The Effect of Molded and Unmolded Orthotics on Balance and Pain While Jogging Following Inversion Ankle Sprain

Linda Combs Orteza MS, PT, ATC
W. Daniel Vogelbach, PT, ATC
Craig R. Denegar, PhD, ATC

ABSTRACT: During this study, we examined the effects of using molded orthotics on persons who had suffered an inversion ankle sprain. We assessed standing balance with a digital balance evaluator for a group of 15 subjects who had no history of ankle sprains and for a group of nine subjects with acute ankle sprains. Then, we assessed the subjective pain experienced by ten subjects with acute ankle sprains while they jogged. During each part of the study, we tested the subjects while they were using a molded orthotic, an unmolded orthotic, and no orthotic in their shoes. We alternated the order of these treatments with each consecutive subject. The results indicate that subjects with a history of recent inversion ankle sprains had poorer balance than uninjured subjects. Molded orthotics had no effect on balance scores in the uninjured group, but their use improved balance scores in the ankle sprain group. Unmolded orthotics did not improve balance scores. Molded orthotics helped to decrease ankle pain during jogging for those with an ankle sprain, but unmolded orthotics did not. These findings suggest that molded orthotics may play a role in the treatment of inversion ankle sprains.

Linda Orteza is director of rehabilitation at SportsMedicine Grant in Columbus, OH.

Daniel Vogelbach is area manager of operations at Health South Rehabilitation Corporate, Orlando, FL.

Craig Denegar is an associate professor at Slippery Rock University, School of Physical Therapy, Slippery Rock, PA.

A sprained ankle is one of the most common injuries in competitive and recreational sports. Without adequate treatment, this injury can result in chronic instability (2). The majority of treatment protocols for ankle sprains call for inflammation control, early motion, gradual strengthening, proprioceptive training, functional progression, and some type of supportive device to protect the talocrural joint (4,12). The subtalar joint is seldom addressed in the treatment protocol, even though subtalar joint motion increases after lateral ankle sprains (9) and subtalar joint motions have a direct effect on ankle injuries (7). Standing talar tilt, which occurs with ankle sprains, can be limited by a neutral orthotic designed to control the subtalar joint, rather than the talocrural joint (14). Clinically, we have observed that such an orthotic decreases pain and permits an earlier return to normal activity following ankle sprains.

The reasons for conducting this study were to determine if: 1) recent inversion ankle sprains affect time out of balance as measured with a digital balance evaluator; 2) molded and unmolded orthotics affect balance measurements; and 3) molded and unmolded orthotics affect perceived pain during jogging following a lateral ankle sprain.

Materials and Methods

This study consisted of two parts: 1) assessment of standing balance with the digital balance evaluator in a group of 15 subjects (6 males, 9 females, 22.0±2.3 yr) who had no history of ankle sprains, and in a group of nine subjects (5 males, 6 females, 17.0±3.4 yr) who had acute ankle sprains; and 2) subjective assessment of pain experienced while jogging by 10 injured subjects (7 males, 3 females, 17.0±3.1 yr) who had acute ankle sprains. For this study, "acute" was defined as an ankle sprain that had occurred within six weeks of testing. All patients with inversion ankle sprains, who received physical therapy at Morgantown Physical Therapy Associates between June 19 and August 13, 1987 or between April 18 and June 30, 1988, were asked to participate in the study. Those who gave their consent were tested. The uninjured group consisted of volunteers from Morgantown Physical Therapy Associates and the surrounding community who had no history of an ankle sprain. All subjects were full weight-bearing at the time of testing. The subjects in this portion of the study were not the same as the injured subjects who were evaluated on the digital balance evaluator, because the testing was not conducted during the same time period.

The digital balance evaluator is a single axis board that allows inversion and eversion of the foot (Fig 1). The board makes electrical contact at 4°, which defines a loss of balance. The amount of time that the loss of balance is maintained is recorded in seconds and is referred to as time out of balance. These two readings accumulate for a 30-second trial period. Time out of balance was analyzed in an effort to measure balance ability. The digital balance evaluator provides reliable measures of the number of touches and time out of balance (6,15).

Molded orthotics were made from 1/8-inch solid Aquaplast™, which is a semi-rigid material. The Aquaplast was molded to the neutral subtalar joint position while the subject lay prone on an examining table. The examiner palpated the talonavicular joint for congruency and loaded the fifth ray. The neutral position for the subtalar joint is defined as the

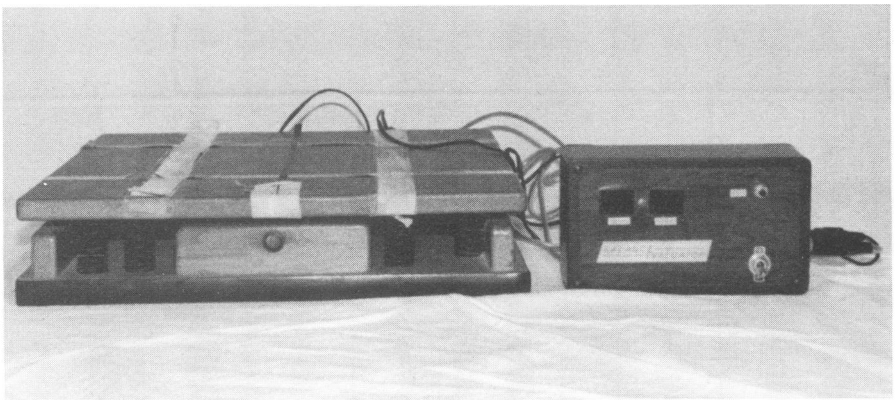

Fig 1.—The digital balance evaluator is a single axis device that assesses time out of balance and the number of times that balance is lost.

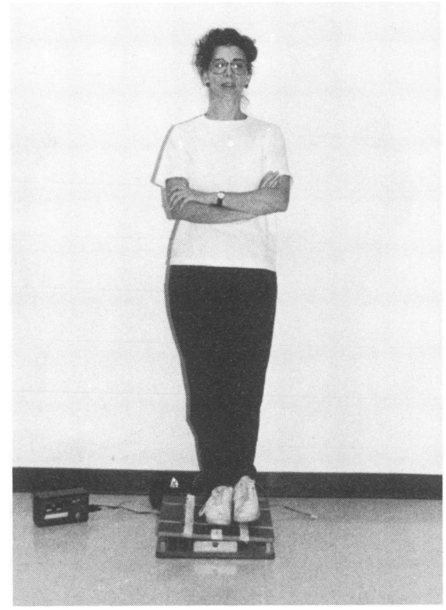

Fig 2.—Subjects were instructed to stand with their arms crossed in front of the chest and to focus on a designated distant object.

position of the foot during which the talonavicular joint is congruent and the forefoot is fully pronated against the rearfoot (1).

The Aquaplast then was ground smoothly to the length of the metatarsal heads, and extrinsic forefoot posting was added to those individuals who, upon examination, were found to have a forefoot varus deformity. Rearfoot varus was corrected by grinding the orthotic more laterally than medially. The Aquaplast then was covered with 1/8-inch Plastazoate® to form a full-length orthotic. No forefoot or rearfoot valgus deformities were found in any subjects.

Unmolded orthotics consisted of a 1/8-inch Plastazoate full-length orthotic. The orthotic was cut to the length of the individual's foot and then was inserted in his or her shoe without heating or molding.

All subjects performed under three separate conditions: 1) wearing a molded orthotic, 2) wearing an unmolded orthotic, and 3) wearing no orthotic in their shoes. Six treatment orders were established with two 3x3 Balanced Latin Squares. Subjects were assigned randomly to one of the treatment orders.

During the first phase, injured (n=19) and uninjured (n=15) subjects were tested on the digital balance evaluator. In order to become acquainted with the digital balance evaluator, the subjects practiced for three minutes. If the practice session caused any discomfort to the subjects who had ankle sprains, the testing was discontinued until it could be performed without pain. Subjects who were pain-free completed three 30-second trials, one under each of the treatment conditions, resting one to two minutes between trials.

The treated foot was placed on the board in the same position for each subject and trial. Subjects were instructed to fix their eyes on a designated distant object, because eye tracking has been shown to have a negative effect on balance (13). Subjects were instructed to cross their arms over their chest and not allow their opposite foot to touch the board or the floor (Fig 2).

In the second phase of the study, 10 injured subjects were asked to jog 20 yards without an orthotic, 20 yards with an unmolded orthotic, and 20 yards with a molded orthotic. After jogging, the subjects were asked to assess their perceived pain level in the injured ankle during gait, as follows: grade four for severe pain, grade three for significant pain, grade two for moderate pain, grade one for minor pain, and grade zero for no pain.

Data Analysis

An analysis of variance (ANOVA) with repeated measures on one factor (treatment condition) was conducted on the digital balance evaluator data. Follow-up analysis was performed in three steps. First, the digital balance evaluator data for time out of balance of the injured and uninjured subjects without orthotic devices was compared using a one factor ANOVA. Repeated measures ANOVAs were conducted separately on the digital balance evaluator data collected from the injured subjects for the molded orthotic, unmolded orthotic, and no orthotic conditions. Then, a repeated measures ANOVA was conducted on the reported pain during running data for each of the trials. Planned comparisons were performed with repeated measures ANOVAs to identify sources of variance. A Bonferroni correction was used to maintain a $p=.05$ alpha level for the balance and pain data from injured subjects. Finally, the digital balance evaluator data of the uninjured group without orthotics was compared to that of the injured subjects with molded orthotics.

Results

The mixed model ANOVA revealed a significant main effect for the treatment condition ($F(2,48)=4.75$, $p=.013$) and a group by treatment condition interaction that approached significance ($F(2,48)=2.56$, $p=.088$). Because the descriptive data suggests that the significant main effect was primarily the result of the use of orthotics with ankle-injured subjects and that the interaction approached significance, follow-up tests were conducted. Injured subjects were out of balance more than uninjured subjects ($F(1,24)=4.95$, $p=.036$). (See the Table for time out of balance means and SDs for injured and uninjured subjects.) For injured subjects, a difference between the three treatments on the digital balance evaluator was found ($F(2,20)=5.03$, $p=.026$).

Planned comparisons identified significant differences between trials with molded orthotics and no orthotics ($F(1,10)=3.68, p<.01$), but no significant differences between unmolded orthotics and molded orthotics ($F(1,10)=1.03$, $p>.335$) or between no orthotics and unmolded orthotics ($F(1,10)=3.75, p=.082$). No significant differences ($F(2,28)=.42$, $p=.661$) in digital balance evaluator scores were found among uninjured subjects using no orthotic, unmolded orthotics, and

Time Out of Balance Values of Uninjured and Injured Subjects in Seconds ($\bar{X} \pm SD$)

	No Orthotic	Unmolded Orthotic	Molded Orthotic
Injured	7.5±5.2	5.9±4.7	4.7±4.9
Uninjured	4.0±2.8	4.0±3.6	3.5±3.5

molded orthotics. The repeated measures ANOVA on the reported pain during jogging under the three conditions revealed a significant difference between trials ($F(2,18)=13.87$, $p<.01$), molded orthotic=.9±.9, unmolded orthotic=1.7±.8, no orthotic=1.8±.6). Planned comparisons revealed that subjects reported significantly less pain ($p<.01$) when wearing a molded orthotic while jogging than when wearing the unmolded orthotic or no orthotic. No differences were found between those subjects using the unmolded orthotic and those not using an orthotic device. Finally, the digital balance evaluator data from the uninjured subjects who did not use orthotics was compared to the molded orthotics trial for the injured group. The difference between those trials was not significant ($F(1,24)=.23$, $p>.05$).

Discussion

Subjects with ankle sprains had significantly higher time out of balance scores. This concurs with Freeman's findings of a decrease in proprioception following an ankle sprain (2,3,4). The molded orthotic did have a significant effect on improving time out of balance scores after an ankle sprain. If the molded orthotic had been effective in both the uninjured and injured groups, one could speculate that the molded orthotic was effective in improving digital balance evaluator scores solely as a result of increased structural support (medially and laterally), thus preventing or retarding inversion and eversion. Because the orthotic did not affect time out of balance scores in the uninjured group, it is unlikely that structural support is the reason for effectiveness in the injured group. In fact, the descriptive data and the final statistical comparison between uninjured subjects without orthotics and injured subjects wearing molded orthotics suggests that molded orthotics restore much of the balance performance deficit created by the ankle injury.

The most common ankle injury is an inversion ankle sprain that usually occurs in plantarflexion (5,7). The anterior talofibular ligament is the most commonly sprained ligament associated with an inversion injury. The anterior talofibular ligament spans the lateral malleolus and the neck of the talus, and functions to limit anterior drawer of the talus and to limit adduction (internal rotation) of the talus (10). Closed chain pronation of the subtalar joint involves plantar flexion/adduction of the talus (11). Excessive pronation may result in undue stress to the injured anterior talofibular ligament. Thus, control of the subtalar joint may decrease ligamentous stress, resulting in decreased pain and improved function.

Joint mechanoreceptors located in the joint capsule and ligaments contribute to joint kinesthetic and proprioceptive feedback and postural movements (8,16). Although there are four types of joint mechanoreceptors (16), distinctions between the different types of mechanoreceptors are not addressed in this study. These mechanoreceptors usually are damaged with ligamentous injury, which results in a decrease in kinesthetic/proprioceptive feedback and functional instability (2,3,4).

Maintaining the foot in a more neutral position may decrease the stress on the injured ligament(s) and enhance the function of the injured joint.

No distinction was made between foot types in this study. Individual biomechanical and foot structure differences may affect the response to neutral orthotics post ankle sprain. The excessively pronated foot may benefit from greater support and control than the excessively supinated foot.

Within the limits of this study, our results suggest that neutral orthotics can play a role in the treatment of ankle sprains. Although the mechanism has not been fully identified, orthotics improve balance skills and decrease pain. Improved joint congruency and decreased stress to the soft and/or bony structures provide a plausible explanation and suggest that the orthotics may promote healing and speed return to activity. More investigation is warranted in order to fully understand the function of the subtalar joint in ankle sprains.

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