THE EFFECT OF THE TAYCO EXTERNAL ANKLE BRACE ON MULTIDIRECTIONAL REACH DISTANCE, BALANCE, AND MOTION IN COLLEGIATE ATHLETES

Running Head: Ankle Brace Testing

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Key Points:

- Significantly greater amounts of motion were demonstrated for the TayCo compared with Lace-up for dorsiflexion and plantar flexion as well as less motion for the TayCo compared to the lace-up for inversion and eversion.
- The TayCo to provide frontal plane restriction while allowing sagittal plane motion without impacting performance measures.
- This study affords clinicians evidence to support the effectiveness of the TayCo external ankle brace alongside traditional lace-up braces, further making it a viable option for effectively stabilizing the ankle joint.

Key Words:

- ATHLETE, BRACE, FUNCTIONAL MOVEMENT, LOWER QUARTER Y-BALANCE TEST

Abstract

Ensuring ankle stability while allowing for functional movement is important when returning patients physical activity and attempting to prevent injury. The purpose of this study is to examine the effectiveness of the TayCo external and a lace-up ankle brace on balance, functional performance, and motion in 18 physically active participants. Significantly greater amounts of motion were demonstrated for the TayCo compared with Lace-up for dorsiflexion and plantar flexion as well as less motion for the TayCo compared to the lace-up for inversion and eversion. The TayCo to provide frontal plane restriction while allowing sagittal plane motion without impacting performance measures.

Introduction

The ankle is one of the most commonly injured areas in the lower extremity when participating in sports and recreational activities.[1] Specifically, ligamentous injuries to the ankle account for 15% of all injuries and the lateral ankle ligament complex is involved 85% of the time.[2] Of these injuries, many result in time lost from work or school of over 1 week.[4] Furthermore, the median reported emergency room charge per ankle sprain event was $1,029 signifying a substantial financial burdon.[5] Beyond the collection of short term challenges faced following an ankle sprain, sufferers are at a high risk for of recurrent ankle sprains.[6] Specifically, between 30 and 70% of those who suffer an initial ankle sprain suffer from residual symptoms, repetitive bouts of ankle trauma, and may develop a condition known as chronic ankle instability (CAI).[7] Patients with CAI experience a myriad of mechanical and functional impairments.[8] These lasting deficiencies have a long-term effect on work and recreational activities, which leads to a reduction in health-related quality of life (HRQOL).[9] Due to the prevalence of ankle sprains and the myriad of physical and financial impacts associated with the condition, it is imperative that innovative prevention strategies are developed.

Finding new approaches to improving ankle stability and preventing injury is a challenge clinicians face when working to return patients back to high levels of function.[10] Ankle braces have been designed to provide external support to the ankle in order to enhance the mechanical stability of the joint. Previous investigations have demonstrated that current ankle braces, semi-ridge and lace-up, provide meaningful improvements in ankle stability by significantly restricting ROM compared to no-brace.[11] However, these brace designs may be limiting functional movement as investigations have seen reductions

in maximum vertical jump height and functional DFROM during a vertical jump.[12] This indicates that while stability is improved it may be coming at a cost of reduced functional performance.

The TayCo external ankle brace has a pioneering design that aims to reduce the mechanical constraints typically found in a semi rigid ankle brace. The TayCo external ankle brace is designed to accomplish a high level of inversion (IV) and eversion (EV) stabilization while allowing for freedom of dorsiflexion (DF) and plantar flexion (PF) movement. Applying the brace outside of the shoe challenges traditional practice and provides clinicians with a new way to achieve functional ankle stabilization. Therefore, the purpose of this study is to examine the effectiveness of the TayCo external ankle brace and a traditional lace-up ankle brace on dynamic balance, functional performance, and motion.

Methods

Patients

Participants were recruited from a National Collegiate Athletic Association Division I Football Championship Subdivision (FCS) team in Indiana and had no history of lower extremity surgery, fracture, or injury in the last 3 months that they were currently receiving treatment for. A total of 18 physically active participants completed the study (Table 1). This study received approval from the university's Institutional Review Board.

Procedures

Each participant took part in a single 60-minute data collection session in which they completed all bracing conditions. Prior to testing, informed consent was completed and demographic information was collected (Table 1). Each participant was assigned a

limb (dominant, non-dominant) to complete the testing procedures. Asking participants which foot they used to kick a ball was utilized to determine limb dominance.[13] Condition order, limb dominance, and outcome measure order were counterbalanced to ensure an equal number of participants in each condition. All tests were completed in self-supplied (team issued) socks and athletic shoes. Lastly, two athletic trainers with 9 to 12 years of experience were used to collect all outcome measures. Each athletic trainer was responsible for collecting all data measurements for specific outcomes and there was no crossover.

Bracing Condition

Three separate ankle stability conditions were assessed through the course of the study (lace-up brace, TayCo, and no-brace). For the lace-up condition each participant was fitted with a lace-up ankle brace (McDavid model 195T, McDavid Inc., Fountain Valley, CA) to perform their testing. For the TayCo condition each participant was fitted in the TayCo external ankle brace (Acute TayCo External Athletic Brace, TayCo Brace LLC., South Bend, IN). Each brace was fitted by a single athletic trainer and self-applied by participants under supervision. The no-braced condition involved each participant completing tasks without a brace.

Range-of-Motion Testing

Active ankle ROM was measured in four directions (plantar flexion, dorsiflexion, inversion, eversion) using a standard handheld goniometer. Positions and procedures were based on previously reported methods.[16] Participants performed two practice trials and three collection trials that were averaged for analysis.

Weight-bearing dorsiflexion was assessed using the knee to wall principle employed by the Weight Bearing Lunge Test (WBLT). WBLT positions and procedures were based on previously reported methods.[17] Participants performed one practice trial and two collection trials that were averaged for analysis.

Dynamic Balance

Dynamic balance was assessed using the Lower Quarter Y-Balance Test (YBT).[18] The YBT requires the participant to balance on a single leg and reach in three separate directions: anterior (ANT), posteromedial (PM), and posterior lateral (PL) with the opposite limb. Testing positions and procedures were based on previously reported methods.[18] Each participant performed four practice and three collection trials of the YBT for each direction. Collected trials were normalized to leg length and averaged for analysis.

Functional Movement

Functional movement was assessed using the figure-8 hop tests and the lateral hop test.[19] Participants were instructed to perform each test on a single leg. Testing procedures for the figure-8 hop test were based on previously reported methods and involved participants hopping through a course for two figure-8s.[19] Each participant was asked to perform two collected trials of the figure-8 hop test that were averaged for analysis.

The lateral or side hop test was performed over a distance of 30 centimeters that was marked on the ground.[19] Each participant was instructed to hop 10 times back and forth on a single limb as quickly as possible. Positions and procedures were based on previously reported methods.[19] Each participant was asked to perform three collected trials of the lateral hop test, which were averaged for analysis.

Statistical Analysis

Separate one-way repeated-measures ANOVAs were performed to evaluate differences between brace conditions (Lace-up, TayCo, No-Brace) for each dependent measure. When indicated post hoc analysis was completed using paired *t*-tests to evaluate pairwise differences. The alpha level for all analyses was at $p<0.05$. Statistical analysis was performed using SPSS (Version 25, SPSS Inc., Chicago, IL, USA).

Results

Means and standard deviations for all outcome measures during all conditions are presented in Table 2. ANOVAs analysis indicated that there were no significant condition main effects for the Figure-8 ($p=0.987$), Lateral Hop ($p=0.62$), ANT ($p=0.155$), PM ($p=0.187$), and PL ($p=0.881$). Significant condition main effects were identified for the outcome measures of WBLT ($p<.001$), ROM-IN ($p<.001$), EV ($p<.001$), DF ($p<.001$), and PF ($p<.001$). Post hoc analysis indicated that there was significantly greater ROM during the control condition compared to TayCo and lace-up for the WBLT ($p<.001$), IN ($p<.001$), EV ($p<.001$), DF ($p<.001$), and PF ($p<.001$). Additionally, there were significantly greater amounts of motion during the TayCo condition compared with lace-up for DF ($p=.043$), and PF ($p<.001$). There were significantly less amounts of motion during the TayCo condition compared to the lace-up for IN ($p<.001$) and EV ($p<.001$). No significant differences were found between the TayCo and lace-up conditions for the WBLT ($p=.772$).

Discussion

The purpose of this study was to examine the effect of the TayCo external ankle brace and a traditional lace-up ankle brace on lower extremity function, dynamic balance, and motion. Our research study was the first to examine differences between the traditional lace-up brace and the TayCo. The primary findings of the study showed that both bracing conditions resulted in decreased ankle ROM compared to the control condition. However, the TayCo brace allowed for greater DF and PF while at the same time caused greater restriction on IN and EV. Finally, there were no significant decreases in functional movement or balance for either brace condition compared to the control. Indicating that the application of either brace condition neither improved, nor was detrimental to functional task performance.

The most common mechanism of injury for an ankle sprain is a combination of excessive foot IN and PF.[20] The purpose of ankle bracing is to support and restrict IN by providing functional stabilization to the joint in order to prevent the occurrence of ankle sprains.[21] Previous research has demonstrated the ability for ankle braces to accomplish this goal but at the cost of concurrent restriction of DF and PF.[12,24] Limiting ankle ROM during jump landing reduces the ability for the soft tissue around the ankle to absorb energy.[22] With this in mind, the TayCo brace was designed to preserve DF and PF to allow for functional movement. Our results demonstrate that the lace-up and the TayCo brace significantly limited IN and EV compared to the no-brace condition. Additionally, the TayCo brace limiting IN and EV significantly more than the lace-up brace. The TayCo brace was also shown to allow for significantly greater DF (22.35 $\pm$ 2.48) and PF (20.63 $\pm$ 5.11) ROM than the lace-up brace (DF=18.98 $\pm$ 2.87, PF=19.02 $\pm$ 4.94). These findings demonstrates the ability of the TayCo brace to provide IN and EV restriction while also allowing for

greater sagittal motion at the ankle that may be necessary for push off and force absorption during functional tasks.[22]

Previous research has demonstrated that lace-up braces restrict PF and may impair athletic performance such as vertical jump height and running speed.[23, 24] It is hypothesized that this performance impairment is due to a reduction in DF and PF, which reduce the energy absorption and creation ability of the ankle.[25] Therefore, the less limitation placed upon DF and PF at the ankle, the less it should negatively impact performance.[26] Past research in this area is conflicting, showing that both that lace-up and semi-rigid ankle braces have minimal impact on hop performance in one study[1] and alternatively showing no significant decrease in performance in speed, balance, or agility tasks in others.[4, 27] Our study found no significant differences in the lateral or the figure-8 hop test between the three bracing conditions we examined. This supports the findings of the previous research studies indicating there may be no immediate effect on performance.[4, 27] These studies all examined the immediate effect on performance. It would be beneficial for future studies to conduct a long-term investigation into the impact ankle braces have on performance.

Limitations and Future Directions

It is important to acknowledge the limitations of the study when drawing conclusions from the findings. We have no way through this study to conclude if the TayCo brace actually results in a reduction in primary or secondary ankle injury. Another potential limitation was the unfamiliarity of the subject with the TayCo as none of the subjects that took part in the study had previously used the TayCo brace. However, participants were familiar with the lace-up brace and had used them previously during

their physical activities. It would be beneficial for future studies to investigate the effects of various ankle braces on muscle strength and muscle activity during functional movement. It would also be beneficial to perform a long-term study to determine if the application of the TayCo brace was able to reduce injury or re-injury. Lastly, there is a need for information concerning the effect of braces on fatigue rates, comfort, and performance.

Conclusion

The study concludes that significantly greater amounts of motion were demonstrated for the TayCo compared with Lace-up for dorsiflexion and plantar flexion as well as less motion for the TayCo compared to the lace-up for inversion and eversion. Additionally, neither brace demonstrated a negative or positive impact on functional performance or dynamic balance. Clinicians have an array of design and materials options to choose from when prescribing an ankle brace. This study affords clinicians evidence to support the effectiveness of the TayCo external ankle brace alongside traditional lace-up braces, further making it a viable option for effectively stabilizing the ankle joint.

Table 1: Demographic Information

	No.
Gender	18 males
Age	20 ± 1.2
Weight (kg)	113.66 ± 24.78
Height (cm)	189.02 ± 8.54
GLTEQ	66.44 ± 20.75
FAAM-Sport (%)	97.6 ± 6.2

GLTEQ=Godin Leisure-Time Exercise Questionnaire, FAAM=Foot and Ankle Ability Measure

Table 2: Means ± SD for Outcome Measures, ANOVA

	Control	Lace-up	TayCo	Main Effect for Condition
Y-Balance (%)				
ANT	55.9 ± 5.0	53.9 ± 4.8	54 ± 5.9	0.155
PM	98.7 ± 9.5	98.5 ± 9.9	101 ± 9.7	0.187
PL	96.7± 10.3	96.0 ± 12.3	96.2± 11.8	0.881
WBLT (cm)	9.40 ± 1.88	8.13 ± 2.19[a]	8.22 ± 2.19[a]	<0.001
ROM (Degrees)				
IN	12.2 ± 2.94	8.61 ± 2.22[a]	3.61 ± 1.13[ab]	<0.001
EV	11.59 ± 2.85	7.98 ± 2.35[a]	3.37 ± 1.12[ab]	<0.001
DF	25.83 ± 3.9	18.98 ± 2.87[a]	22.35 ± 2.48[ab]	<0.001
PF	23.41 ± 6.56	19.02 ± 4.94[a]	20.63 ± 5.11[ab]	<0.001
Figure 8 (s)	11.71 ± 1.25	11.71 ± .1.36	11.73 ± 1.5	0.987
Lateral Hop (s)	7.7 ± 1.25	7.9 ± 1.21	7.81 ± .886	0.62

ANT=Anterior, PM=Posterior Medial, PL=Posterior Lateral, WBLT=Weight-Bearing Lunge Test, ROM=Range of Motion, IN=Inversion, EV=Eversion, DF=Dorsiflexion, PF=Plantar Flexion.

[a] Indicates significant difference from Control group at $p<0.05$

[b] Indicates significant difference from the Lace-up group at $p<0.05$

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