A THREE-DIMENSIONAL KINETIC COMPARISON OF THE EFFECTS OF PROPHYLACTIC ANKLE DEVICES

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INTRODUCTION

With the rising cost of athletic tape many sports medicine programs are switching to reusable ankle support devices. Over the past decade various devices have been compared for their effects on range of motion (ROM), strength, and speed using isokinetic devices (Gross et al., 1991; Gehlsen et al., 1991), goniometers (Laughman et al., 1980; Greene and Wight, 1990), and case studies (Garrick and Requa, 1973; Rovere et al., 1988). Few studies have placed subjects in an actual weight bearing situation and fewer still have simulated actual game or practice conditions. Hamill et al. (1986) compared ground reaction forces between tape and lace-up supports in a regular gait pattern. However, to this time there have been few three-dimensional kinetic studies comparing ROM and internal joint forces allowed by the various stabilizers on the market. The purpose of this study was to compare three of the most commonly used support designs for effects on ankle range of motion and attenuation of forces in the lower extremity while landing from a volleyball block jump. Using three-dimensional cinematographic and kinetic data analysis, the Swede-O-Universal Athletic, Aircast Sport-Stirrup, and Active Ankle Trainer were compared.

METHODOLOGY

Twelve female intercollegiate volleyball players, mean age of 20.08 ± 2.0 years, mean height of 172.94 ± 8.02 cm, and mean mass of 67.84 ± 8.5 kg, from Texas Women's University participated on a voluntary basis. Each subject supplied signed informed consent, and University procedures for protection of human subjects were followed. All subjects were injury free for six months prior to the investigation. Injury free was defined as having no ankle, knee, hip, or back injury causing the subject to miss more than one University match or practice.

Using a table of random numbers, subjects were assigned to one of three test groups, Active Ankle Trainer (AA), Aircast Sport-Stirrup (AC), or Swede-O-Universal Athletic (SW). To allow ample break in time but prevent subjects from becoming dependent on the supports, all devices were broken in for 1 hour to 1 hour 30 minutes during each of five practice sessions prior to test date. Subjects also received new Mizuno Power Star volleyball shoes which were worn only with the braces during the break-in period and during data collection. During the break-in period anthropometric measurements on each subject were obtained using methods described by Vaughan et al. (1989). Three-dimensional cinematographic data were obtained using one Photosonics and one Locam high-speed camera at 104 and 93 fps, respectively. Force data were collected at 100 Hz using a Kistler force platform. Braces were worn on both ankles and data were collected for the right ankle of each subject for each of three experimental conditions: a) before application of braces (NB), b) immediately after application of braces (BP), and c) after braces were worn for a 1 hour 30 minute off-season practice session (AP). All devices were applied by the same certified athletic trainer. Subjects were not allowed to make adjustments to the braces after application. All athletes wore Mizuno volleyball shoes during data collection.

During each test condition, a volleyball net set to standard height and a ball suspended above the net helped to simulate an actual blocking situation. The subjects were instructed to approach from the left side of the forceplate, perform a center block jump, and land on the force platform with the right foot only. Three trials from each condition were performed. Data collected from one representative trial were used for analysis. An NAC film analysis projector and Numonics graphic digitizer interfaced to an IBM compatible personal computer were used to obtain two-dimensional coordinates. A stationary direct linear transformation program was then used to obtain three-dimensional coordinate data. Force data matched to the lowest camera frame rate were used to compute kinematic and kinetic variables.

Using BMDP software, a two-way repeated measures analysis of variance (α =0.05) with a Scheffe post hoc was used for statistical analysis of each factor in question. Variables which were analyzed included absolute ankle angle, medial/lateral ankle forces, and compression force at both the ankle and knee.

RESULTS and DISCUSSION

Means (sd) for the kinematic and kinetic data are presented in Table 1.

Table 1. Means and standard deviations for maximum ankle and knee variables.

		Brace Type		
Variable	Condition	Active Ankle	Aircast	Swede-O
Ankle angle	NB	140.64 (11.12)	139.59 (2.08)	151.77 (2.08)
	BP	146.73 (1.76)	142.19 (3.79)	146.68 (5.02)
	AP	147.36 (6.93)	143.13 (4.93)	147.67 (5.11)
Eversion force	NB	0.13 (0.18)	0.28 (0.30)	0.07 (0.04)
	BP	0.14 (0.19)	0.49 (0.41)	0.38 (0.07)
	AP	0.33 (0.35)	0.54 (0.45)	0.31 (0.44)
Inversion force	NB	0.49 (0.45)	0.87 (0.68)	0.34 (0.12)
	BP	0.70 (0.39)	0.44 (0.51)	0.43 (0.58)
	AP	0.65 (0.39)	0.49 (0.32)	0.36 (0.31)
Ankle comp.	NB	2.13 (0.71)	2.56 (0.56)	1.81 (0.65)
	BP	2.07 (0.35)	2.57 (0.63)	2.09 (0.41)
	AP	2.42 (0.57)	2.62 (0.78)	1.91 (0.68)
Knee comp.	NB	2.05 (0.80)	2.48 (0.57)	1.72 (0.78)
	BP	1.96 (0.31)	2.60 (0.67)	2.21 (0.38)
	AP	2.41 (0.51)	2.52 (0.68)	1.72 (0.75)

Statistical analysis revealed a significance across brace effect ($p<0.05$) for maximum ankle angle and across condition effect for maximum lateral force ($p<0.05$); however, post hoc analysis found no significant differences between any two groups for either case. No significant main effect or interaction was found for maximum inversion, ankle compression, or knee compression forces. Examination of force and angle patterns throughout the landing cycle showed consistency across conditions for all brace types. An example is presented in Figure 1. Vertical ground reaction force time curves for all subjects' landings under all conditions were consistent with those found by Stacoff et al. (1988) for a typical forefoot landing. One subject from each test group changed from a non-heel contact landing, similar to that reported by Gross and Nelson (1988), during the non-braced condition to a heel contact landing after bracing (Figure 2). This phenomenon could be due to subjects' familiarity with the testing conditions and increased awareness of the lower extremity caused by bracing.

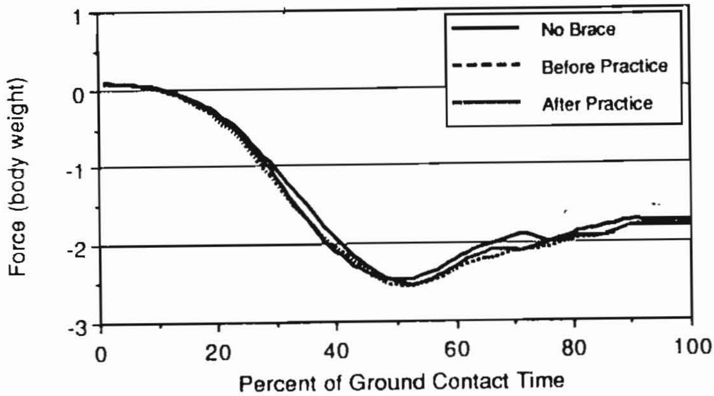

Figure 1. Average ankle compression force :AirCast treatment (n=4).

a) b)

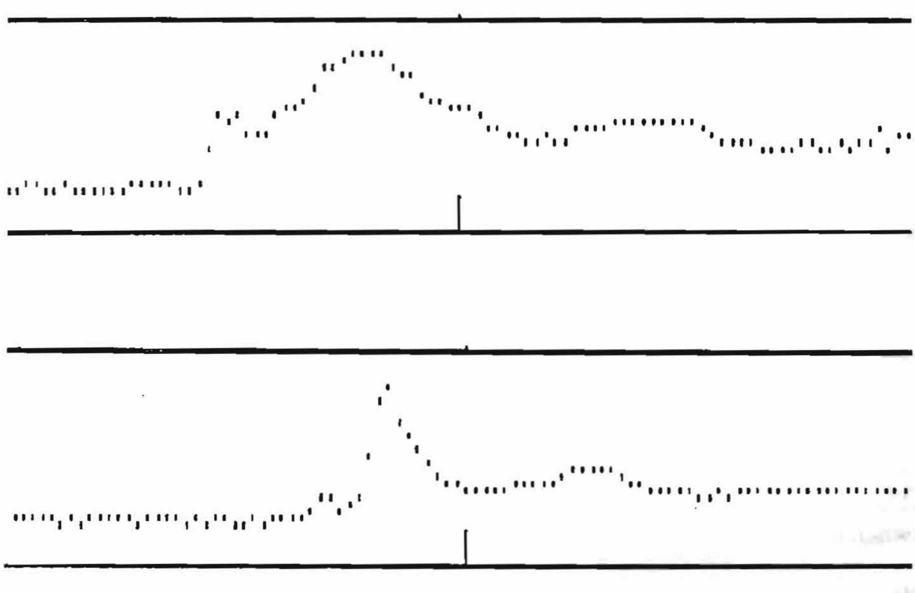

Figure 2. a) GRF curve pre-brace and b) post-brace.

CONCLUSIONS

Results of this study suggest that the differences in design between the Swede-O-Universal, Active Ankle, and Aircast ankle brace systems do not vary in effect on ankle angle and attenuation of forces in the lower extremity when landing from a volleyball block jump. Landing style is also not affected by the application of any of these devices. Based on these findings, the selection of prophylactic ankle support should be left to athlete preference and budget. Future studies which may further strengthen these conclusions include the use of additional brace designs and increased numbers of subjects. Examination of ankle inversion and eversion moments under various athletic conditions should also be considered.

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