysis. Similarly, Group B, i.e. eccentric training, also showed statistically significant improvements in active and passive calf muscle flexibility for within-group analysis. After between-groups analysis, Group B showed statistically significant improvements in active and passive calf muscle flexibility when compared to Group A, i.e. static stretching, in university male students.

According to Ferreira, Teixeira Salmela, and Guimaraes (2007) and LaRoche, Lussier, and Roy (2008) increased flexibility from long-term stretching training enhances muscle performance, which, in turn, improves functional capacity. Less responsive muscle spindles could result in a decrease in the number of muscle fibres that are activated later (Beedle et al., 2008). Mahieu et al. (2007) demonstrated that the ankle dorsiflexion of healthy subjects increased after 6 weeks of eccentric training.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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