Effects of Ankle Braces Upon Agility Course Performance in High School Athletes

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Abstract: *The purpose of this study was to compare the effects of wearing the Aircast™ Sports Stirrup, Aircast™ Training brace, Swede-O™ brace, and DonJoy™ Ankle Ligament Protector while running an agility course. Eighty-five high school athletes with no history of ankle injury and no experience in wearing any ankle support served as subjects. Each subject participated in four separate testing sessions. During sessions 1 and 4, subjects ran the agility course under the control (unbraced) conditions. Sessions 2 and 3 consisted of randomly wearing the ankle braces while running the agility course. A questionnaire concerning support, comfort, and restriction was completed by each subject after wearing each of the braces. An analysis of variance (ANOVA) with repeated measures revealed that a significant difference existed between the agility times. Tukey's post hoc test indicated that a significant difference existed between each ankle brace and the control 2 agility times as well as a control 1 and control 2 time difference. The control time difference was attributed to a learning effect. An ANOVA with repeated measures of only the four braces revealed that a significant difference existed between the agility times. Tukey's post hoc test showed the only difference was between the DonJoy Ankle Ligament Protector and the Aircast Training brace. We concluded: 1) there is limited practical performance effect upon agility while wearing an ankle brace; and 2) an athlete's perceived comfort, support, and performance restriction are contributing factors that may directly influence the effectiveness of ankle bracing.*

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Ankle sprains continue to be a leading injury of many of today's athletes. External ankle support is generally accepted as a preventive practice for these injuries. Over the years, adhesive taping has been considered the standard method of ankle support. However, ankle bracing has been introduced as an alternative to this established standard, based upon comparisons of supportive quality[3,7,8,14] and economical benefits.[10,14,17] The supportive quality of semirigid and lace-up design braces has been reported as comparable[3,8] and superior[7,14] to that of tape.

While the supportive quality of braces has been examined in several studies,[2,3,5–9,11,12,14] few have addressed performance impedance, which can be attributed to the wearing of ankle braces.[4,6,13] Despite limited examination of the effects of braces on athletic skills, we have found that many athletes, coaches, and health care professionals have a personal perception that ankle braces restrict performance. Therefore, we designed a study to: 1) compare the times required to run an agility course while wearing the Aircast™ Sports Stirrup, the Aircast™ Training brace, the Swede-O™ brace, and the DonJoy™ Ankle Ligament Protector; and 2) compare the levels of perceived support, comfort, and performance restriction reported by the athletes while wearing each of the ankle braces.

Methods

Eighty-five high school athletes (64 males, 21 females; 15.9 ± 1.2 yr) volunteered as subjects. Informed consent and memorandum forms were completed by both subjects and their parents before any data were collected. Limiting criteria for all subjects consisted of: a) no prior history of an ankle injury during the 6 months before testing; and b) no prior experience in wearing any type of ankle support.

Data collection involved four separate testing sessions. Session 1 involved: a) the explanation of the experimental protocol; b) the running of two familiarization trials of the agility course (Fig 1); and c) the running of two timed agility trials under the control (unbraced) condition.

The created agility course can be used on any gymnasium floor that has a standard high school/collegiate basketball key. The course incorporates forward and backward running, lateral shuffling, and directional changes. These are all skills that are commonly used for participation in most team sports played on fields or gymnasium floors.

Sessions 2 and 3 involved the running of timed trials while wearing the Swede-O brace, the Aircast Training brace, the Aircast Sports-Stirrup, and the Donjoy Ankle Ligament Protector. Two separate models for the Aircast brace were used to see if width of the braces affected performance.[1,8] Both braces are 9 inches in length, but the Sports-Stirrup is narrower in malleolar coverage.

Both sessions 2 and 3 consisted of: a) running one familiarization trial; b)

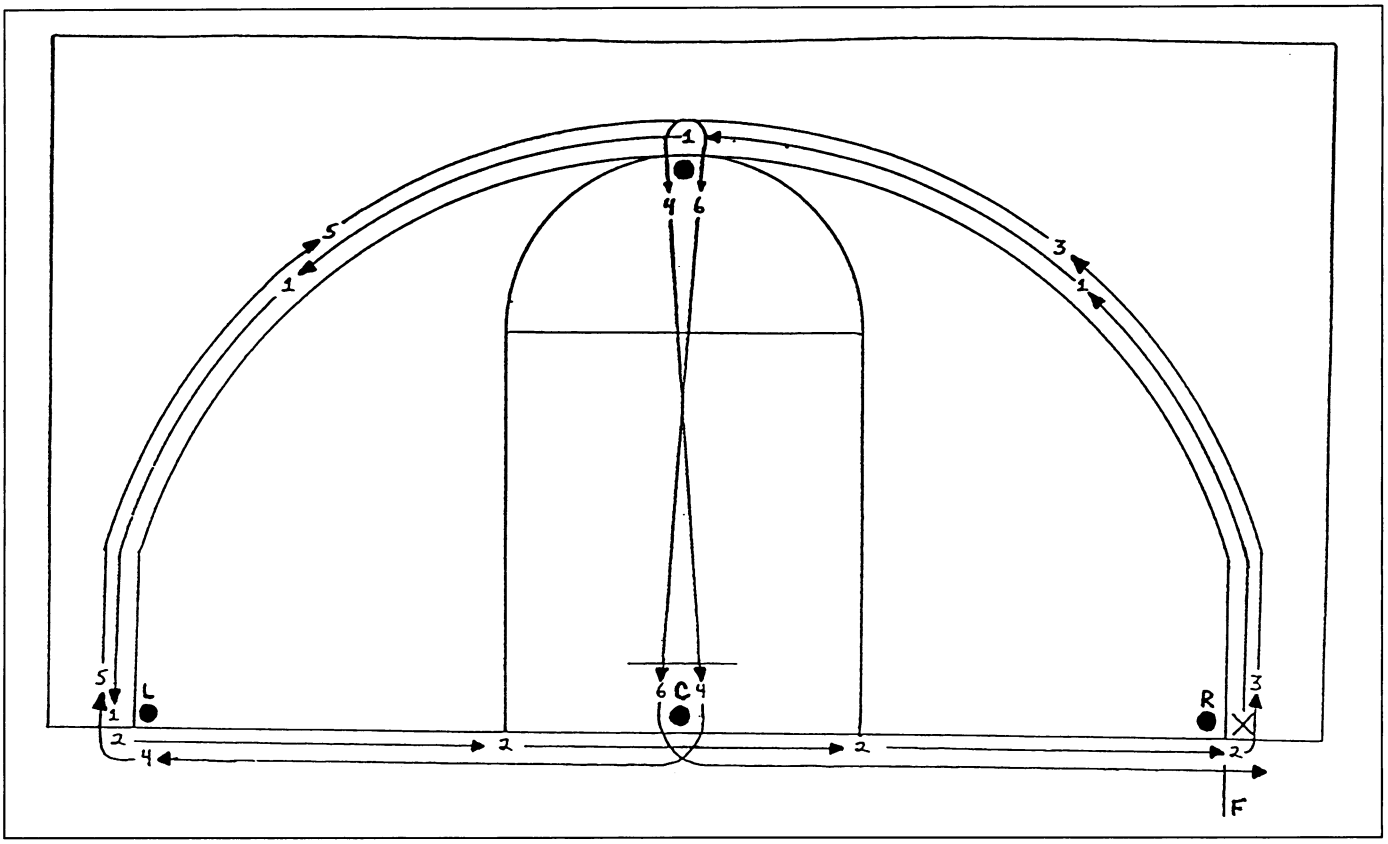

Fig 1.—Agility course used for timed trials. Subjects (*X*) start the agility course behind the baseline, next to the right (*R*) baseline cone. They: *1*, sprint along the three-point arch until they pass the left (*L*) baseline cone; *2*, sprint backwards along the baseline until they pass the (*R*) cone; *3*, shuffle (without crossing feet) along the arch, while facing the basket, until they pass the "top-of-the-key" cone; *4*, spint towards the basket and around the center (*C*) baseline cone and continue along the baseline towards the (*L*) cone; *5*, shuffle along the arch, while facing the basket, until they pass the top-of-the-key cone; *6*, sprint towards the basket and around the (*C*) cone and continue along the baseline towards the (*R*) cone. Time is stopped when the subject crosses the finish line (*F*). (Subjects run around cones and run as close as possible to lines while staying outside them; ● refers to cones.)

running two timed trials while wearing one of the braces; and c) running two more timed trials wearing a different brace. All ankle braces were applied to each subject's right ankle according to manufacturers' guidelines.[1,16,18] The order in which the ankle braces were tested was randomized for each subject through the use of a table of random numbers.[19]

Session 4 involved: a) the running of one familiarization trial; and b) the running of two timed trials under the control condition. The running of two separate control conditions was completed to examine any learning effect that may have occurred.

Throughout testing, subjects were asked to wear the sneakers that they felt provided optimal traction (the same pair was worn during all four sessions). Before the running of any trials, during each of the four sessions, the subjects ran two warm-up laps around the gymnasium and performed quadriceps, hamstring, and hip adductor stretching exercises. A 4-minute rest period was given between all trials. The faster time of two hand-held timers was recorded to the nearest tenth of a second. Subjects were not shown any of their agility times until the final session was completed. The mean value of the two trials, for each condition, was used for data analysis.

Subjects were asked to complete a questionnaire (Fig 2) regarding how well each brace rated for support, comfort, or restriction of speed and quickness following the completion of the time trials under each bracing condition. Each subject was also asked to respond to the following brace preference question at the completion of all testing: "If you were required to wear one of the braces for activity following an ankle sprain, which one would you choose?"

To statistically analyze the agility time differences between the braces, an analysis of variance (ANOVA) with repeated measures was used. If significance was found, Tukey's post hoc test was employed to locate the specific differences. All analyses were performed using the SAS statistical package.[15] In all instances, the level of significance used was $p < .05$.

The Chi-square statistic was used to compare the set of observed frequencies with a set of expected frequencies for each of the questionnaire ratings of the four braces. For questions 1 and 2, subjects were

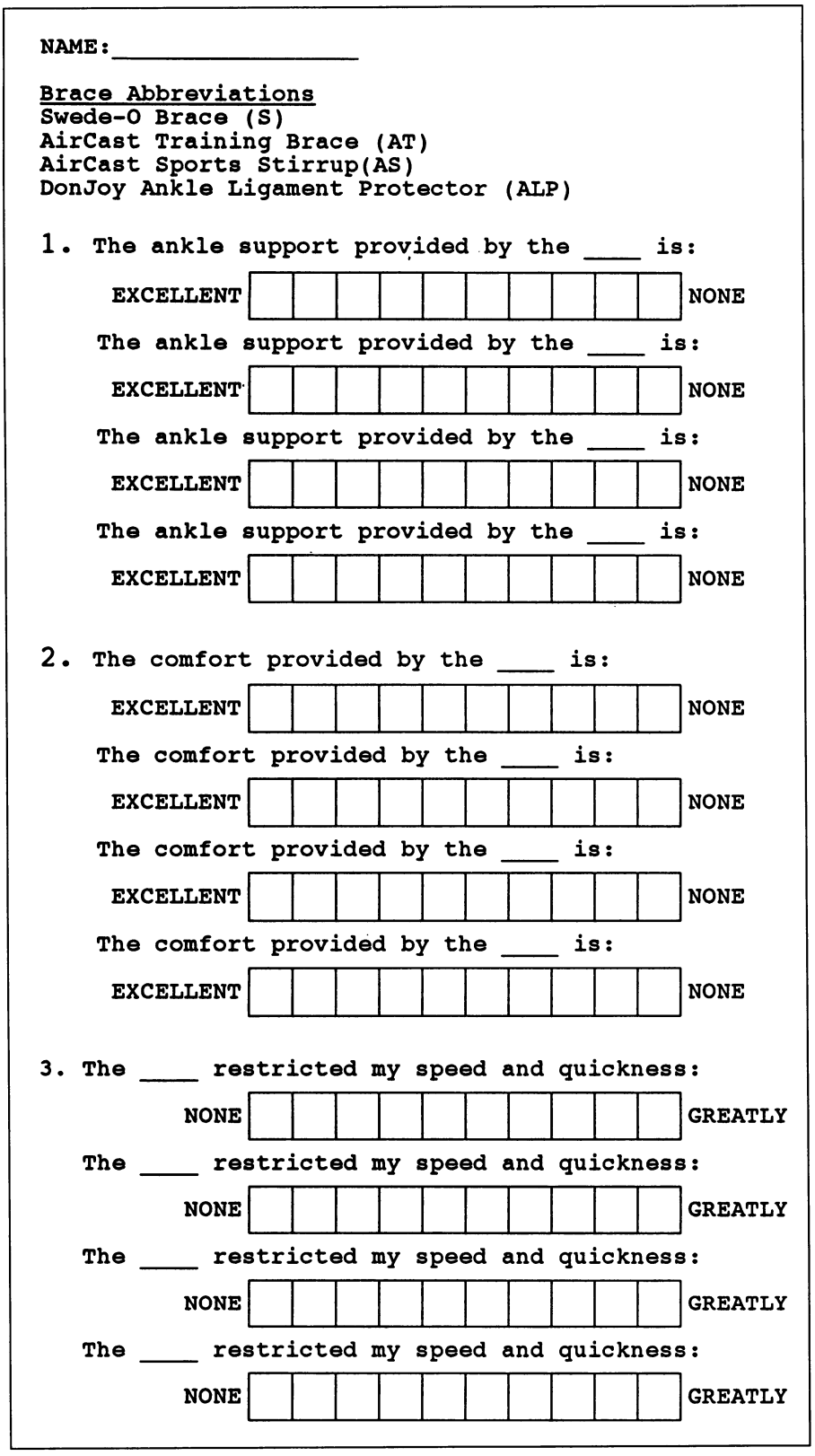

Fig 2.—Subjective questionnaire for ankle braces.

asked to shade the box for each brace, which they subjectively rated from "none" (one box shaded) to "excellent" (ten boxes shaded) for support and comfort. Question 3 used the subjective rating continuum from "none" to "greatly" for rating the restriction of speed and quickness for the four braces. The level of significance used was $p < .05$.

Results

The Table summarizes the results of the agility times for the experimental conditions. Agility times were significantly less for Control 2 (posttest) than for control 1 (pretest) ($F[1,83] = 46.5$, $p < .0001$). This suggested that a learning effect occurred and that a further evaluation should include only braced agility times. There was a significant difference between the four braces ($F[3,252] = 5.61$, $p < .001$). Subjects performed the agility test quicker when wearing the Aircast Training Brace than when wearing the DonJoy Ankle Ligament Protector (Tukey; $p < .05$). No other significant differences existed between the braces (Tukey; $p > .05$).

Subjects felt the four braces provided unequal support ($\chi^2[12] = 854$, $p < .05$), comfort ($\chi^2[12] = 810$, $p < .05$), or restriction of speed and quickness ($\chi^2[12] = 869$, $p < .05$). They suggested that the Swede-O brace, the Aircast Sports Stirrup brace, and the Aircast Training brace provided excellent support and comfort and were the least restrictive of speed and quickness.

Regarding the question concerning brace preference, 42% of the subjects preferred wearing the Swede-O brace, while only 9% preferred the DonJoy Ankle Ligament Protector brace (see Table).

Discussion

Injury prevention is a common concern for all those involved with athletics. Anatomical bracing is used to reduce both the frequency and severity of injuries that occur during the performance of athletic skills. The selection of any type of bracing does not revolve entirely around supportive quality. While supportive quality remains the primary focus,[2,3,5–9,11,12,14] other factors contribute to the effectiveness of bracing. These factors address the concerns of the athlete, which directly influence the bracing practice. The contributing factors are: 1) subjective comfort, support, and performance restriction effects, and 2) objective effects upon performance.

Agility Time (Seconds) and Brace Preference (n = 85)

Brace	Mean	± SD	Preference
Control 1 (unbraced)	22.6	1.7	
Aircast™ Sports Stirrup	22.6	1.9	20, 23%
Aircast™ Training	22.3*	1.9	22, 26%
Swede-O™	22.5	2.0	36, 42%
DonJoy™ Ankle Ligament Protector	22.7*	1.9	8, 9%
Control 2 (unbraced)	22.0	1.9	

* Means with superscripts are significantly different.

Subjective Factors

The athlete's perceived support, comfort, and performance directly influence an athlete's ankle bracing preference. This was demonstrated by the results of our questionnaire and the subjects preference in braces, which is similar to the results of Alves et al.[2] They examined the comfort, support, and brace of choice reported by 27 subjects for the Aircast Sports-Stirrup brace, the DonJoy Ankle Ligament Protector brace, the Swede-O brace, and the Kallassy brace. Each subject was asked to: 1) rank the braces from most comfortable to least comfortable; 2) rank the braces from most supportive to least supportive; and 3) choose their personal preference if they had to wear one of the four braces. Subjects ranked the braces after a 10-minute exercise session consisting of: 1) stationary bicycling for 5 minutes, 2) running basketball lines for 2 minutes, 3) running and cutting for 2 minutes, and 4) lateral slalom jumping for 1 minute.

In the Alves et al[2] study, the subjects rated the Kallassy, Aircast Sports Stirrup, and the Swede-O braces as the most supportive and comfortable, and rated the DonJoy Ankle Ligament Protector as providing the least support and comfort, as did the present study. The present study further found the DonJoy Ankle Ligament Protector to be the most restrictive for speed and agility and the least preferred brace of choice, as did Alves et al.

In our study, the lower rating for the DonJoy Ankle Ligament Protector brace in all three questions directly influenced its low preference percentage. The higher ratings for the three other braces suggest the subject's preference for these braces. The higher percentage of athletes preferring the Swede-O brace over the Aircast Sports Stirrup and Aircast Training braces may be due to its design. The Swede-O brace may be viewed as easier to apply. Once the Swede-O brace is sized appropriately, according to manufacturers' guidelines (shoe size), its lace-up design requires no adjustments or landmarking. The Aircast Sports Stirrup and Aircast Training braces require the athlete to apply the brace using the malleoli as landmarks.

Objective Factors

Our results, and those of others,[4,6,13] suggest that some braces have little effect upon the completion of athletic skills. Paris[13] reported no significant differences in performance of 18 elite soccer players during speed, balance, agility, and vertical jump testing. The athletes performed the skills under taped, McDavid brace, New Cross brace, Swede-O brace, and unbraced conditions. The three braces used were lace-up designs.

Burks et al[4] tested 30 university athletes in the broad jump, vertical jump, 10-yard shuttle run, and 40-yard sprint. They completed these skills under taped, Swede-O brace, Kallassy brace, and unbraced conditions. The speed and directional changes used during the shuttle run are recognized as a test of agility.[19] The two braces were not significantly different compared to unbraced conditions during the shuttle run. However, there was a significant difference between tape and the Kallassy brace during the shuttle run. The three other skills reported superior performance with no ankle protection, but not all differences were statistically significant.

Green and Wright[6] tested 12 university softball players in base running times. They reported no significant difference between the DonJoy Ankle Ligament Protector, Swede-O brace, and unbraced conditions. However, the Aircast brace (size not mentioned) significantly impaired the athletes' running times.

Our results showed that there was a significant difference between the braced conditions and control 2 (unbraced) condition, as well as a significant difference between the two control conditions. However, there was no significant difference between any of the braced conditions and the control 1 condition. This may be attributed to a learning effect occurring during testing.

The only significant difference among the braces was between the Aircast Training brace and the DonJoy Ankle Ligament Protector brace. The slower time of the DonJoy Ankle Ligament Protector (.3-second difference) is insignificant when applied to an actual agility-type event requiring at least 22 seconds to complete.

Our results should be encouraging to athletes, coaches, and health care professionals who may have been hesitant in the past to use ankle braces. There should not be a concern for restricted performance when choosing an ankle brace for preventive support. We believe that any performance impedance that is evident in athletes who wear an ankle brace following injury may be attributed to the residual effects of the injury requiring the brace to be worn.

Conclusions

Commercial braces should continue to be chosen, based on economical benefits, ease of application, and supportive qualities. Based on our results we conclude: There is limited practical performance effect upon agility while wearing an ankle brace. An athlete's perceived comfort, support, and performance restriction are contribut-

ing factors that may directly influence the effectiveness of ankle bracing.

Acknowledgments

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