Effects of textured insoles on dynamic balance and ankle muscle activity in soccer players with and without chronic ankle instability

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BACKGROUND: Chronic ankle instability (CAI) poses challenges in sports. Textured insoles (TI) are a promising intervention for enhancing dynamic balance in CAI athletes. This study aimed to investigate the effects of TI on dynamic balance performance and ankle muscle activity in soccer players with and without CAI.

METHODS: Thirty-eight soccer players (19 CAI, 19 non-CAI) participated. Participants performed a modified star excursion balance test (mSEBT) while wearing TI and standard insoles (SI). The %SEBT reach distance and electromyography (EMG) activity of tibialis anterior (TA), medial gastrocnemius (MG), and peroneus longus (PL) were measured during maximum reached in each direction of the mSEBT.

RESULTS: No significant effects or interactions were found between ankle conditions (CAI vs. non-CAI) or insole types (TI vs. SI) on %SEBT reach. However, CAI players showed greater MG activity in posteromedial and posterolateral direction ($p=0.04$, $p=0.01$).

CONCLUSIONS: Overall, the application of TI did not have immediate effects on dynamic balance performance or ankle muscle activity in either CAI or non-CAI soccer players. Nonetheless, CAI players seemed to employ a different ankle strategy involving the MG muscle, possibly to control stability during dynamic movement, particularly in the posteromedial and posterolateral directions.

KEY WORDS: Ankle injuries - Electromyography - Postural balance - Foot orthoses.

Introduction

A lateral ankle sprain is one of the most frequent athletic injuries.[1] Acute damage to the soft and bony tissues is caused by uncontrolled plantarflexion and inversion of the ankle joint.[2] Many patients progress to the development of chronic ankle instability (CAI) following an initial ankle sprain.[3] This condition is characterized by frequent feeling of the ankle giving way, ankle instability, ligamentous laxity, pain, swelling, and weakness, as well as mechanical and functional insufficiencies of the ankle.[2] Static and dynamic balance deficits as well as disrupted neuromuscular control are other well-documented consequences of CAI.[4-6]

The incidence of ankle sprains are most common during dynamic activities such as jumping, landing, or cutting.[7] Assessments of dynamic balance tasks mimic the functional movements that lead to injury. Poor performance on tests such as Star Excursion Balance Test (SEBT) had been linked to diminished postural control in individuals with CAI and distinguishes between those with and without CAI.[8-10] For instance, individuals with CAI demonstrate decreased reach performance on SEBT compared to those without CAI, as well as when comparing the injured leg to the uninjured leg.[8, 11] Additionally, poor performance on dynamic balance tasks increases the susceptibility to ankle injuries.[12]

Examining altered neuromuscular control strategies using electromyography (EMG) alongside a range of functional activities provided valuable insights into the underlying functional instability observed in individuals with CAI.[9, 10, 13] EMG measurements allow for the direct assessment of muscle activity patterns during these tasks, provide insight into how neuromuscular control is affected in individuals with CAI. These findings deepen our understanding of the complex relationship between altered neuromuscular control and proprioceptive impairments in individuals with CAI.[14, 15]

The association between muscle activity and the SEBT has been investigated by several researchers.[9, 10] Broadly, SEBT is used to detect functional asymmetries and instability, while EMG analysis can identify muscle activation differences between unaffected and affected limbs.[16] Collectively, these data enable targeted treatment strategies to address specific muscle weaknesses and abnormal activation patterns.[17] Addressing the underlying neuromuscular problems at the individual level should be a pathway to restore balance, stability, and quality of life in individuals suffering CAI.

Alongside the role of neuromuscular deficits in reduced dynamic balance performance is altered proprioceptive function. Previous research has consistently shown that various technologies aimed at enhancing proprioceptive function, such as foot orthoses,[8] ankle braces,[18] kinesiology tape,[19] and textured materials,[20] can lead to improved balance and postural control. For instance, textured insoles have been demonstrated to enhance the perceptual-motor system's performance in static postural stability tasks by stimulating sensory receptors on the skin's surface without restricting joint mobility.[21] These insoles facilitate somatosensory output from the plantar surface of the foot, thereby improving postural control and perception of ankle inversion and eversion positions.[22]

Textured insoles are designed with specialized surface features, such as raised bumps[23] or patterns,[22] that serve to stimulate the sensory receptors on the sole of the foot. This approach is considered cost-effective, usable, and convenient, including for athletes. Indeed, textured insoles has been shown to improve dynamic balance performance in athletes with CAI as measured by reach performance of the SEBT.[8] In part, this may be because textured material provides the necessary sensory feedback for accurate foot positioning, a capability which should reduce the risk of ankle injury in dynamic sport tasks.[24] While previous studies have demonstrated the positive effects of textured insoles on balance and postural control, an understanding of the underlying neuromuscular mechanisms remains limited. Given the observed improvements in balance with textured insole, it is imperative to delve deeper into the specific neuromuscular changes mediating these effects. Therefore, analyzing EMG data is essential for gaining insights into the potential neuromuscular alterations that contribute to enhanced postural control with textured insoles.

The outcome data from the SEBT and the analysis of ankle muscle activity are crucial for healthcare practitioners to assess and manage CAI symptoms on an individual basis. Incorporating textured insoles into CAI therapy can enhance its effectiveness. However, the impact of textured insoles on ankle muscle activation during dynamic balance performance is not well understood. Therefore, this study aims to evaluate and compare the effects of textured insoles on dynamic balance performance, as measured by normalized SEBT reach, and ankle muscle activation during the SEBT assessment, in soccer players with and without CAI.

Materials and Methods

Participants

The sample size of this study was calculated using G*Power (version 3.1.9.4). It was based on a priori power analysis with an expected effect size of 0.5, an alpha level of 0.05, and a desired power of 0.8. This calculation indicated a minimum requirement of 34 participants. To account for potential drop-out during the testing protocol, the study accordingly involved 38 participants, which consisted of 19 CAI and 19 non-CAI. Participants' demographic data were shown in Table 1. The inclusion criteria for

CAI group were based on the guidelines provided by the International Ankle Consortium Position Statement,[25] which included: (i) a history of at least one significant lateral ankle sprain, with the initial sprain occurring at least 12 months prior to enrollment and the most recent ankle sprain occurring at least 3 months prior to enrollment; (ii) episodes of ankle joint giving way and feelings of instability; and (iii) Cumberland Ankle Instability Tool (CAIT) score of < 25. The non-CAI group was selected based on specific inclusion criteria, which included: (i) absence of ankle sprain or symptoms of ankle instability; and (ii) CAIT scores of ≥ 25. The exclusion criteria for both groups included: (i) a history of previous injuries to the musculoskeletal structures (i.e., bones, joint structure, nerves) of the lower limb; (ii) a history of surgery or fracture requiring realignment of the lower limb; and (iii) any acute injuries sustained within the 3 months prior to the study. All participants read and signed an informed consent document, approved by the Mae Fah Luang University Ethics Committee on Human Research, prior to data collection.

Design and Procedures

Prior to testing, participants were medically screened and completed the CAIT questionnaire. In both groups, the ankle with the lower CAIT score was selected for testing. Lower limb length was measured with tape, from the anterior superior iliac spine to the middle aspect of the ipsilateral medial malleolus and taken while participants were lying supine on an examination table. The length of the testing leg was used to normalize the distances reached during SEBT.[26] After warming up for 5 minutes on a treadmill, participants had EMG electrodes placed on the tibialis anterior (TA), medial gastrocnemius (MG), and peroneus longus (PL) muscles. Each participant engaged in three maximum voluntary isometric contractions (MVICs) for each muscle, against manual resistance. For TA, each participant lay in a supine position and performed maximum ankle dorsiflexion against resistance. For MG, participants lay on their stomachs, knees extended, and feet projecting over the edge of the examination bed. Participants then plantarflexed their feet maximally against resistance. For PL, participants sat on the examination bed with a support under the knee joint, then maximally plantarflexed their foot with eversion against resistance. EMG recordings were made during these MVICs and used for normalizing EMG data. Participants then put on standard athletic socks, of 89% polyamide and 11% spandex. They were then assessed on all testing tasks under two conditions: standard insoles (SI) and textured insoles (TI). The sequence of the conditions was selected randomly using a computer-generated schedule (Research Randomizer. (n.d.). Research Randomizer. http://www.randomizer.org/).

The textured insoles used in this study were 2 mm thick and constructed using soft insole material (270 density Ethylene Vinyl Acetate (EVA)). The surface of the textured insoles comprised nodules that were 7 mm in diameter and 2 mm in height and were uniformly dispersed over the insole surface.[23] The textured insoles were cut to fit the feet of each participant and were intended to be used as replacements for the standard insoles in their usual soccer boots.

The present study employed a compact version of modified star excursion balance test (mSEBT)[27] to assess dynamic balance ability. The mSEBT setup consisted of a single line with a tape grid in one direction, with specific placement instructions provided for each directional test (anterior, posteromedial, and posterolateral) for the balancing foot.

During the mSEBT testing protocol, participants were instructed to stand with their testing leg in the center of the mSEBT tape grid, ensuring that most distal part of the foot was aligned with the starting line.[27] Participants were then asked to reach as far as they could with a non-testing leg in each direction while maintaining single-leg stance, with their hands on hips, lightly touching the ground on the designated line with their foot and returning to the starting position without shifting weight. Prior to data collection, participants completed three practice trials to familiarize themselves with the mSEBT, followed by three randomized testing trials in each direction. Participants were closely monitored during testing to ensure compliance with protocol criteria, and any trials where participants did not maintain proper form were repeated.

Reach distance in each direction was recorded as the distance from the point of maximum reach touched on the floor to the center of the mSEBT tape grid. Additionally, the time over which each reach occurred was recorded using the time between foot contact and maximum reach. These measurements were manually recorded, and EMG time series were registered.

A custom-built Force Sensitive Resistor (FSR) plate, integrated into the testing track, was used as a foot switch to sample muscle activity during the reaching task. This system consists of two FSR sensors placed between metallic plates, capable of measuring forces from 0-100 N with a response time of 0.5-1 ųs and sensitivity of 15±5 g. Powered by a micro-USB cable and regulated by an Arduino IDE module operating at 2.67 MHz, the FSR plate was overlaid with artificial turf and synchronized with the EMG system to determine the precise timing of ground contact during maximum reaching motion (see Figure 1).

(insert Figure 1 here)

Figure 1. Schematic of the experimental setting, including the Arduino control module with the embedded FSR plate, synchronized with the EMG system.

Measurements

Electromyography

Ankle muscle activity for the TA, MG, and PL was recorded using the TrignoTM wireless surface electromyography (EMG) system (Delsys, Wireless Biofeedback System, USA). Each sensor measured 37 mm by 26 mm by 15 mm, weighed 14 g, and contained two bar electrodes and two reference bar electrodes. The muscles chosen for investigating neuromuscular control in this study are the TA, MG, and PL due to their essential roles in maintaining ankle stability during dynamic movements.[28] Specifically, the TA is crucial for movement control of ankle inversion, dorsiflexion, and joint stabilization; the MG primarily facilitates plantarflexion and sagittal plane stabilization, while the PL is important for eversion and frontal plane stability. Their coordinated actions ensure proper joint alignment, precise movement control, and provide critical sensory input for balance control, making them particularly relevant for assessing balance and neuromuscular control in individuals with CAI. In addition, they were superficially located and thus readily accessible with surface EMG. The electrode placement on the muscles provided adequate distance between them, thereby reducing crosstalk.[29] Electrodes were placed on the test legs according to the recommendations of Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM).[30] For TA, the electrode was positioned at a third of the distance between the fibula and medial malleolus. For MG, the electrode was placed on the muscle's most prominent protrusion. For PL, the electrode was positioned at 25% of the distance on the line between the head of the fibula and the tip of the lateral malleolus. Before placing the electrodes, each site was shaved, then cleansed with isopropyl alcohol. The EMGworks® Acquisition software (Delsys Inc., Natick, MA, USA) was used to evaluate signal quality before data collection. All EMG data were sampled at a frequency of 1926 Hz.

During all testing trials, the MVICs of the TA, MG, and PL muscles were used to normalize the EMG amplitude. For each reach, normalized EMG activity (%MVICs) of each muscle was quantified during maximum reach of each direction. The moment of maximal reach was determined by when the toe touched the FSR plate, which was synchronized with the Delsys EMG system and embedded within the testing track. Throughout the testing session, EMG signals were processed by bandpass filtering within a frequency range of 20–450 Hz, rectification, and smoothing[10] using EMG analysis software (EMGworks® Analysis version 4.7.9).

SEBT reach distance

The reach distance for the three trials of mSEBT was averaged and normalized to the participants' leg length [27] from the following equation:

Normalized score (%)

$$= \frac{\text{Mean of the three trials in testing direction (cm)}}{\text{Tested limb length (cm)}} \text{ x } 100$$

After recording performances in each direction, %SEBT reach of all directions was calculated from the following equation:

$$\%\text{SEBT reach} = \frac{\text{Norm anterior score}(\%) + \text{Norm posteromedial score }(\%) + \text{Norm posterolateral score }(\%)}{3}$$

where anterior, posteromedial, and posterolateral reaches are normalized scores for anterior, posteromedial, and posterolateral directions, respectively.[27]

Statistical Analyses

Data were summarized using the mean and standard deviation (SD) for quantitative variables. A Shapiro-Wilk's test was used to examine the normality of the variables. A 2-by-2 factorial ANOVA was used to evaluate the main effects of ankle conditions (non-CAI vs. CAI) and insole types (TI vs. SI) and interaction effects. The level of significance was set at $p < .05$. All statistical tests were conducted using IBM SPSS Statistical Software version 25 (Chicago, IL, USA).

Results

All 38 soccer players recruited completed the study (19 players with CAI and 19 players without CAI). Table 1 shows their descriptive and CAIT scores. No statistical differences between groups were found for age *(p = 0.72)*, height *(p = 0.83)*, weight *(p = 0.86)*, leg length *(p = 0.62)*, or experience in soccer *(p = 0.99)*. Participants with CAI reported significantly lower CAIT scores *(p < 0.001)* than those without CAI.

Table 1. Descriptive data and CAIT scores for the participants in the non-CAI and CAI groups. Data is reported as mean (SD).

(insert Table 1 here)

Following the application of SI and TI, the percentage of SEBT reach was evaluated among participants (see Figure 2). However, statistical analysis indicated no significant differences across the groups or insole conditions (see Table 2).

(insert Figure 2 here)

Figure 2. %SEBT reaches between non-CAI and CAI soccer players.

Figures 3A, 3B, and 3C show TA, PL, and MG muscle activity during the anterior, posteromedial, and posterolateral reaches under the application of SI and TI. The findings revealed heightened muscle activation in the MG among CAI soccer players during both posteromedial and posterolateral maximal reaches, regardless of the insole conditions (see Table 2).

(insert Figure 3A, 3B, 3C here)

Figure 3. EMG activity of the TA, PL, and MG muscles following the application of SI and TI among participants with and without CAI during anterior (A), posteromedial (B), and posterolateral (C) on mSEBT.

** denotes significant difference between groups following the application of SI (P < 0.05)*

*** denotes significant difference between groups following the application of TI (P < 0.05)*

Table 2 summarizes the main effects and interactions for ankle and insole conditions with data from the %SEBT reach and %MVIC of the TA, PL, and MG muscles during maximum reach in each direction of the mSEBT. Multi-factorial ANOVA was conducted to evaluate the main effects and interactions of ankle and insole conditions on %SEBT reach, and %MVIC for all testing muscles, during maximum reach in each direction of the mSEBT.

Table 2. Main effects and interactions of ankle and insole conditions on %SEBT reach and %MVIC of TA, PL, and MG muscles during maximum reach in each direction of the mSEBT.

(insert Table 2 here)

The results demonstrated that there were no significant main effects or interactions between ankle and insole conditions on %SEBT. During maximal reach in the posteromedial direction, the CAI group $(M = 9.05; SD = 6.28)$ exhibited significantly higher MG activity than the non-CAI group $(M = 6.55; SD = 4.12)$, $F(1,72) = 4.16$, $p = 0.04$, $\eta_p^2 = 0.06$. Moreover, the CAI group also showed significantly higher MG activity $(M = 15.2; SD = 12.54)$ during posterolateral maximal reach than the non-CAI group $(M = 9.13; SD = 6.76)$, $F(1,72) = 6.71$, $p = 0.01$, $\eta_p^2 = 0.09$. On the other hand, no main effects or interactions were identified between ankle and insole conditions on TA or PL muscles during posteromedial and posterolateral maximal reach. Furthermore, no significant main effects or interactions between ankle and insole conditions were seen on any muscles during the maximal anterior reach.

Discussion

This study aimed to investigate the effect of textured insoles on dynamic balance and ankle neuromuscular control during mSEBT performance in soccer players with and without CAI. The findings indicated that soccer players with and without CAI exhibited comparable dynamic balance performance under both standard and textured insole conditions. However, CAI soccer players exhibited a different ankle strategy involving increased activation of MG muscle during the posteromedial and posterolateral reaches of the mSEBT, which may be necessary for ankle stability following an injury.

Research has shown that individuals with CAI have deficient dynamic balance performance and altered lower limb muscle activity[10, 31, 32] compared to those without CAI. Textured insoles have been suggested as a potential intervention to improve balance control, with studies indicating positive effects on dynamic balance improvement.[8, 22, 33] The textured insole surface can induce mechanical and functional changes in the foot and ankle complex, stimulating cutaneous receptors and potentially enhancing postural control in CAI.[8, 34]

However, this study found no evidence supporting the hypothesis that added texture can enhance dynamic balance performance. The differences in research findings may be attributed to various factors. Firstly, the differences in neuromuscular control systems involved in SEBT reach performance such as muscle strength, flexibility, or proprioceptive ability.[10] Secondly, methodological differences may contribute, particularly the configuration of the textured insole. This study used a flat textured insole, while previous research utilized a textured insole with a custom-molded deep heel cup, which could provide superior ankle support and enhance dynamic balance performance in individuals with CAI.[8] Additionally, differences in material choice could impact the results. While this study utilized ethylene-vinyl-acetate (EVA), known for its soft and cushioning properties, previous research employed a more rigid rubber material,[8, 22] potentially offering firmer and more localized tactile feedback. Moreover, variations in surface patterns of the textured insole may play a role. This study used circular nodules, providing sensory feedback across a broader area, while previous studies used smaller wedge patterns,[8, 22] potentially offering more precise feedback to specific areas requiring correction. These factors collectively contribute to the differences in dynamic balance performance across studies.

Previous research has shown that individuals with CAI exhibit significantly reduced reach on the affected leg compared to healthy controls,[8, 9, 32] which was not evident in our data, regardless of the presence of added texture. The fact that our study did not yield evidence supporting the hypothesis that textured insoles enhance balance. While muscle activation patterns did not indicate any direct influence of textured insoles, other mechanisms, such as neural adaptations to CAI may be at play. In certain instances, CAI may manifest with increased ankle muscle activity, and this phenomenon is often observed as a compensatory mechanism. Although CAI is generally associated with altered and delayed muscle activation patterns, certain situations may result in increased muscle activity. These instances may represent protective and compensatory responses, fear of instability, and adaptive alterations in motor control strategies.[31]

Significant differences in muscle activity between ankle conditions were revealed during the posteromedial and posterolateral maximal reaches. During these reaches, CAI soccer players demonstrated greater MG muscle activity than non-CAI soccer players. Individuals with CAI are often associated with neuromuscular adaptations in the ankle muscles.[4, 31, 35] As a result, they may exhibit higher recruitment of their MG muscle as a compensatory mechanism for the inadequate functioning of other ankle muscles, such as the PL muscle, to stabilize the joint during dynamic balance tasks. The present study indicates that CAI soccer players exhibit elevated MG muscle activity when attempting to maintain postural stability in dynamic balance tasks, particularly when the contralateral foot is displaced in the posteromedial and posterolateral directions. Thus, our data suggests that CAI soccer players employ a different compensatory strategy involving increased MG muscle activity to mitigate excessive ankle dorsiflexion during posteromedial and posterolateral reaches compared to non-CAI soccer players.

Another possible contributing factor might be attributed to the persistent and long-lasting character of CAI. Individuals with CAI often experience recurrence of ankle sprains, which can lead to heightened fear of reinjury.[36] This fear can be profound, as they may have experienced multiple instances of instability-related pain and discomfort over time. Fear of reinjury can trigger a protective response in individuals with CAI. To minimize the risk of further injury, individuals with CAI may exhibit increased muscle guarding and activation, such as increased MG muscle activity, as seen in the current study. This alteration in muscle activity serves as a protective mechanism to stabilize the ankle joint during challenging dynamic balance tasks.[31] Moreover, as time progresses, the persistent instability associated with CAI induces adaptive modifications in neuromuscular control. Individuals with CAI develop altered movement patterns in response to chronic instability, also characterized by altered muscular activity.[31] This provides their best attempt at joint stability, particularly when exposed to stimulation that increases fear of reinjury.

The persistent instability in CAI leads to long-term alterations in proprioception in the affected ankle.[4] To address the proprioceptive impairment, it has been proposed that individuals with CAI exhibit increased muscle activity as a compensatory mechanism, as suggested by previous work.[37] Collectively, the increased activation of MG muscle observed during dynamic balance tasks in the current study highlights the complexity of neuromuscular control in CAI individuals, making understanding these complexities necessary for developing individualized rehabilitation protocols designed to enhance balance and ankle function in CAI patients. However, this hypothesis is proposed cautiously since current research has not evaluated the variation in kinematic parameters between groups. Therefore, future research should include kinematic and kinetic analyses of performance during dynamic balance tasks, and it may be necessary to observe EMG activity in the trunk and proximal muscles of the lower limb.

Limitations

A limitation of the current study lies in the complicated features of dynamic postural control ability, which involve multiple neuromuscular control systems. Factors such as muscle strength, flexibility, activity level, and proprioceptive ability vary significantly among individuals with CAI and may influence our results. Additionally, the configuration of the textured insoles used in our study differed from other research, with our study employing flat textured insoles compared to designs incorporating custom-molded deep heel cup, and variations in nodule shape and density. These differences, along with variations in socks and/or shoes, may have affected muscle recruitment patterns observed in our study. Furthermore, we did not evaluate the specific rehabilitation protocols used by CAI soccer players following previous ankle injuries, which could have influenced our results. Lastly, the absence of kinematic information is another limitation of this investigation. Future research should incorporate kinematic analysis of dynamic balance performance tasks and broaden EMG analysis to include the activity of the proximal lower limb and trunk muscles for a more comprehensive understanding of dynamic postural control in individuals with CAI.

Conclusions

The findings of the present study indicate that soccer players with and without CAI exhibited comparable dynamic balance performance under both standard and textured insole conditions. Compared to non-CAI soccer players, CAI soccer players appeared to demonstrate a different ankle strategy, one involving overactivation of the MG muscle, which may be necessary to increase control of ankle stability during the posteromedial and posterolateral reaches of the mSEBT following an ankle injury. Although textured insoles have been suggested as an instrument to improve dynamic balance performance, our data did not show any immediate benefit for performance nor that there were observable effects on muscle activation patterns.

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Authors' contributions

Aimkosa Ratakorn and Han Jia have given substantial contributions to the conception or the design of the manuscript, analysis and interpretation of the data. Orth Dominic and Adams Roger contributed to the interpretation of the data. Aimkosa Ratakorn, Xu Zhelin, and Lyu Jie contributed to the literature review and discussion section of the manuscript. All authors have participated in drafting and revising of the manuscript. All authors read and approved the final version of the manuscript.

Table 1. Descriptive data and CAIT scores for the participants in the non-CAI and CAI groups. Data is reported as mean (SD).

Variables	**non-CAI (n = 19)**	**CAI (n = 19)**	**P value**
Age (years)	20.21 (0.79)	20.11 (0.99)	0.72
Height (cm)	172.5 (6.54)	172.1 (5.29)	0.83
Weight (kg)	65.42 (17.6)	66.26 (10.4)	0.86
Leg length (cm)	87.55 (4.38)	88.19 (3.46)	0.62
Experience in soccer (years)	6.32 (1.29)	6.32 (1.42)	0.99
CAIT scores	26.58 (2.27)	21.11 (1.73)	<0.001*

* *denotes significance at $p < 0.05$*

Table 2. Main effects and interactions of ankle and insole conditions on %SEBT reach and %MVIC of TA, PL, and MG muscles during maximum reach in each direction of the mSEBT.

	Main effect: ankle condition			**Main effect: insole type**			**Interaction**		
	F(1,72)	**p**	η_p^2	**F(1,72)**	**p**	η_p^2	**F(1,72)**	**p**	η_p^2
%SEBT reach	1.58	0.21	0.021	0.014	0.91	<0.001	0.09	0.77	0.001
<u>Anterior reach</u>									
TA	1.86	0.18	0.03	0.29	0.59	0.004	0.002	0.97	<0.001
PL	2.18	0.14	0.03	1.87	0.18	0.03	0.09	0.76	0.001
MG	2.64	0.11	0.04	1.86	0.18	0.03	0.2	0.66	0.003
<u>Posteromedial reach</u>									
TA	0.1	0.76	0.001	0.08	0.78	0.001	0.35	0.56	0.005
PL	1.46	0.23	0.02	0.007	0.93	<0.001	0.14	0.71	0.002
MG	4.16	*0.04**	0.06	0.36	0.55	0.005	0.94	0.36	0.01
<u>Posterolateral reach</u>									
TA	1.68	0.2	0.02	0.07	0.79	0.001	0.98	0.33	0.01
PL	2.51	0.12	0.03	0.07	0.79	0.001	0.005	0.95	<0.001
MG	6.71	*0.01**	0.09	0.02	0.9	<0.001	0.001	0.97	<0.001

where TA = tibialis anterior; PL = peroneus longus; MG = medial gastrocnemius

* *denotes significance at* $p < 0.05$