



The effect of duration of stretching on calf muscle tendon for increasing range of motion in elderly

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Abstract

Background: Static stretching of the calf muscle tendon is often used as a line of treatment to increase Range of Motion and flexibility in people with shortened connective tissues. Stretching protocols for elderly people (above 65 years of age) have not been studied to determine the effectiveness of increasing range of motion for ankle dorsiflexion. The objective of this study was to determine which of 3 durations of stretches would produce the maximum gain in ankle dorsiflexion ROM in elderly population.

Subjects: Thirty subjects (mean age 69.9 years, SD 5.6, range 65–79) with tight calf muscle tendon participated. Subjects were recruited from a housing complex, hospital and those who carried out their daily activities independently.

Methods: Subjects were randomly assigned to 1 of 3 groups. The randomly selected right or left limb of subjects in group 1 (n10, mean age 69.6 years, SD 4.222), group 2 (n10, mean age 69.9 years, SD 4.306), and group 3 (n10, mean age 70 years, SD 3.682) was stretched 5 times per week for 6 weeks for 15, 30, and 60 seconds, respectively. Range of motion was measured at the end of the week for 6 weeks of the treatment.

Results: A 60-second stretch produced a greater rate of gains in ROM (60-second stretch 7.7° per week, 30-second stretch 6.1° per week, 15-second stretch 5.2° per week).

Conclusion: Longer hold times during stretching of the calf muscle tendon resulted in a maximum increase in ROM elderly population. This result may vary from those of who performed on younger individuals because of age-related physiologic changes.

Keywords: static stretching, calf muscle, rom, duration

Introduction

A muscle immobilized in a shortened position atrophies and weakens at a faster rate than if it is held in a lengthened position over time. There is a shift to the left in the length tension curve of a shortened muscle, which decreases the muscle's capacity to produce maximum tension at its normal resting length as it contracts. The increased proportion of fibrous tissue and subcutaneous fat in muscle that occurs with immobilization contributes to the decreased extensibility of the shortened muscle but may also serve to protect the weakened muscle when it stretches. Increased flexibility and ROM are the potential benefits and outcomes of stretching. A sustained end range stretch force, applied with overpressure and by manual contact or a mechanical device, elongates a shortened muscle-tendon unit and periarticular connective tissue by moving a restricted joint just past the available ROM [1].

Static stretching is well accepted as an effective form of stretching to increase flexibility and ROM. It is a commonly used method of stretching in which soft tissues are elongated just past the point of tissue resistance and then held in the lengthened position with a sustained stretch force over a period of time. The duration of static stretch is predetermined prior to stretching or is based on the patient's tolerance and response during the stretching program. In research studies the term "static stretching" has been linked to durations of a single stretch cycle ranging as few as 5 seconds to 5 minutes

per repetition when either a manual stretch or self-stretching procedure is employed. In healthy young and/or middle age adults stretch duration of 15, 30, 45 or 60 seconds or 2 minutes to lower extremity musculature produced significant gains in ROM [1]. But the same duration is effective in elderly population is not yet known. Achilles tendon stretching exercises are consistently reported to be one of the more effective nonsurgical modalities.

Clinicians have reported that, even in healthy individuals, the loss of ankle dorsiflexion range of motion may lead to compensatory hindfoot pronation with subsequent anterior knee joint pain due to altered patellofemoral tracking [2]. Clinicians have also stated that loss of Ankle Dorsiflexion Range of Motion may lead to greater stress concentrations and pain in the knee, hip [9] and low back [10]. Calf muscle stretches are commonly prescribed to increase ankle dorsiflexion and reduce the symptoms of Plantar Fasciitis and Achilles tendonitis [5].

For our study, a "long-duration" stretch was defined as a stretch of greater than 30 seconds' duration for one repetition, and a "low-intensity" stretch was defined as a stretch based on each subject's perception of the onset of discomfort in the back of the lower leg.

The common use of terms "decreased flexibility" or "increased stiffness" in association with reduce in ankle dorsiflexion ROM shows implies that Calf muscle tendon unit may get stiffer with aging [3, 12, 13]. To our knowledge, the

effect of duration of stretching on calf muscle tendon to increase ankle dorsiflexion has not been performed. We therefore conducted a systematic study to find the suitable duration of static calf muscle stretching that increases ankle dorsiflexion significantly.

Materials and Method

The study was approved by the Institutional Ethical Committee at Tilak Maharashtra Vidyapeeth, Pune. Subjects recruited for this study were independently living in a retirement housing complex and were informed of the purpose of the study. Of the 35 subjects who volunteered for the study, 30 subjects (mean age 69.9 years, SD 2.23, range 65–79) qualified by not having any hip or knee replacements or any history of pathology in the low back, hips, or knees for the 3 months prior to the study. Subjects voluntarily participated and signed an informed consent form approved by Tilak Maharashtra Vidyapeeth, Pune.

To further qualify for the study, subjects had to demonstrate “tight” calf muscle tendon, defined as inability to dorsiflex the ankle joint while the person was positioned supine. Subjects were asked to maintain their level of activity throughout the study. Thirty subjects (10 male, 20 female) completed the treatment portion of the study.

A double-arm (30.5-cm [12-in]) clear plastic goniometer was used to measure ankle dorsiflexion ROM. Prior to data collection, we performed a pilot study to establish intratester reliability of measurements of ankle dorsiflexion ROM. An ICC of .96 was considered appropriate to continue the study. Choice of which lower extremity to use for the stretching protocols was determined by the toss of a coin for each subject; tails represented the right lower extremity, and heads represented the left lower extremity. Each subject was then measured for ankle dorsiflexion ROM on both lower extremities. To increase dorsiflexion of the ankle with the knee extended.

The subjects were randomly divided in 3 groups.

- Group 1 received passive static stretch that will be sustained for 15 seconds.
- Group 2 received passive static stretch that will be sustained for 30 seconds.
- Group 3 received passive static stretch that will be sustained for 60 seconds.

Hand placement and procedure

Grasp the patient’s heel with one hand, maintain the subtalar joint in a neutral position, and place your forearm along the plantar surface of the foot. Stabilize the anterior aspect of the tibia with your other hand. Dorsiflex the talocrural joint of the ankle by pulling the calcaneus in an inferior direction with your thumb and fingers while gently applying pressure in a superior direction just proximal to the heads of the metatarsals with your forearm.

Subjects in group 1, 2 and 3 received a total of 4 stretches for their designated time period, with a 10-second rest between each stretch. Stretching was given 5 days per week for a total of 6 weeks. At the end of every week all those whose muscle was stretched were evaluated for ROM.

All subjects were measured on the different day as per the therapist’s convenience and at the same time each week,

before they had stretching for that day. Measurements were taken on the stretched lower extremity once a week for 6 weeks during the treatment period.

If a subject missed a scheduled session, he or she made up the session on another day during the same week this occurred a total of 10 times throughout the stretching period of 6 weeks. Prior to treatment, the researchers decided that if any subject missed more than 4 days without stretching, the subject would be eliminated from the study. No subject missed more than 3 “stretch days” throughout the 6-week treatment program.

Result

30 individuals with calf muscle tendon tightness were invited to participate in this study, and demographic and clinical data were collected from 28 patients.

Table 1: Age Classification

	Group I	Group II	Group III
Age	69.6	69.9	70

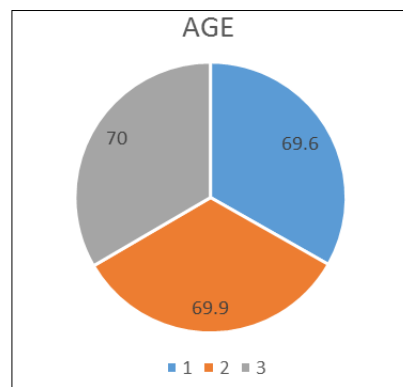


Fig 1

Interpretation

This result shows that the mean age of Group 1 is 69.6 with SD ±4.22

Group 2 is 69.9 with SD ± 4.30

Group 3 is 70 with SD ± 3.68.

Table 2: ROM of Group I week-wise (15 sec)

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	SD
ROM (mean)	13.8	14	15.3	16	17.7	18.4	1.891

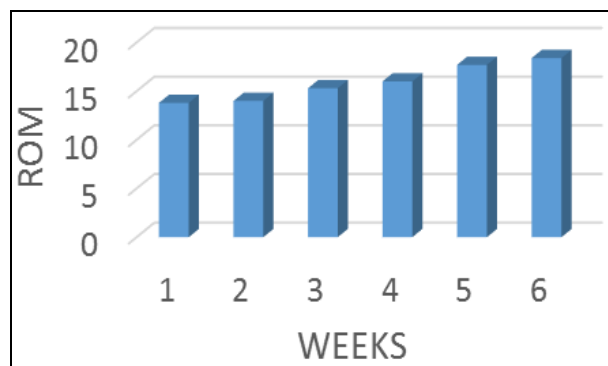


Fig 2

Interpretation

Above mentioned are the mean of ROM for Group I with SD ± 1.891 .

Table 3: ROM of Group II week-wise (30 Secs)

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	SD
ROM (mean)	13.1	14	15.2	16.4	17.6	19	2.22

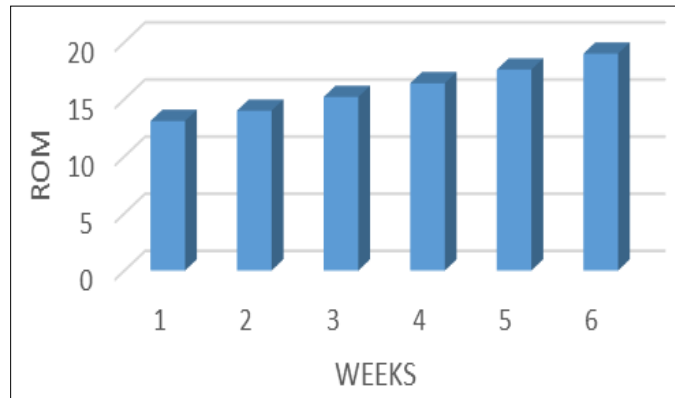


Fig 3

Interpretation

Above mentioned are the mean of ROM for Group II with SD ± 2.22

Table 4: ROM of Group III week-wise (60 secs)

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	SD
ROM (mean)	13.1	14.7	16.3	17.7	19	19.8	2.56

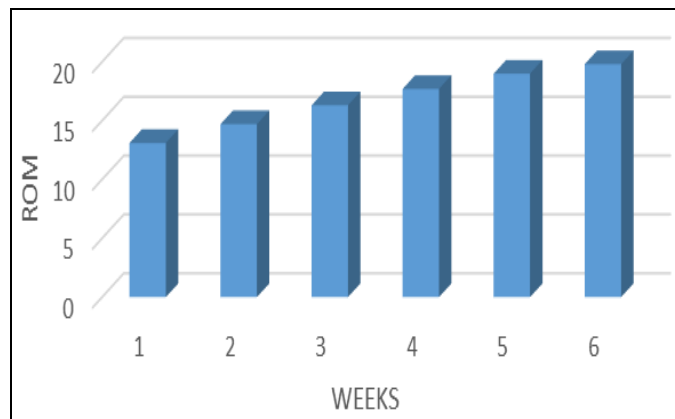


Fig 4

Interpretation

Above mentioned are the mean of ROM for Group III with a SD ± 2.56 .

Table 5: ROM progression of all the three groups:

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
15 seconds	13.8	14	15.3	16	17.7	18.4
30 seconds	13.1	14	15.2	16.4	17.6	19
60 seconds	13.1	14.7	16.3	17.7	19	19.8

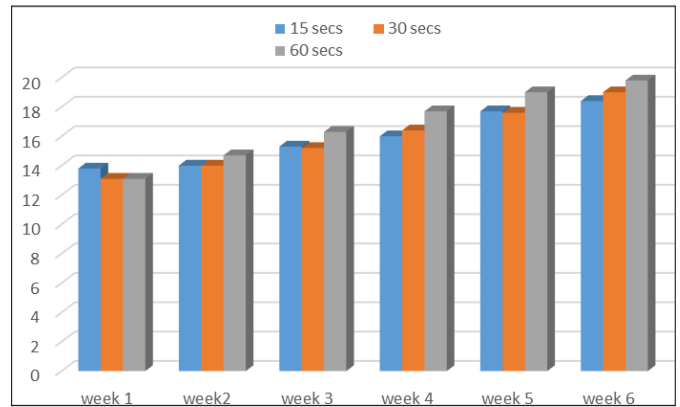


Fig 5

Interpretation

Above graph tabulates mean ROM every week for all 3 groups.

Table 6: Comparison of mean ROM pre and post stretching

	Pre stretching	Post stretching	MD	P value
Group I	13.2	18.4	5.2	
Group II	12.9	19	6.1	0.0086
Group III	12.9	19.8	7.7	

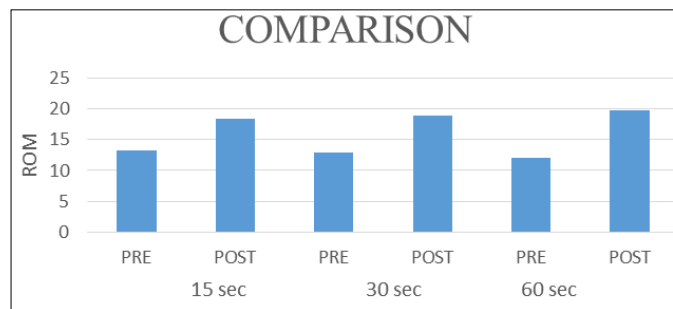


Fig 6

Interpretation

The average gain in ROM of Ankle DF was 5.2⁰ for the 15-second duration stretch group, 6.1⁰ for the 30-second and 7.7⁰ for the 60 second group.

Discussion

The results indicated that a 60-second stretch was more effective in increasing ankle dorsiflexion ROM than a 15-or 30-second stretch within this elderly group.

Statistical analysis stated that there was a significant change observed in the ROM post stretching in Group III (60 sec). For group III, the Mean of Pre ROM was 12.1 and Post ROM was 19.8 mean difference was calculated as 7.7. Repeated measures ANOVA was used to analyze the data with p Value-0.0086, which is very significant. There are studies that reported no difference between stretching once or repeating the stretch 3 times using either a 30- or 60-second static stretch.

Understanding that a longer-duration stretch will improve ROM in elderly people is particularly important, in our opinion, because joint mobility declines with increasing age.

Research has shown a decline in both active and passive ROM of lower-limb joints from 70 to 92 years of age, with a more pronounced decline during the ninth decade.

There are various studies that have examined skeletal muscle adaptations in animal models as a result of immobilization in the shortened position have shown relationship between disuse muscle atrophy and reduction in muscle length. Accordingly, the calf muscle tendon unit shortens during aging along with the loss of motor units and muscle mass^[3].

In our study, all stretches were repeated 4 times with a 10-second rest between stretches. We used repeated stretches because a study suggested that maximal muscle-tendon unit elongation occurs after approximately 4 stretches, and additional stretches (i.e, up to 10 stretches) resulted in little further improvement. We believe that this cyclic stretching technique may be even more beneficial for elderly people due to the physiological changes of increased muscle stiffness and collagen deposition that occur with aging^[4].

There are studies which chose the wall calf stretch method contradicting our line of treatment. We chose Static stretching because in this technique soft tissues are elongated just past the point of tissue resistance and then held in the lengthened position with a sustained stretch force over a period of time. Furthermore, during static stretching it is thought that the golgi tendon organ, which monitors tension created by stretch of a muscle-tendon unit, may contribute to muscle elongation by overriding any facilitative impulses from the primary afferents of the muscle spindle and may contribute to muscle relaxation by inhibiting tension in the contractile units of the muscle being stretched^[1].

Understanding that a longer duration stretch will improve ROM in elderly people is particularly important, in our opinion, because joint mobility declines with increasing age. A research has shown decline in both active and passive ROM of lower-limb joints from 70 to 92 years of age. Older muscles are more susceptible to contraction-induced injury, especially when the muscle is lengthened during the contraction, and have a diminished ability to recover from acute or repetitive musculoskeletal trauma. This reduced capacity for healing, combined with a higher predisposition for injury, is why we believed that the static stretching technique may be more suitable than any other techniques for elderly people^[4].

The 60-second duration may have been more beneficial than the 15 or 30 sec durations in overcoming the increased muscle stiffness and collagen deposition that also accompany the aging process^[5]. A study done by J Brent Feland showed that a 60-second stretch produced a greater rate of gains in ROM, 4 weeks after treatment. As this was done for 4 weeks and our study was conducted for 6 weeks, which is longer duration, we can state that it definitely gives us better results and help get a specific best duration for stretching^[5].

Conclusion

We demonstrated that 60-second stretching, repeated 4 times, five times per week for 6 weeks, can yield greater rate of improvement in Ankle dorsiflexion ROM than similar regimens of 15- or 30-second stretches in elderly population. In order to maintain ROM post stretching sessions, stretching must be continued.

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