Journal of Athletic Training 2008;43(2):172–178

www.nata.org/jat

original research

Subtalar Joint Position During Gastrocnemius Stretching and Ankle Dorsiflexion Range of Motion

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Context: Gastrocnemius stretching exercises often are prescribed as part of the treatment program for patients with overuse injuries associated with limited ankle dorsiflexion. However, little is known about how the position of the subtalar joint during gastrocnemius stretching affects ankle dorsiflexion range of motion (ROM).

Objective: To determine the effect of subtalar joint position during gastrocnemius stretching on ankle dorsiflexion ROM.

Design: This study was a 3-way mixed-model design. The 3 factors were subtalar joint position (supinated, pronated), lower extremity (experimental, control), and time (pretest, posttest). Lower extremity and time were the repeated measures.

Setting: University research laboratory.

Patients or Other Participants: Thirty-three healthy volunteers (29 women, 4 men).

Intervention(s): Participants performed a gastrocnemius stretching exercise 2 times daily for 3 weeks with the subtalar joint of the randomly assigned experimental side (dominant or nondominant) in the randomly assigned position (supination or pronation). The contralateral lower extremity served as the control.

Main Outcome Measure(s): Before and after the 3-week gastrocnemius stretching program, we used goniometers to measure ankle dorsiflexion ROM in weight-bearing and non–weight-bearing positions with the subtalar joint positioned in anatomic 0°.

Results: Ankle dorsiflexion ROM measured in weight-bearing and non–weight-bearing positions increased after the gastrocnemius stretching program ($P = .034$ and $.003$, respectively), but the increase in ROM did not differ based on subtalar joint position ($P = .775$ and $.831$, respectively).

Conclusions: Subtalar joint position did not appear to influence gains in ankle dorsiflexion ROM after a gastrocnemius stretching program in healthy volunteers.

Key Words: subtalar joint pronation, subtalar joint supination

Key Points

- Gastrocnemius stretching increased ankle dorsiflexion range of motion with the subtalar joint positioned in pronation or supination.
- The increase in range of ankle dorsiflexion was not different between participants who performed gastrocnemius stretching with the subtalar joint positioned in supination and those who stretched with the joint positioned in pronation.

Limited ankle joint dorsiflexion has been associated with many overuse injuries of the lower extremity, including plantar fasciitis,[1–3] Achilles tendinopathy,[3–6] shin splints,[7,8] iliotibial band syndrome,[8] and patellofemoral pain syndrome.[9] Gastrocnemius muscle tightness limits ankle joint dorsiflexion when the knee is in an extended position.[10] Maximal dorsiflexion during the stance phase of gait occurs just before heel-off when the knee is normally close to full extension,[11,12] so tightness of the gastrocnemius muscle may prevent normal advancement of the tibia relative to the foot during midstance.[12,13] Therefore, when clinicians determine that the gastrocnemius muscle is tight, they often prescribe gastrocnemius stretching exercises with the goal of increasing dorsiflexion at the talocrural joint to prevent or treat overuse injuries of the lower extremity.[1,10,14,15]

When the subtalar joint is pronated during weight-bearing activities, dorsiflexion can occur at the subtalar and midtarsal joints and at the talocrural joint, so increased subtalar pronation before heel-off can compensate for limited dorsiflexion at the talocrural joint.[1,16–19] Therefore, when clinicians measure ankle joint dorsiflexion or prescribe gastrocnemius stretching exercises to increase ankle joint dorsiflexion, they often advocate maintaining the subtalar joint in a neutral or supinated position to direct the force to the talocrural joint rather than to the subtalar and midtarsal joints.[15,17–21]

Some investigators[19,21] have suggested that the position of the subtalar joint influences goniometric measurements of ankle joint dorsiflexion, but little evidence has demonstrated the effect of subtalar position during gastrocnemius stretching on gains in ankle dorsiflexion range of motion (ROM). Worrell et al[22] reported no differences in dorsiflexion ROM within 19 asymptomatic participants who stretched the gastrocnemius muscle of one lower extremity with the subtalar joint positioned in supination and stretched the contralateral gastrocnemius muscle with the subtalar joint positioned in pronation. They measured ankle joint dorsiflexion in a weight-bearing position and used foot templates and a scale to ensure consistency of foot position and passive force during the stretch. However, specific control of subtalar joint position during the measurement of ankle dorsiflexion was not reported.[22] Maintaining the subtalar joint in anatomic 0° (that is, positioned in neither varus nor valgus) is one method of controlling subtalar joint position. The purpose of our study was to ascertain the effect of subtalar joint position during a gastrocnemius stretching program on ankle joint dorsiflexion ROM measured with the subtalar joint positioned in anatomic 0°.

METHODS

We used a 3-way mixed-model design. The 3 independent variables were subtalar joint position (supinated, pronated), lower extremity (experimental, control), and time (pretest, posttest). Lower extremity and time were the repeated measures. The dependent variables in this randomized trial were passive ankle dorsiflexion ROM measured in the non–weight-bearing position and passive ankle dorsiflexion measured in the weight-bearing position.

Participants

We used convenience sampling to enroll 33 participants (29 women, 4 men, age = 24.5 ± 2.1 years, height = 166.5 ± 6.4 cm, mass = 59.3 ± 9.2 kg, standing rearfoot angle = 8.6° ± 4.3° valgus) from metropolitan Atlanta, GA. Eligibility criteria for inclusion in the study were (1) from 5° through 12° of passive ankle dorsiflexion ROM bilaterally when measured with the knee extended in a non–weight-bearing position; (2) bilaterally, no less than 5° of subtalar joint eversion passive ROM relative to anatomic 0°; (3) bilateral absence of knee flexion contracture; (4) age from 18 through 55 years; (5) no history of neurologic dysfunction or disease, systemic disease affecting the lower extremities or ambulation, macrotrauma involving bone or nerve injury to the lower extremity, or musculoskeletal soft tissue injury to the lower extremity within 6 months of participation in the study; and (6) less than 2 cm of anatomic leg-length discrepancy. Activity levels of participants were assessed but were not used as eligibility criteria.

The passive ankle joint dorsiflexion eligibility criterion of 5° to 12° was based on evidence that 4° to 10° is normal during the stance phase of ambulation.[11,23–25] Thus, participants would exhibit the amount of dorsiflexion considered normal during gait but would not exhibit substantially more degrees than that, preventing a potential ceiling effect of a gastrocnemius stretching program (including potential limitation of dorsiflexion due to capsular or bony structures).

We used an a priori power analysis to determine the sample size for the study. Based on an α level of .05 and an effect size of 0.53 (rounded to 0.50), we projected that a sample of 33 participants would obtain a power level of .79 for ankle dorsiflexion ROM.[26] The effect size was based on pilot measurements and significant findings from a similar study by Worrell et al.[22] The institutional review board of Emory University approved this study, and each volunteer signed an informed consent form before beginning the study.

Instrumentation

One standard 8-in (20.32-cm) plastic goniometer (Benchmark Medical, Inc, Malvern, PA) was used to measure subtalar joint eversion, and 1 standard 12-in (30.48-cm) plastic goniometer (QualCraft; AliMed, Inc, Dedham, MA) was used to measure knee extension passive ROM. Two standard 8-in (20.32-cm) plastic goniometers (Benchmark Medical, Inc) were used to measure non–weight-bearing and weight-bearing ankle dorsiflexion. Weight-bearing ankle dorsiflexion passive ROM was measured using a platform equipped with an imbedded floor scale and covered with a clear plastic grid (Figure 1).

Figure 1. Measurement of ankle dorsiflexion in weight-bearing position with the subtalar joint positioned in anatomic 0°.

Procedures

All measurements were performed 3 times, and the average was recorded. Subtalar joint eversion was measured with the participant positioned prone as described by Smith-Oricchio and Harris.[27] The axis of the goniometer was placed over a line bisecting the posterior calf, and the movable arm was placed over a line bisecting the posterior calcaneus. The calcaneus was everted passively to obtain subtalar joint eversion ROM. We used standard goniometric procedures[28] to measure knee extension passive ROM with the participant positioned supine. A rolled towel was placed under the volunteer's heel to enable the lower extremity to relax into maximal knee extension passive ROM. Anatomic leg length (centimeters) was measured with a tape measure from the anterior-superior iliac spine to the ipsilateral inferior border of the lateral malleolus while the participant lay supine on the plinth.[29]

Each participant's dominant or nondominant lower extremity was selected randomly for a gastrocnemius stretching program, and the contralateral lower extremity served as the control. Leg dominance was determined by having the participant kick a stationary ball 3 times. The leg used to kick the ball at least 2 times was considered the dominant leg. The subtalar joint position during gastrocnemius stretching of the participant's experimental lower extremity was assigned randomly to pronation or supination. The order of variables measured was assigned randomly to the experimental or control lower extremity and then to order of measurement of the 2 ankle dorsiflexion dependent variables. For a randomly selected group comprising 25% of the volunteers, a second investigator also measured ankle dorsiflexion in weight-bearing and non–weight-bearing positions, knee extension passive ROM during the weight-bearing ankle joint measurement, and subtalar eversion ROM to assess interrater reliability of these measurements.

Passive ankle dorsiflexion was measured in degrees in both non–weight-bearing and weight-bearing positions. We located the fibular heads and greater trochanters and marked them with a skin pencil. The mark on the greater trochanter was used when measuring the knee position during the weight-bearing dorsiflexion measurement. Calipers were used to locate the midpoints at 2 locations on the posterior aspect of each calf and calcaneus. These marks were connected to form a line on each calf and calcaneus. All ankle dorsiflexion measurements were taken with the subtalar joint positioned in anatomic 0°. Anatomic 0° is the position in which the angle formed by the lines drawn on the midlines of the calf and calcaneus (rearfoot angle) equals 0° on a goniometer.

Non–weight-bearing passive ankle dorsiflexion was measured with the volunteer lying prone, the knee extended, and the foot positioned beyond the edge of the plinth (Figure 2). One investigator positioned the participant's subtalar joint in anatomic 0°, using a goniometer to verify a rearfoot angle of 0°. While the anatomic 0° position was maintained, a second investigator measured the range of passive ankle dorsiflexion by aligning the stationary arm of the goniometer with the fibular head and the moving arm of the goniometer with the lateral aspect of the fifth metatarsal and by placing the axis of the goniometer over the lateral aspect of the calcaneus.

To measure ankle dorsiflexion in the weight-bearing position, we directed the participant to stand on a platform and place the foot of the extremity being measured on a scale imbedded in the platform (Figure 1). The platform was constructed to provide a level surface for measuring weight-bearing dorsiflexion, and the scale was used to monitor the amount of weight-bearing force used to dorsiflex the ankle. The amount of weight-bearing force applied was maintained at 50% of the participant's mass during both pretest and posttest measurements. In the pilot study, several volunteers reported pain under the fifth metatarsal head when applying more than 50% of their mass while stretching in bare feet with the subtalar joint in supination. Similar pain also was reported in a previous study when participants stretched in bare feet while weight bearing.[22] A plastic grid taped to the platform was used to control the position of both feet during pretest and posttest measurements by bilaterally marking the coordinate locations of the midline of the posterior aspect of the participant's calcaneus and first and fifth metatarsal heads (Figure 2). During weight-bearing dorsiflexion measurements, 2 investigators aligned goniometers as described for the non–weight-bearing dorsiflexion measurement to ensure subtalar joint anatomic 0° and to measure ankle dorsiflexion (Figure 1). While measuring dorsiflexion, the second investigator also monitored the force applied through the scale as the participant leaned toward the wall until reporting a strong stretch in the posterior calf. The second investigator then measured the volunteer's knee joint position on the posterior leg. The degree of knee joint extension during the measurement of weight-bearing ankle dorsiflexion was held constant during pretest and posttest measurements.

After measuring ankle dorsiflexion in the weight-bearing position on the experimental side, we constructed a stretching template by tracing the participant's experimental foot onto the plastic grid covering the platform and by retracing the footprint onto a template. The template consisted of a 4-ft × 2-ft (120-cm × 60-cm) piece of clear, plastic sheeting with nonskid backing taped to the underside (Figure 3).

Figure 2. Measurement of ankle dorsiflexion in non–weight-bearing position with the subtalar joint positioned in anatomic 0°.

Next, the participant was instructed in a standard gastrocnemius stretching exercise in the weight-bearing position, and the template was used to control the position of the experimental foot and the position of the subtalar joint. Shading on the forefoot and midfoot areas of the

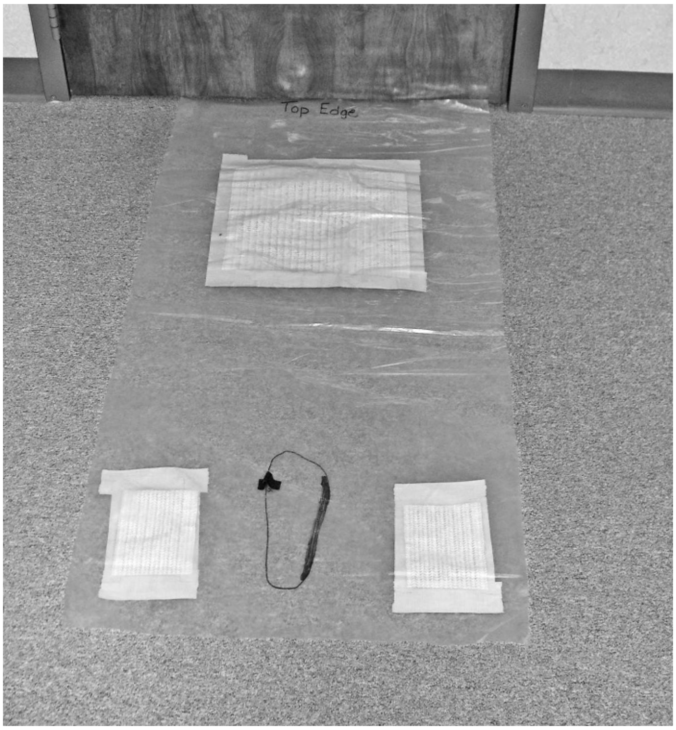

Figure 3. Sample template with foot placement outlined and visual and tactile cues for gastrocnemius stretching with the subtalar joint positioned in supination. Participants were instructed to avoid forefoot contact with the tactile cue and to shift weight bearing toward the visual cue.

template served as a visual cue to indicate weight bearing on the medial or lateral border of the foot for a position of subtalar joint pronation or supination, respectively. Hook-and-loop tape that was approximately 1-in (2.54-cm) long was placed on the template opposite the shaded area (under the first or fifth metatarsal head) and served as a tactile cue to avoid weight bearing on the medial or lateral side of the forefoot while keeping the heel in contact with the ground. For example, a participant who was selected randomly to perform gastrocnemius stretching with the subtalar joint positioned in supination would have red shading on the lateral surface of the foot tracing and hook-and-loop tape on the tracing where the first metatarsal head would be positioned. Before instruction in the gastrocnemius stretching exercise, the template was placed on the floor with its top edge flush against the wall.

The participant was instructed to perform the gastrocnemius stretching exercise using the template to position the experimental foot and placing the control foot in a self-selected position anterior to the experimental foot. The volunteer leaned toward the wall until reporting a stretching sensation in the posterior calf. If a participant was assigned randomly to stretch with the subtalar joint positioned in pronation, he or she was instructed to shift weight to the medial aspect of the experimental foot, applying weight through the first metatarsal (onto the shaded area), and to avoid weight bearing under the fifth metatarsal by avoiding contact with the hook-and-loop tape. If a participant was assigned randomly to stretch with the subtalar joint positioned in supination, he or she was instructed to shift weight to the lateral aspect of the experimental foot, applying weight through the fifth metatarsal (onto the shaded area), and to avoid weight bearing under the first metatarsal by avoiding contact with the hook-and-loop tape.

The volunteer was instructed to hold the stretch for 30 seconds and repeat it 4 times (total of 5 repetitions) with a 10-second rest period between repetitions. The participant received instruction until the investigators observed that he or she independently performed the stretch correctly. The participants were instructed to perform the stretching exercises twice daily, with at least 4 hours between sessions, for a total of ten 30-second stretches per day for 3 weeks. The number of stretches, the length of time that each stretch was held, the frequency of the stretching, and the duration of the stretching program were chosen based on previous research on stretching of the gastrocnemius and hamstring muscle groups.[22,30]

Participants were given a stretching log to take home and were instructed to document each session of stretching exercises that they performed and at what time each was performed. They also were given the template to take home. We followed up by telephone during each week of the home program to answer any questions and to monitor compliance.

The participants returned 3 weeks later. The stretching logs and templates were collected during the second measurement session. The stretching logs were used to monitor compliance with the home program. Compliance was defined as completing at least 30 of 42 stretching sessions and not missing more than 2 consecutive days of stretching.[31] Participants' activity levels were reassessed to confirm that activities other than the gastrocnemius stretching had not changed. Non–weight-bearing ankle dorsiflexion with the knee extended and weight-bearing ankle dorsiflexion were measured, as described. Weight-bearing ankle dorsiflexion was measured using the foot placement coordinates and the same knee position angle recorded during the pretest session. After taking these measurements, we dismissed the participants.

Data Analysis

We analyzed the data using Minitab (version 14; Minitab Inc, State College, PA). Ankle dorsiflexion passive ROM measured in the weight-bearing and non–weight-bearing positions were summarized using means, SDs, and 95% confidence intervals of the means. We used the Shapiro-Wilks test and Bartlett test to ensure normality of distribution and homogeneity of variance, respectively, for the 2 ankle dorsiflexion measurements. Intrarater and interrater reliability were assessed with intraclass correlation coefficients (ICCs).

Ankle dorsiflexion ROM in the weight-bearing and non–weight-bearing positions were compared among subtalar joint position during stretch (supination, pronation), pretest and posttest measurements, and experimental and control lower extremities using a 3-way mixed-model analysis of variance. Post hoc pairwise comparisons were performed using the Tukey honestly significant difference test for significant interactions. The α level for all statistical analyses was set at .05.

RESULTS

Descriptive statistics for ankle dorsiflexion in the weight-bearing and non–weight-bearing positions at pretest and posttest for the experimental and control lower extremities are presented in Table 1. The ICCs and standard error of measurement are presented in Table 2. Knee extension angle during the weight-bearing dorsiflexion measurement resulted in lower interrater ICC values because of low variability among participants and the small range (within 4°) among measurement values.

Ankle dorsiflexion measured in the non–weight-bearing position showed an interaction between lower extremity and time ($F_{1,31} = 5.95$, $P = .016$) and main effects for lower extremity ($F_{1,31} = 6.92$, $P = .010$) and time ($F_{1,31} = 77.96$, $P < .001$). No main effect was noted for subtalar joint position ($F_{1,31} = 0.05$, $P = .831$). Post hoc pairwise comparisons of the lower extremity-by-time interaction showed no difference in ankle dorsiflexion between the lower extremities (control versus experimental side) at the pretest ($t_{31} = 0.14$, $P > .999$) but showed more dorsiflexion on the experimental side than on the control side at the posttest ($t_{31} = 3.59$, $P = .003$). Both the control and the experimental lower extremities showed more dorsiflexion at the posttest than at the pretest ($t_{31} = 4.52$, $P < .001$, and $t_{31} = 8.10$, $P < .001$, respectively). The mean difference between the pretest and posttest measurements for the control side was 0.6°, and the effect size was 0.07. The mean difference between the pretest and posttest measurements for the experimental side was 3.1°, and the effect size was 0.26.

For ankle dorsiflexion measured in the weight-bearing position, ankle dorsiflexion was greater at the posttest than at the pretest ($F_{1,31} = 4.59$, $P = .034$). However, it was not

Table 1. Ankle Dorsiflexion Range-of-Motion Values of Control and Experimental Lower Extremities

	Ankle Dorsiflexion (°)					
	Pretest			Posttest		
Variable	Mean	SD	95% CI	Mean	SD	95% CI
Non–weight-bearing position						
Pronation group						
Control	8.4	2.8	7.0, 9.7	11.7	4.3	9.5, 13.8
Experimental	8.6	2.2	7.5, 9.7	14.8	2.8	13.4, 16.2
Supination group						
Control	8.3	1.8	7.2, 9.3	12.3	3.5	10.4, 14.3
Experimental	8.2	2.8	6.7, 9.8	15.0	5.1	12.2, 17.9
All participants						
Control	8.3	2.4	7.5, 9.1	12.0	3.9	10.6, 13.4
Experimental	8.4	2.5	7.5, 9.3	14.9	3.9	13.5, 16.3
Weight-bearing position						
Pronation group						
Control	31.4	4.3	29.3, 33.6	32.2	5.5	29.4, 34.9
Experimental	31.3	5.0	28.8, 33.7	35.1	5.4	32.4, 37.8
Supination group						
Control	32.7	5.6	29.6, 35.8	33.2	6.5	29.6, 36.8
Experimental	31.9	5.2	29.1, 34.8	34.2	5.9	31.0, 37.5
All participants						
Control	32.0	4.9	30.3, 33.8	32.6	5.9	30.6, 34.7
Experimental	31.6	5.0	29.8, 33.3	34.7	5.5	32.8, 36.7

Abbreviation: CI, confidence interval.

different between the subtalar joint positions (supinated or pronated) during the stretch ($F_{1,31} = 0.08$, $P = .775$) and was not different in the experimental lower extremity versus the control lower extremity ($F_{1,31} = 1.05$, $P = .308$). The mean difference between the pretest and posttest measurements for the control side was 3.7°, and the effect size was 0.23. The mean difference between the pretest and posttest measurements for the experimental side was 6.5°, and the effect size was 0.73.

DISCUSSION

We found that gastrocnemius stretching with the subtalar joint positioned in either pronation or supination increased ankle dorsiflexion ROM. This finding concurs with the findings of Worrell et al,[22] who reported increases in ankle dorsiflexion after gastrocnemius stretching with the subtalar joint positioned in either supination or pronation. In our study, the mean increase in dorsiflexion measured in the weight-

Table 2. Intrarater and Interrater Reliability of Goniometric Measurements

Variable, °	Intrarater Intraclass Correlation Coefficients (3,k)	Intrarater Standard Error of Measurement, °	Interrater Intraclass Correlation Coefficients (2,k)	Interrater Standard Error of Measurement, °
Ankle dorsiflexion				
Non–weight bearing				
Control	.97	0.85	.92	1.13
Experimental	.96	0.70	.91	1.04
Weight bearing				
Control	.99	0.88	.98	2.12
Experimental	.99	0.87	.98	1.54
Knee extension angle during weight-bearing ankle dorsiflexion measurement				
Control	NA	NA	.59	0.15
Experimental	NA	NA	.77	0.26
Subtalar eversion				
Control	.96	0.50	.78	0.43
Experimental	.93	0.47	.84	0.74
Passive knee extension				
Control	.99	0.15		
Experimental	.99	0.15		

Abbreviation: NA, not applicable.

bearing position was 3.1° compared with the 2.2° that Worrell et al[22] reported. The slightly larger increase in dorsiflexion in our study may have been due to the greater total amount of stretching, because our participants stretched at least 75 minutes for 3 weeks compared with those who stretched 13 minutes for 2 weeks in the Worrell et al[22] study. Alternatively, the slightly larger increase in our study may have been due to selection of volunteers with no more than 12° of dorsiflexion, which may have prevented a ceiling effect for gains in ROM in some. Worrell et al[22] had no eligibility criteria related to dorsiflexion ROM, and their pretest measures of dorsiflexion in the weight-bearing position were higher (average = 35°) than in our investigation (average = 32°).

In our study, participants who performed gastrocnemius stretching with the subtalar joint positioned in supination showed no more increase in ankle dorsiflexion than those who stretched in pronation. We measured weight-bearing and non–weight-bearing ankle dorsiflexion with the subtalar joint positioned in anatomic 0°. Theoretically, measuring dorsiflexion with the subtalar joint positioned in anatomic 0° prevents pronation at the subtalar joint and, therefore, dorsiflexion at the subtalar or midtarsal joints.[1,16–19] However, goniometric measurements do not enable specific differentiation of dorsiflexion to occur at the talocrural, subtalar, and midtarsal joints. Stretching the gastrocnemius with the subtalar joint in neutral or supination may not ensure that the increase in dorsiflexion occurs only at the talocrural joint. Bohannon et al[21] reported a slight decrease (2.7°) in passive non–weight-bearing ankle dorsiflexion when they aligned the stationary arm of the goniometer with the calcaneus rather than with the fifth metatarsal. Thus, although these investigators positioned the subtalar joint in neutral, some of the dorsiflexion appeared to occur at a joint or joints distal to the talocrural joint. We positioned the subtalar joint in anatomic 0° instead of neutral because the determination of the subtalar neutral position has been associated with low intrarater and interrater reliability[32,33] and with poor validity.[34] However, the average subtalar joint neutral position in healthy volunteers is between 1° and 2° of varus,[27,29] so positioning the subtalar joint in anatomic 0° is likely to place the subtalar joint 1° to 2° more toward pronation than subtalar neutral. The participants who stretched with the subtalar joint positioned in supination possibly gained more ROM at the talocrural joint than those who stretched with the subtalar joint positioned in pronation, but the gains in overall dorsiflexion were no different. In addition, when measuring ankle dorsiflexion ROM, the clinician may need to position the subtalar joint fully at end range of supination to prevent dorsiflexion at the subtalar and midtarsal joints.

The mechanism underlying an increase in joint ROM resulting from stretching also may explain the results of our study. In animal studies, investigators have demonstrated that chronic or prolonged stretching clearly changed both the contractile[35,36] and passive[37] elements of skeletal muscle, but similar changes after static stretching in human muscle have not been demonstrated.[38] In contrast, researchers[39–41] have shown that static stretching of the human hamstrings muscle increased joint ROM without a concomitant decrease in stiffness or electromyographic activity of the stretched hamstrings muscle. These findings suggest that a central, rather than a peripheral, mechanism causes the increase in joint ROM after static stretching, and increased tolerance to stretching is the proposed central mechanism.[38–41] If an increased tolerance to stretching resulted in increased range of ankle dorsiflexion in our volunteers, joint positioning may not have been as relevant as it would have been if mechanical changes occurred within the contractile or passive elements of the gastrocnemius muscle.

Interestingly, in our study, ankle dorsiflexion measured in the non–weight-bearing position increased in the control lower extremity and in the experimental lower extremity. This increase may have resulted from increased stretch tolerance through a central effect, as discussed. Alternatively, this increase may have resulted from the position of the participant's control lower extremity during stretching, whereby the control ankle did stretch into dorsiflexion although the knee was in flexion. Thus, the increase in dorsiflexion ROM in the control lower extremity may have resulted from an increase in Achilles tendon extensibility. Additionally, although dorsiflexion measured both in the weight-bearing and non–weight-bearing positions increased after gastrocnemius stretching, the percentage increase was much greater when measured in the non–weight-bearing position (average = 76%) than when measured in the weight-bearing position (average = 10%). The lower passive forces may have been more sensitive to increased extensibility of the gastrocnemius when dorsiflexion was measured in the non–weight-bearing position than when dorsiflexion was measured in the weight-bearing position. We were not blinded to the subtalar position groups or the goniometric measurement, so some investigator bias may have been introduced. Investigator bias would have been more likely during the non–weight-bearing measurement because the investigators controlled the passive dorsiflexion force than in the weight-bearing position, where the scale and the participant controlled the passive dorsiflexion force.

Limitations

A limitation of our study was the inclusion of only healthy individuals with ankle dorsiflexion ROM from 5° through 12°. In future research, investigators may identify whether subtalar joint position during gastrocnemius stretching affects dorsiflexion ROM differently in a sample exhibiting less than 5° or more than 12° dorsiflexion ROM or in a patient population. Additionally, subtalar position during gastrocnemius stretching may affect dorsiflexion during functional activities, such as walking or running. The investigators also did not directly observe that the subtalar joint was positioned in the intended supinated or pronated position when volunteers performed the stretching exercise at home. Finally, we did not measure forefoot position and mobility. Future researchers may illuminate whether stretching in supination versus pronation has different effects on increases in ankle dorsiflexion among participants with specific forefoot types.

CONCLUSIONS

Subtalar joint position during gastrocnemius stretching did not appear to influence gains in ankle dorsiflexion ROM. Gastrocnemius stretching of 5 repetitions twice daily for 3 weeks resulted in increases in dorsiflexion ROM, regardless of subtalar joint position. When prescribing a gastrocnemius stretching program, clinicians may not need to emphasize maintaining a supinated subtalar position to effectively increase dorsiflexion ROM.

ACKNOWLEDGMENTS

We thank Jim Hudson for his technical support; Paul Weiss, MS, and Zoher Kapasi, PT, for assisting with the statistical analyses; and Pamela Catlin, EdD, PT, for assisting with research design and for her statistical expertise.

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Marie Johanson, PhD, PT, OCS, contributed to conception and design; analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Jennifer Baer, MPT; Holley Hovermale, DPT; and Phouvy Phouthavong, MPT, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article.

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