

# **AN ANKLE ORTHOSIS WITH A SUBTALAR LOCKING SYSTEM IS MORE EFFECTIVE IN RESTRICTING PASSIVE AND ACTIVE ANKLE KINEMATICS**

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## **INTRODUCTION**

The ankle joint is the most injured joint during sports participation (Arendt 1995, Garrick 1988, Hootman 2007). Ankle braces are superior to adhesive ankle taping in restricting ankle inversion and eversion range of motion (ROM). Ankle orthoses have also been shown to be effective in reducing ankle inversion injuries. Efficacy of ankle orthoses is often assessed by comparing reduction of inversion ROM in a passive setting as well as peak inversion angle and ROM in an inversion drop test, between braced and unbraced movements (Alt 1999, Cordova 1998, De Clercq 1997, Lohrer 1999). Therefore, the objective of this study was to examine the effectiveness of a new semi-rigid ankle orthosis with a subtalar joint locking mechanism in restricting ankle inversion motion during passive and dynamic movements.

## **METHODS**

Ten female (age:  $24.8 \pm 3.6$  yrs, height:  $1.65 \pm 0.06$  m, mass:  $57.9 \pm 5.8$  kg) and ten male subjects (age:  $24.4 \pm 3.7$  yrs, height:  $1.75 \pm 0.07$  m, mass:  $73.4 \pm 15.7$  kg) with no current ankle injury and no history of major lower extremity injuries participated in the study. A seven-camera motion analysis system (240 Hz, Vicon Motion Analysis Inc., UK) was used to obtain the three-dimensional (3D) kinematics during the test. Reflective anatomical and tracking markers were placed on foot, ankle, leg, knee, thigh and pelvis of the right side of the body to obtain 3D kinematics. An electrogoniometer

was placed around the posterior side of the heel and leg of the subject to measure passive inversion and eversion range of motion of the ankle joint in wearing no brace (NB), a semi-rigid Element ankle brace with a calcaneal and subtalar locking system (AB1, DeRoyal), a semi-rigid Functional ankle brace with a hinge joint (AB2, DeRoyal), and a soft ASO lace-up ankle brace (AB3, Medical Specialties). The participant performed five ankle inversion drop trials of  $30^\circ$  in each of four conditions on a customized inversion drop platform: wearing no brace, AB1, AB2 and AB3.

A one-way repeated measures ANOVA was used to evaluate differences among the brace conditions on selected variables ( $p < 0.05$ ) with post hoc comparisons conducted to detect specific differences among the braces using a Bonferroni adjustment (SPSS, Inc.).

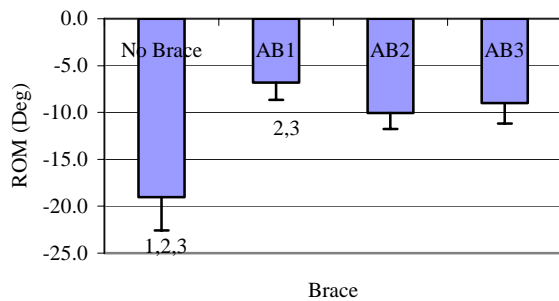
## **RESULTS**

The statistical results showed that the inversion ROMs for three braces were significantly reduced compared to no brace (Figure 1). Furthermore, AB1 had smaller ROMs than the other two braces and the ROMs for AB3 were significantly smaller than AB2.

During the inversion drop test, the right leg was dropped to invert the ankle soon after the foot touches the ground. The ankle inversion movement during the test shows two distinctive peak angles, with first and smaller peak occurring soon after the release of the trap door prior to its contact with

ground, and a second and greater peak occurring at around 330 ms after the door release.

For the inversion drop test, the ANOVA results showed that the peak inversion angle after contact for the three braces were all significantly reduced than that of no brace (Table 1). The inversion ROM was also significantly reduced in all three braces compared to the no brace. The peak inversion velocity was also significantly reduced by wearing an AB1 and AB2 brace (Table 1).



**Figure 1.** Mean and standard deviation of passive inversion ROM. <sup>1</sup> – significantly different from AB1, <sup>2</sup> – significantly different from AB2, and <sup>3</sup> – significantly different from AB3.

Cond	Max_Inv (deg)	Max_Inv_Vel (deg/s)
NB	26.1 ± 6.7 <sup>1,2,3</sup>	236.8 ± 75.2 <sup>1,2</sup>
AB1	13.7 ± 8.2	146.9 ± 84.3
AB2	17.1 ± 8.9	183.1 ± 94.5
AB3	18.7 ± 11.0	188.5 ± 110.2

Table 1. Average selected ankle kinematic variables of ankle inversion drop: Mean ± SD. <sup>1</sup>: significantly different from AB1, <sup>2</sup>: significantly different from AB2, <sup>3</sup>: significantly different from AB3.

## DISCUSSION

The effectiveness of the three ankle braces is evident with reductions of inversion ROM of 70%, 49% and 61% for AB1, AB2 and AB3 respectively. The efficacy of the

braces was further demonstrated in the kinematic behaviors during the inversion drop test. The peak inversion angle in the inversion drop test showed reductions of 48%, 34% and 28% for AB1, AB2 and AB3, respectively, compared to the no brace condition. For the ROM, reductions of 35%, 17% and 21% were seen for these braces. The reduction for the peak inversion velocity showed similar trends with 38%, 23% and 20% reduction for the same braces. The Element (AB1) was most effective, showing a greater reduction (more control) on peak inversion (13%), inversion ROM (18%), and peak inversion velocity (15%) than Functional Ankle brace (AB2) and ASO brace (AB3).

## SUMMARY

In summary, the Element ankle brace with a subtalar locking system is most effective in restricting inversion motion during the passive and dynamic tests.

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