Effect of Deep Heating and Foam Rolling vs. Static Stretching of the Gastrocnemius and Soleus Complex in Improving Active Ankle Dorsiflexion Range of Motion

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ABSTRACT

Purpose: There are many means of intervention when it comes to improving range of motion (ROM) of a joint. There is no consensus as to which treatment is the most beneficial for increasing dorsiflexion of the ankle. The purpose of this study was to determine which treatment protocol involving static stretching, deep heating, and/or foam rolling would provide greater improvements in ankle dorsiflexion range of motion. **Methods:** The deep squat component of the Functional Movement Screening (FMS) was used as a screening tool to determine the eligibility of volunteers. Those who scored "2 = proper squat with a board placed underneath heals" on the FMS were included in the study. Eighteen Division III Track and Field athletes (ages 19.94 ± 1.43 years) were eligible to participate and were randomly assigned to three treatment groups [static stretching (SS), static stretching and foam rolling (SS+FR) or ultrasound, foam rolling and static stretching (US+FR+SS)].The study measured left and right active ankle dorsiflexion (degrees) with the knee in the extended and flexed to approximately 90 degrees position. Measurements were taken at baseline, prior to and immediately after each treatment session, and at a final assessment after 3 weeks of a treatment period. **Results:** The two-way repeated measures analysis of variance (ANOVA), with an alpha of .05, revealed there was no group effect, but a significant time effect on all dependent variables. Paired samples t tests revealed left ankle dorsiflexion with the knee extended at final (M = 19.12; SD = 5.54) was significantly greater than baseline (M = 14.11; SD = 3.76), $t(16)$ = -5.97, p <.001. Left ankle dorsiflexion with the knee flexed at final (M = 27.12; SD = 6.81) was significantly greater than baseline (M = 22.50; SD = 7.08), $t(16)$ = -3.30, p = .005. Right ankle dorsiflexion with the knee extended at final (M = 18.88; SD = 5.70) was significantly greater than baseline (M = 15.12; SD = 4.26), $t(16)$ = -3.15, p = .006. Right ankle dorsiflexion with the knee flexed at final (M = 29.29; SD = 7.82) was significantly greater than baseline (M = 24.47; SD = 6.47), $t(16)$ = -2.70, -p = .016. **Conclusions:** All participants improved bilateral active dorsiflexion ROM from baseline to final, which demonstrated that all three treatment types were similar in their effectiveness. Future research should consider involving individuals who have suffered from lower leg injuries in the past year and of various activity levels to generalize our findings in collegiate Division III Track and Field athletes.

INTRODUCTION

- Limited ankle dorsiflexion range of motion (ROM) has been identified as a risk factor for knee, ankle, shin, and hamstring injuries such as ankle sprains, medial tibial stress syndrome, and hamstring strains.[1]
- A recently developed tool to assess injury risk is the Functional Movement Screen (FMS).[2] This means of instrumentation can be used to identify functional deficiencies, which can appropriately predict future injuries.[3]
- All of the previous research has shown that stretching, foam rolling and heating individually will induce an increase in tissue extensibility.[1, 4]
- There is no consensus about which treatment protocol is most effective in decreasing soleus tightness and increasing ankle dorsiflexion.

PURPOSE

The purpose of this study was to determine which treatment protocol provides better results in regards to improving ankle dorsiflexion ROM among track and field athletes.

METHODS

Participants

- 18 total University of Wisconsin- Eau Claire Track and Field athletes completed the study.
- Age ranged between 18-22 years old (average 19.94 years).
- Participants were randomly assigned to one of the three treatment groups: static stretching (SS), foam rolling and static stretching (FR +SS), and ultrasound, foam rolling, and static stretching (US+FR +SS).

Table 1. Descriptive Data of Participants

Gender	Age (Years)	Height (Inches)	Weight (Pounds)
9 males 9 females	19.94 ± 1.43	68.9 ± 4.37	176.12 ± 51.08

Table 2. FMS Scoring Criteria: Deep Squat

3	• Upper torso parallel with tibia or is vertical • Femur below horizontal • Knees over feet • Dowel over feet (no lumbar flexion noted)
2	• Same criteria for a score of 3, but heels are elevated
1	• Tibia and upper torso not parallel • Femur not below horizontal • Knees not over feet • Lumber flexion noted (dowel not over feet)

Note: Criteria from http://psitton.com/movement/downloads/assets/FMS%20Scoring%20Criteria.pdf

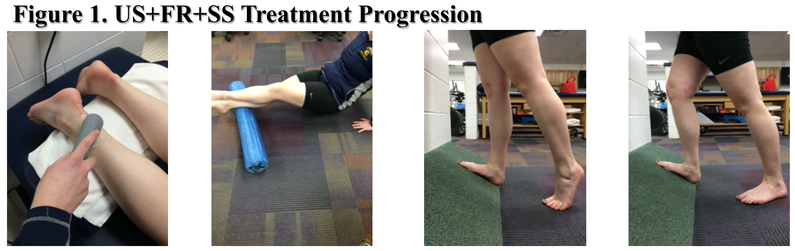
Eligibility Screening

- Pre-assessment questionnaire about health history and signed an informed consent form stating that their participation was voluntary and all personal information will remain confidential.
- Ubersence Coach Video Analysis iPad application was use to further assess FMS deep squat technique and score participants out of 3 (Table 2).
- An original subscale was created to see what errors the subject made in order to not meet the FMS score of 3.
- Inclinometer iPad application was used to measure right and left ankle dorsiflexion ROM with the knee flexed and extended.

Procedures

- Over a 3 week period, 5 treatments were completed with a minimum of 72 hours in between treatment sessions.
- Right and left dorsiflexion ROM with knee flexed and extended was measured prior to and following each individual treatment.
- Treatment Groups
  - SS: 3x30s calf stretch with knee extended on slant board with 30s rest in between sets. Stretching was held at a discomfort level of 5/10, which represents a nagging, uncomfortable, troublesome sensation. Repeat with knee slightly flexed. Repeat bilaterally.
  - FR+SS: Foam roll for 90s on from popliteal fossa to the calcaneus. Used longer strokes until a trigger point was felt (pain that was greater than 5/10), maintained that position until pain was relieved or returned to a 5/10, and finally continued with the long stroke pattern until another trigger point was felt. Completed SS protocol. Repeat bilaterally.
  - US+FR+SS: Ultrasound on the musculotendinous junction of the gastrocnemius-soleus complex for 7 minutes at 1MHz, 100%, 1.5W/cm². Completed FR+SS protocol. Repeat bilaterally.
- A final assessment was conducted 72 hours after treatment session 5. It included a reassessment of FMS deep squat and bilateral ankle dorsiflexion ROM.

Figure 1. US+FR+SS Treatment Progression



Ultrasound | Foam rolling | Static stretching with knee extended | Static stretching with knee flexed

RESULTS

Table 3. Results of Two-Way Repeated Measures Analysis of Variance

	F	df nominator	df denominator	p
Left ankle DF (knee extended)				
Time Effect	21.62	1.54	21.6	<.001
Group Effect	0.03	2.0	14.0	0.975
Interaction Effect	0.51	3.09	21.60	0.684
Left ankle DF (knee flexed)				
Time Effect	13.1	2.0	28.0	<.001
Group Effect	0.173	2.0	14.0	0.843
Interaction Effect	0.865	4.0	28.0	0.497
Right ankle DF (knee extended)				
Time Effect	9.33	1.69	23.6	0.002
Group Effect	0.328	2.0	14.0	0.726
Interaction Effect	2.39	3.37	23.6	0.089
Right ankle DF (knee flexed)				
Time Effect	11.25	1.67	23.39	0.001
Group Effect	1.93	2.0	14.0	0.182
Interaction Effect	1.54	3.34	23.39	0.229

Note: DF= dorsiflexion; Group Effect= SS, FR+SS, US+FR+SS

- No significance (p > .05) in group effect nor interaction effect
- Significance (p < .05) in time effect was found.
- Paired samples T-test was conducted for time effect to see significance in changes from post session 3 and baseline, final and post session 3, and final and baseline (Table 4).

Table 4. Results of Paired Samples T-test for Each Dependent Variable

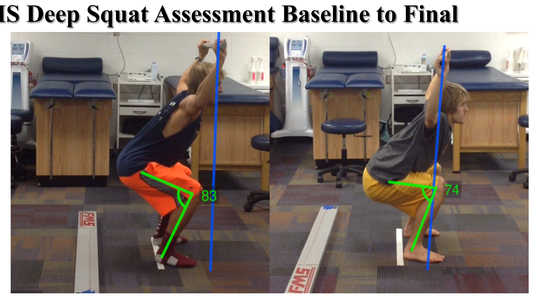
	Baseline	Post-session 3	Final	t_1	p_1	t_2	p_2	t_3	p_3
Left ankle DF (knee extended)	14.11 ± 3.76	18.22 ± 6.34	19.12 ± 5.54	-4.41	<.001	-2.60	.021	-5.97	<.001
Left ankle DF (knee flexed)	22.50 ± 7.08	30.44 ± 8.98	27.12 ± 6.81	-4.43	<.001	4.34	.001	-3.30	.005
Right ankle DF (knee extended)	15.00 ± 4.12	18.39 ± 6.46	18.88 ± 5.70	-2.85	.011	-1.20	.246	-3.15	.006
Right ankle DF (knee flexed)	24.83 ± 6.47	32.39 ± 6.90	29.29 ± 7.82	-3.77	.002	2.465	.025	-2.70	.016

Note: DF = dorsiflexion; t_1, p_1 = comparison between post session 3 and baseline; t_2, p_2 = comparison between final and post session 3; t_3, p_3 = comparison between final and baseline

SUMMARY AND CONCLUSIONS

- FMS subscale reassessment to see changes in errors while performing a FMS deep squat: 3/18 (16.7%) improved, 14/18 (77.8%) no change, and 1/18 (5.5%) declined.
- 14/18 (77.8%) improved squat depth and 4/18 (22.2%) had no change (Figure 2).
- All participants improved bilateral active dorsiflexion ROM from baseline to final, which demonstrated that all three-treatment types were similar in their effectiveness.

Figure 2. FMS Deep Squat Assessment Baseline to Final



Baseline | Final

Note: Figure 3 used the Ubersense application to approximate degrees of motion. All landmarks (greater trochanter, lateral epicondyle and lateral malleolus) are approximate for each measure.

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