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Effectiveness of eccentric training using theraband in improving triceps surae muscle flexibilty among young healthy individuals

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Abstract

Background: Restricted ankle dorsiflexion has been found to impact many functional movement patterns the squat, stepdown, and landing from a jump. This may impact a person's ability to perform sport specific movements as well as normal daily activities.

Objective: To determine the effectiveness of eccentric training using theraband in improving triceps surae muscle flexibility.

Methods: In this study, 20 subjects (Age 15-20 years) were selected based on inclusion criteria by simple random sampling method. After obtaining the consent of subjects, they were allotted in single group and were given the intervention for 30 seconds 6 repetitions, 5 days in a week for 4 weeks. ADFROM was measured before and after the study. Goniometer was the tool used to evaluate ADFROM.

Results: T-Test was used for data analysis. The mean difference and standard deviation of ADFROM for the group was 9.25±2.22 for pre-test and 16.30±1.56 for post-test. The intragroup analysis of the group showed that ADFROM was extremely statistically significant difference with $p \leq 0.05$ (p=0.0001).

Conclusion: This study concluded that eccentric training for triceps surae muscle was effective in increasing the flexibility of the triceps surae muscle, resulting in increased ADFROM. There is significant difference in pretest and posttest measurement.

Keywords: Theraband, triceps surae muscle flexibility, eccentric training, ankle dorsiflexion range of motion

Introduction

The main function of the triceps surae is to perform plantar flexion of the foot at the ankle joint, allowing heel to elevate against gravity [1]. Flexibility has been defined as the ability of a muscle to lengthen and allow one joint (or more than one joint in a series) to move through a range of motion [2]. Increased flexibility is one of the basic concerns addressed in the day-to-day practice of physical therapy. It is a goal for any patient recovery from a period of immobilization or injury involving the connective tissue. Optimal flexibility is also desirable for participants in most athletic activities and normal day to day function. A shortened muscle may create imbalance in joints and faulty postural alignment that may lead to injury and joint dysfunction. Regarding the triceps surae flexibility, clinicians have reported that, even in healthy subjects, the loss of ankle dorsiflexion range of motion (ADFROM) may result in compensatory hindfoot pronation. Ankle dorsiflexion range of motion from tight calf muscle have been linked to injuries such as Achilles tendonitis, gastrocnemius strains, and plantar fasciitis [4].

Stretching is used as part of physical fitness and rehabilitation programme because it is thought to positively influence performance and injury prevention. Numerous studies have been conducted to investigate the effectiveness of stretching [1, 4, 9, 12]. Shortness and contracture of plantar flexor muscle may cause limitation in range of motion (ROM) that restricts the normal range of muscle.

Lower limb injuries are very common among athletes, with significant consequences for both athletes and their teams. It is important therefore to identify, and effectively manage, factors that could reduce injury risk and the time until return to sport.

Several factors have been proposed as contributing to the high incidence of lower limb injuries, including non-modifiable factors such as age, gender, and previous injury. Modifiable factors have also been implicated, including altered neuromuscular control, reduced muscle strength, altered muscle length-tension curve and reduced flexibility [19]. There is some evidence that using an early stretching programme to increase flexibility may reduce the time until return to sport. However, the main benefit of stretching seems to be an increase in flexibility, with most studies suggesting stretching is ineffective at reducing injury risk, postexercise muscle soreness, or improving performance.

Increased flexibility after a single bout of stretching only lasts approximately 30 min [19]. This short-term increase is mainly due to temporary changes in viscoelastic behaviour. A stretching programme performed regularly for several weeks' results in meaningful improvements in range of motion (ROM), however, such increases in flexibility do not seem to reduce injury risk. Considering the existing evidence of reduced flexibility in some lower limb injuries, the limited evidence to support stretching appears contradictory.19 However, it is possible that deficits in flexibility which are observed clinically are simply one manifestation of an alteration in muscle function.

This increases the joint angle at which peak torque is generated and increases muscle fascicle length (FL). The use of such eccentric training to increase flexibility would combine strengthening and 'stretching' of the muscle tissues, which may be important considering the advantages for lower limb tissues avoiding prolonged eccentric loading at lengthened joint angles. Currently, in the absence of clear effectiveness of many exercise interventions, training and rehabilitation of lower limb injuries commonly includes strengthening, stretching and other components including balance training [19].

However, research from animal models suggests that eccentric training could increase flexibility via sarcomere without the need for additional stretching exercises. This is significant considering the additional benefits of eccentric training in terms of power development and injury risk reduction [19]. Furthermore, technological developments have facilitated the imaging of intramuscular responses to exercise, such as ultrasound imaging of muscle However, it is not clear if there is sufficient data from human studies to support the hypothesis that eccentric training is an effective stimulus for increased flexibility. Therefore, the aim of this systematic review was to appraise the evidence [19]. The ankle is a hinge joint and is only able to move (on its own) through one plane of motion - the sagittal plane. There are two movements within this plane, plantarflexion, and dorsiflexion [13].

Materials and Methods

Research Design: Quasi Experimental design.
Research Setting: PES College of Physiotherapy PESIMSR.
Duration of study: 1 month.
Research Population: Physiotherapy students in PESIMSR.
Sampling Method: Simple random sampling.
Sample Size: 20 subjects.

Criteria for selecting sampling

Inclusion criteria

- Female subjects were included in the study is age ranged between 17-25 years.
- All participants should be healthy and regularly participate in regular physical activity.
- Undergraduate students.
- Subjects having ROM (5^0-15^0) of ankle dorsiflexion.

Exclusion criteria

- Subjects having neurological and vestibular impairment.
- Males are not included in this study.
- History of recent trauma and musculoskeletal injury.
- Subjects having any lower limb injuries.
- Subjects having hypermobility.
- Subjects under medications (muscle relaxants) Subjects having any open wounds.
- Subjects having any skin diseases.
- Subjects having vascular injury.
- Subjects having any metal implants in leg.
- Fracture when it has not completely healed.
- Subjects with limited movement at the joint due to presence of a bony block.
- Subjects having osteoporosis.
- Subjects having nerve injuries.
- Acute inflammation or infection.
- Acute rheumatoid arthritis within the affected joint.

Procedure

Approval from the ethical committee was obtained and then recruitment of subjects was carried out among the PESIMSR physiotherapy students. Samples who met the inclusion criteria were selected. Then they were allotted into single group and consent letter was signed.

The study was done over a 4-week period with subject receiving 1 treatment a day for 5 consecutive days. Measurement was taken at pre- treatment on 1st day and post-treatment on 4th week. The ankle range of motion of all the subjects were measured after 7 days of the last treatment session as a follow up measurement.

The tools used in the study

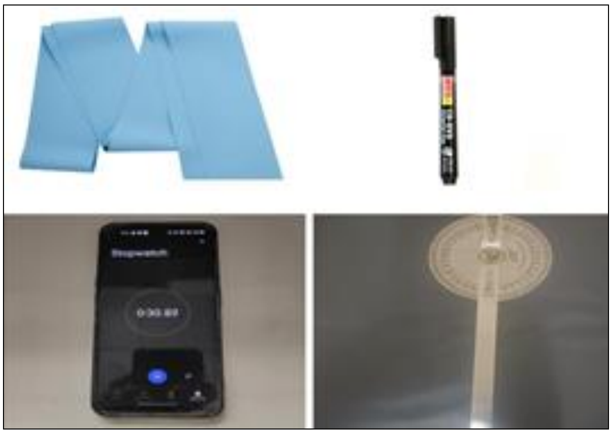


Fig 1: Theraband, marker, stopwatch, goniometer.

Pre-test

ROM was measured with a goniometer. For goniometric measurements, fibular head, lateral malleolus, the base of 5th metatarsal and the 5th metatarsal head was marked with a permanent marker. The stationary arm of the Goniometer was placed along the long axis of fibula by using the marks on the fibular head and the lateral malleolus. Moving arm of the Goniometer were placed parallel to the lateral border of the foot by using the marks on the base and head of the 5th metatarsal. The axis of the Goniometer fell on the lateral border of foot. The zero position of dorsiflexion was defined as the 90-degree angle between the long axis of the fibula and the lateral border of the foot. All the measurements were recorded as the subjects achieved maximum active dorsiflexion. To establish reliability of ROM measurements across sessions, we took pre and post treatment ROM and used their means for analysis.

Fig 2: Measuring triceps surae flexibility.

The full range of motion eccentric training for the triceps surae muscles. The subject lie supine with left leg fully extended. A 3-feet (0.91m) piece of blue theraband (50% elongation, 4.5 pounds) [26] was wrapped around the fore foot of right leg and the subject held the ends of the Thera-band in each hand. The subjects were instructed to keep the right knee flexed and ankle in neutral position. Then she was instructed to bring the ankle in dorsi flexion by pulling on the Thera-band attached to the forefoot with both arm, knee was taken towards extension. As the subject pulled the ankle in full dorsi flexion with the arms, she was instructed to simultaneously resist the ankle dorsiflexion and knee extension by eccentrically contracting the triceps surae muscle during entire range of ankle dorsi flexion. And the subject was then instructed to provide sufficient resistance with arms to overcome the eccentric activity of triceps surae muscle, so that the entire range of ankle dorsi flexion will take place approximately 5 seconds to complete. Once achieved, this position was held for 5 seconds, and then extremity was made to gently relaxed. This procedure was repeated 6 times, with no rest in between, here by providing a total of 30 seconds of stretching at the end range. And the subjects were trained for 6 repetitions in one session for 5 consecutive days in a week for a period of 4 weeks. Post-test were taken, ankle dorsiflexion was measured.

Fig 3: Eccentric training initial position

Fig 4: Final position of full knee extension

Post test: post-test was similar as pre-test.

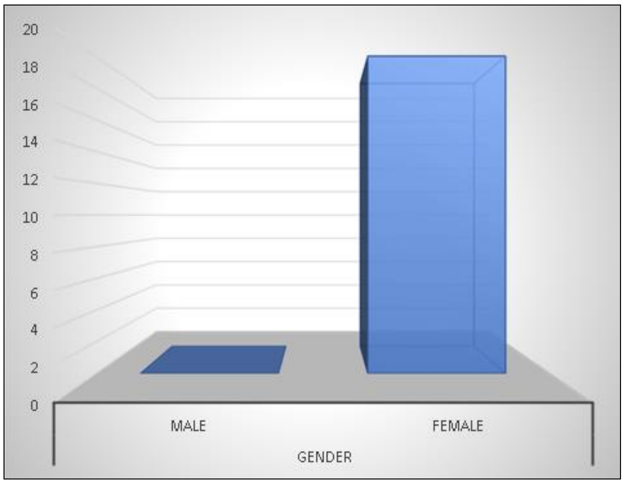
Fig 5: Measuring ankle dorsi flexion range of motion

Data analysis

Graph Pad software was used for statistical analysis to analyze and interpret the data. The paired t-test was used for intragroup analysis.

Table 1: Number of Gender

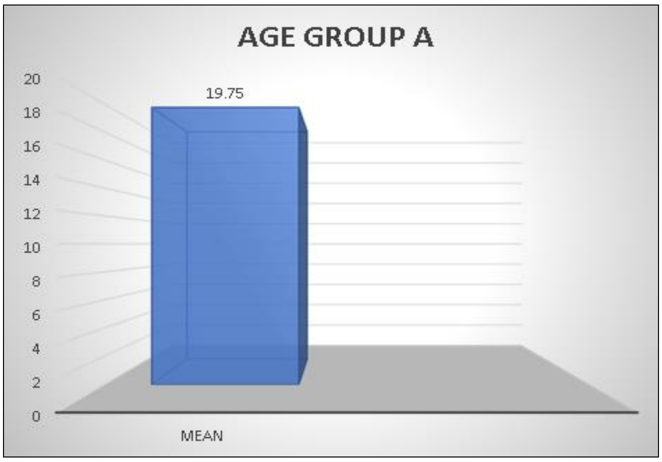
	Gender	
	Male	**Female**
Number	0	20



Graph 1: Gender (Male - Female)

Table 2: Mean Age of Group A

	Age
	Group A
Mean	19.75



Graph 2: Mean Age of Group A

Paired sample statistics

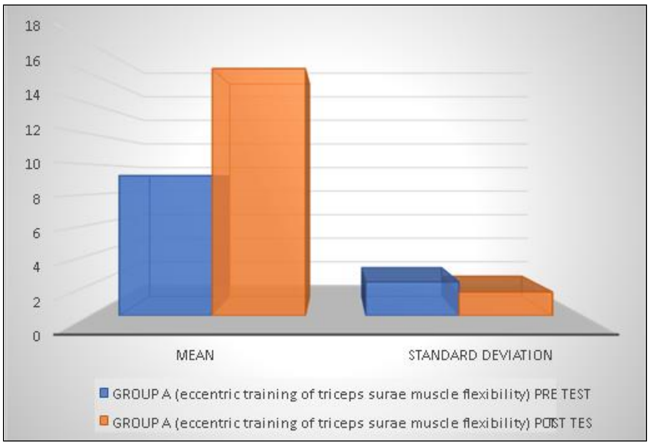
Intra Group Analysis: Group a eccentric training of triceps surae muscle.

Table 4: Group a eccentric training of triceps surae muscle

Group A Active ADFROM	Paired Differences				T	N	DF	Sig. (2 tailed)
	Mean	Standard Deviation	95% Confidence Interval of the Difference					
			Lower	Upper				
Pre-Test	9.25	2.22	-7.82	-6.28	19.25	20	19	0.0001
Post-Test	16.3	1.56						

Table 5: Mean and Standard Deviation of Group A

	Group A (Eccentric training of triceps surae muscle flexibility)	
	Pre-test	Post- test
Mean	9.25	16.30
Standard Deviation	2.22	1.56



Graph 5: Mean and standard deviation of group A

Results

The results show that intragroup analysis of Group A eccentric training of triceps surae muscle shows statistically significant difference with $p \leq 0.05$ (p=0.0001), with mean 9.25±2.22 for pre-test and 16.30±1.56 for post-test with mean difference 7.05±0.66.

Discussion

We reject the null hypothesis that there will be significant difference in triceps surae muscle flexibility by eccentric training using theraband. The group that performed eccentric training in triceps surae shows significantly greater gains in flexibility compared to pre-test and post-test.

Given the significant difference in triceps surae muscle flexibility between pretest and posttest in experimental group eccentric training appears to be more effective in increasing triceps surae muscle flexibility. In analysis, experimental group shown to be effective and improving significantly. The result supports the theory that eccentric training through a full range of motion increases muscle flexibility.

Noberga, *et al*, (2010) says that resistance training alone did not increase flexibility, but resistance training did not interface with increase in joint range of motion during flexibility training. These results support the concept that specific training should be employed to increase either muscle strength or flexibility, whereas eccentric training increases strength of the muscle and in our study, we had proved that it also increases flexibility [25].

TG Potier *et al.*, (2011) investigated whether eccentric strengthening changed the muscle architecture of human biceps femoris and consequently, knee range of motion and they found increase in FL (fascicle length) in the biceps femoris and this could lead to increase in ROM of knee [25].

In this study they concluded that based on six high-quality studies in different muscle groups, this systematic review demonstrated consistent evidence that eccentric training is an effective method of increasing lower limb flexibility, measured using either joint ROM or muscle FL in uninjured participants. Combine with evidence that eccentric training is also associated with benefits including reductions in pain, disability an injury recurrence, as well as alterations in peak torque, muscle length tension curves and athletic performance, eccentric training is an important part of lower limb rehabilitation. It remains unclear if the improvements in flexibility with eccentric training reduce the need for static stretching to increase flexibility, and whether the improvements in flexibility are similar with other exercises interventions.

Siddiqui M Aijaz, Unaise A Hameed, *et al.*, (2011) Nishat Quddus had conducted a study on a comparative study on eccentric training using Thera-band and static stretching in improving triceps surae muscle flexibility [25]. This study shows that eccentric training and static stretching both are effective in increasing, but the eccentric training is more effective and statistically significant in increasing triceps surae muscle flexibility in subjects [25].

This study is done to find the effectiveness of eccentric training of triceps surae muscle flexibility using theraband. The subjects were allotted in a single group (group A) in a group A eccentric training shows statistically significant difference in the pre-test and post-test with a mean value of 9.25±16.30 and 2.22±1.56 with p value $p \leq 0.05$ (p=0.0001).

This study shows that intra group analysis shows statistically significant of a p value of $p \leq 0.05$ (p=0.0001). Hence the eccentric training known has having the effect of improving the ankle dorsi flexion range of motion.

Hence the alternate hypothesis was accepted, and null hypothesis was rejected.

Conclusion

In this study it showed an increase in the flexibility of the triceps surae muscle, resulting in increased ADFROM, however there is significant difference in pretest and posttest measurement. This result suggests that there is further scope for the use of eccentric training for flexibility training in individual muscle groups in a more functional type of activity.

Limitation of study
- The limitation of the study was the application of eccentric training of triceps surae muscle can't be applied identically to every subject.
- Only female samples are taken.
- Small sample size.
- The age group taken was limited. Further studies can be done with different age groups.
- Measurement with goniometer needs more perfection, with inclinometer or more recent devices.
- Only UG students were included in the study.
- Only one color theraband is used.

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