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ORIGINAL RESEARCH

Prophylactic Bracing Versus Taping for the Prevention of Ankle Sprains in High School Athletes: A Prospective, Randomized Trial

LCDR Timothy J. Mickel, MD,[1] LTC Craig R. Bottoni, MD,[2] Garvin Tsuji, MS, ATC,[3] Kevin Chang, ATC, CSCS,[4] Lenny Baum, ATC,[5] and Kristie Ann S. Tokushige, MS, ATC[6]

Prophylactic ankle taping has been considered the mainstay of ankle injury prevention and has been used at all levels of competitive football. An alternative to taping is a semirigid ankle orthosis. This study prospectively compared the incidence of ankle sprains in high school football players during a single season, after randomization to either prophylactic bracing or taping of both ankles. Of 83 athletes followed up for an entire season, 6 ankle sprains occurred, 3 in each treatment group; and there was no statistically significant difference in the incidence of ankle sprains between the 2 groups. The time required to tape an athlete averaged 67 seconds per ankle, resulting in a total of 97 minutes per ankle during an entire season, and the average cost to tape each ankle during an entire season was greater than the cost of the commercially available brace. The projected cost savings for an athletic program using prophylactic bracing could be substantial when compared with the use of prophylactic taping of the ankle. (The Journal of Foot & Ankle Surgery 45(6):360–365, 2006)

Key words: ankle, bracing, taping, instability

Introduction

Ankle sprains are one of the most common injuries sustained by athletes who engage in sports that demand frequent changes in the direction of body movement and rapid acceleration and deceleration, maneuvers that are commonly required in American-style football (1). It has also been estimated that over 25,000 ankle sprains occur per day in the United States (2), and ankle sprains have been shown to account for 10% to 15% of all injuries sustained in American football (3). When an ankle sprain occurs, the anterior talofibular ligament is most commonly injured, followed in frequency by the calcaneofibular ligament (4). Moreover, inversion sprains of the ankle can significantly affect performance and result in lost practice and game time, and they can lead to the development of chronic ankle instability and pain (5). Because of the high prevalence of these injuries, many organized sports associations have implemented prophylactic measures in an attempt to decrease the incidence and severity of ankle inversion injuries. Despite the prevalence of ankle sprains, however, controversy continues to exist in regard to the best method of treatment and prevention of these injuries (1, 6–13), and a review of the literature reveals a number of investigations that address the effects of shoegear (6, 7, 14), taping (1, 11), and bracing (12, 13, 15) on the incidence of ankle injuries.

Address correspondence to: Craig R. Bottoni, MD, OrthoSports, LLC, 3251 McMullen Booth Rd, Suite 201, Clearwater, FL 33761. E-mail: CBottoni@OrthoSPorts.com.

[1]Orthopaedic Surgery Resident, National Naval Medical Center, 8901 Rockville Pike, Bethesda, MD.

[2]Sports Medicine Orthopaedic Surgeon, OrthoSports, LLC, 3251 McMullen Booth Rd, Suite 201, Clearwater, FL.

[3]Head Athletic Trainer, Radford High School, 4361 Salt Lake Boulevard, Honolulu, HI.

[4]Head Athletic Trainer, 2825 Ala Ilima Street, Honolulu, HI.

[5]Head Athletic Trainer, Leilehua High School, 1515 California Avenue, Wahiawa, HI.

[6]Head Athletic Trainer, 730 Iliaina Street, Kailua, HI.

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In 2003, Gross and Liu (15), in a review of the then current literature, concluded that the prophylactic use of semirigid ankle braces appeared to be warranted, especially for athletes who participated in activities that had the highest risk of ankle injury. They found that ankle braces reduced the incidence of initial and, in particular, recurrent ankle sprains. In a 2-year prospective study of 2526 college-aged intramural basketball players, Garrick and Requa (1) reported that ankle taping reduced the incidence, severity, and long-term complications of ankle sprains, and that this resulted in less time lost from athletic performance. Rovere et al (11) compared laced ankle stabilizers with taping in a retrospective study of 297 college football players and found that laced ankle stabilizers were significantly more effective than taping in preventing ankle injuries (2.56 sprains per 1000 exposures vs 4.91 sprains per 1000 exposures). Furthermore, Tropp et al (16) evaluated the effect of an ankle orthosis on the incidence of ankle injury in a prospective, randomized study of 439 male soccer players and showed that the orthosis group demonstrated a 3% incidence of ankle sprains, whereas the control group demonstrated a 17% incidence, and this difference was statistically significant. Still further, Sitler et al (12) evaluated the effect of a semirigid ankle brace in a 2-year randomized clinical trial of 1601 intramural basketball players and showed that the brace group demonstrated a contact-related ankle injury rate of 1.6 sprains per 1000 athlete-exposures, whereas the control group demonstrated a statistically significantly greater injury rate of 5.2 sprains per 1000 athlete exposures. In that same study, no significant difference was noted for non–contact-related injuries. In a similar study by Surve et al (13), the effect of a semirigid ankle orthosis was evaluated in 504 soccer players who were stratified by, among other variables, the presence or absence of a history of previous ankle sprain. The athletes were randomized to either a semirigid orthosis or no prophylactic ankle support (the standard therapy control group), and the investigators observed that athletes with a history of previous ankle injury who were braced showed a statistically significantly lower incidence of ankle sprains (0.46 per 1000 playing hours) in comparison with those who were treated without any form of ankle support (1.16 per 1000 playing hours). Furthermore, these investigators did not observe a statistically significant difference in the overall incidence of ankle sprains between the treatment groups.

Traditionally, prophylactic ankle taping has been the mainstay for prevention of ankle injuries (1, 14). Proper ankle taping is generally understood to reduce plantarflexion and inversion of the ankle (9), and this has been shown to be the most common mechanism associated with ankle sprain injuries (3, 17). Taping is also believed to improve proprioception (18), and Thonnard et al (19) have proposed that the sprain-preventive effect of an orthotic device, such as a semirigid ankle brace, exists because of reloading and maintenance of the anatomical alignment of the ankle, such that a compressive load sustained by the orthosis wedges the talus into the tibiofibular mortise and subsequently prevents initiation of an inversion moment. Taping has been criticized for loosening with physical activity, and it has been stated that it offers no useful support after about 1 hour of exercise (10); and loosening has been shown to result in a reduction of as much as 40% to 50% of the original support after only 10 to 30 minutes of exercise (20, 21). Another criticism of the routine use of taping to stabilize the ankle is related to the total cost related to materials (tape, pre-tape skin-protectant spray and wrap) and the time necessary for application of a suitable ankle strap. One study reported a cost of $1.75 per ankle when taping was used to prevent ankle sprains, resulting in a cost of more than $400 per athlete over 1 college football season (11). For these reasons, a number of ankle braces, both laced and semirigid with Velcro straps, have been developed. Such braces can be applied by the athlete, retightened during play (8), and present a one-time cost (11) to the athlete or athletic program.

Our review of the literature revealed that there has never been a prospective, randomized comparison of ankle taping with semirigid ankle bracing for ankle sprain prevention in high school football players. The purpose of this study was to prospectively compare, in a randomised fashion, a commercially available semirigid ankle brace (AirSport Ankle Brace; Aircast, Inc, Summit, NJ) with conventional ankle taping for the prevention of ankle sprains in high school football players over the course of a single football season.

Methods

The study was approved by our institution's investigational review board. The subjects were enrolled from the 4 local community high school football teams and followed up for a single season. The only selection criterion used for the participating high school football teams was proximity to our institution. The regular season consisted of 7 regular season games excluding play-off games. Each game consisted of four 12-minute quarters. The typical practice averaged approximately 120 minutes. For the purposes of our investigation, each game or practice in which a player participated was counted as a single athlete-exposure. Because of military regulations related to human research, the individual athletes who participated in the study had to have an official military affiliation. Moreover, enrolled athletes had to meet academic eligibility requirements for participation in interscholastic sports based on their prior semester grade point average to be included in this intervention trial. Ninety-three consecutive military-dependent athletes who played varsity or junior varsity high school football were enrolled from the selected high schools. To participate, all

of the enrolled athletes also had to have currently stable, uninjured ankles and no current complaints related to either ankle, based on clinical examination. The subjects were randomized to 1 of 2 study groups using a group assignment list created with a random number generator (Microsoft Excel, Microsoft, Redmond, WA). The 2 groups consisted of those who had their ankles taped and those who used an ankle brace for every practice or game.

All practices and games were played on natural grass. Shoe type included a molded or screw-on cleat in all players, and the choice of shoegear was left up to the individual player. Team coaches, players, and athletic trainers were educated in regard to the terms of the investigation and were able to contact the investigators at any time during the course of the study. After being fitted for the ankle brace and after receiving written and verbal instructions on its application and use, and before the first practice session of the season, all of the participants in the brace group had to demonstrate proper application of their ankle brace to a research team member. The AirSport Ankle Brace was the ankle orthosis selected by the investigators for this study, and all of these devices were provided by Aircast, Inc, free of charge, for the purposes of this investigation. This particular device is a semirigid ankle brace with medial and lateral thermoplastic uprights lined with foam-filled air cell cushions. This ankle brace is designed for prophylactic use in the prevention of ankle ligament sprains and is attached to the leg with 3 Velcro straps (Velcro USA, Inc., Manchester, NH). The correct application of the ankle stabilizer was also explained to the participants and supervised by the head athletic trainer of each participating team. Players were also allowed to adjust the brace as necessary during practice and games at the individual athlete's discretion. For those athletes in the ankle taping group, team athletic trainers performed each ankle taping before practice and games. The tape used was Johnson & Johnson 1½-inch Coach adhesive tape (Johnson & Johnson, Inc., New Brunswick, NJ), and this was applied in a closed basket weave with a figure-of-eight heel lock. Nonstick spray, malleolar pads, and standard foam underwrap material were also used for each application of tape. Before each practice and game, the teams' head athletic trainer ensured compliance with the requirements of the study.

An ankle sprain injury was the outcome of interest, and this was defined as acute inversion trauma to the ankle ligaments resulting in an athlete's inability to participate for at least 1 day after the injury. All injuries were seen promptly by the athletic trainers who supervised all practices and games, and who were responsible for identifying the presence of sprained ligaments. The trainers were not blinded to the intervention, and the diagnosis was made based on clinical examination and did not include the use of radiographic inspection. Specifically, the diagnosis was based on direct clinical examination that included verbal questioning of the athlete regarding the nature and location of pain, and physical examination that entailed visual inspection, ligament palpation, and joint manipulation. Injuries were categorized by mechanism, either inversion or eversion, and the severity of the injury was graded as either grade I, II, or III (22, 23). After classification by the athletic trainers on the filed, all of the injuries were then reevaluated and confirmed by the senior author (C. R. B.). Grade I injuries displayed minimal visible swelling and no gross ligamentous instability on anterior drawer and/or inversion or eversion stress manipulation. Grade II injuries displayed moderate visible swelling and palpable ligamentous instability with a firm end range of motion on anterior drawer and/or inversion or eversion stress manipulation. Grade III injuries displayed marked moderate to severe edema and complete ligamentous instability without a firm end range of motion on anterior drawer and/or inversion or eversion stress manipulation. The number of ankle sprains and exposures (practices and games) were recorded in a central database, and the crude incidence of the outcome was calculated as the number of ankle sprains (numerator) divided by the number of exposures (denominator).

Statistical Plan

The data were collected in a manner that allowed for the determination of "injury exposure," and, as noted above for the purpose of calculating incidence, this figure served as the denominator and the number of sprains served as the numerator. The proportion of injuries between braced ankles was compared with taped ankles using the Fisher exact test with a 2-tailed comparison and an alpha error set at the 5% level. An a priori statistical power analysis indicated that, with 50 players participating in 23 practices/games in each intervention group, resulting in 150 (50 players multiplied by 23 practices/games) exposures in each group, there would be 79% power to detect a difference of 2.4% (a difference consistent with or smaller than the differences observed in previous trials comparing taping with other therapies for the prevention of ankle sprains in certain athletes) (11–13, 16).

To calculate the time and cost required to tape our subjects' ankles over the course of the study, one of the participating athletic trainers (G. T.) with 8 years' experience was timed to tape 50 ankles without interruption. This task averaged 62 seconds per ankle taped. The cost per ankle was then calculated by tape usage and cost per role (excluding the estimated cost of pre-tape wrap, nonadherent skin protectant spray, and the proportion of the trainer's wages spent on taping ankles).

TABLE 1 Results by intervention group (N = 93 participants)

Variable	Intervention group	
	Brace	Tape
n	48	45
Dropouts	6	4
Dropout rate (%)	12.5	8.89
Ankle sprains	3	3
Exposures*/group	3636	3906
Sprains/1000 exposures	0.83 (0.47, 1.21)†	0.77 (0.54, 1.04)*
Cost ($)‡/intervention/ ankle/season	<30α, <30β	776α, 1164β

*Exposure = each practice or game in which an athlete participated.
†Fisher's exact test with point estimate and 95% confidence interval.
‡Crude comparison based on the material costs of tape versus bracing, and the time required to apply tape to an athlete's ankle and the trainer's wage.
αCost based on a trainer's wage of $10/hour.
βCost based on a trainer's wage of $15/hour.

Results

Ninety-three subjects were enrolled in the study. Ten subjects, 6 from the bracing group and 4 from the taping group, were subsequently dropped from the analysis because of academic ineligibility that prevented them from playing, leaving 42 subjects (84 ankles) in the brace group and 41 (82 ankles) in the taping group (Table 1). Those athletes dropped from the study had been enrolled before commencement of team practice. However, they were deemed ineligible for participation in interscholastic sports activities based on their prior semester grades, and, therefore, no intervention data were collected on these individuals. During the preparticipation screening, our population of 93 individuals had 4 subjects with previous ankle injuries, 3 reporting a prior history of ankle sprain and 1 reporting a history of a "loose-feeling" ankle. All had normal clinical examinations as determined by the senior author (C. R. B.), and, therefore, none of these athletes were excluded from participation in study.

There were 3636 total exposures in the brace group and 3906 in the tape group (Table 1). There were 6 documented ankle injuries throughout the season in the overall study population, 3 in each intervention group. All 6 injuries were determined to be grade I lateral ligamentous sprains with an average of 4 missed exposures immediately after the injury (range, 1–6). There were no clinically evident fractures or "high" (disruption of the inferior tibiofibular syndesmosis) ankle sprains in either group. The overall rate of ankle sprains, regardless of the method of prophylaxis, was 0.796 per 1000 exposures. The brace group displayed a mean average of 0.83 ankle sprains per 1000 exposures compared with 0.77 sprains per 1000 exposures in the tape group, and this difference was not statistically significant ($P > .05$). Based on the actual number of exposures measured, our data provided a likelihood of 84% that a difference of 4 sprains per 1000 exposures could be detected, and thus left open the question of whether the sample provided enough statistical power to identify a significant difference between the incidence rate of ankle sprains in the 2 intervention groups. In an effort to further assess this potential limitation, an estimate of the largest probable difference between the crude incidence rate was computed. This analysis showed that there was approximately 1 chance in 20 that the true mean of the taped group, for instance, was 1.77 sprains per 1000 exposures (upper limit of 95% confidence interval, Table 1), and thus the true difference between the braced group and taped group would be 1 sprain per 1000 exposures. Therefore, a difference of 1 sprain per 1000 exposures could exist, albeit such a difference would be at the extremes of probability. Nonetheless, such a difference would result in 4 additional sprains per year in the taped group.

Based on actual measurements of use, the mean average amount of tape required to tape a single ankle was estimated to be 75% of a standard roll of tape. The cost per roll of tape was $1.12. Therefore, the cost was calculated to be $0.84 for each ankle per exposure. The cost over 1 season (48 exposures) for 1 ankle was approximately $40.01. This was compared with the average wholesale cost of the AirSport ankle brace of $28.00. The time required to apply the tape per ankle averaged 67 seconds, resulting in a total of 97 minutes per ankle (3 hours and 14 minutes for both ankles) during the season. This was compared with the time required by the trainer to fit and instruct the athlete on use of the brace, which, after the initial training visit, was minimal throughout the study. Taking these factors into consideration, the cost of taping an ankle far surpassed the cost of bracing for a single season (Table 1).

Discussion

The results of our study demonstrate that a semirigid ankle stabilizer used for prevention of ankle sprains in high school football athletes was equivalent to prophylactic taping. Furthermore, the overall rate of sprains in high school football, in Hawaii, on natural turf, in military-dependent athletes using either prophylactic ankle taping or a brace was 0.796 per 1000, lower ($P = .003$, binomial exact test was used because the total number of exposures was not available for the collegiate study) than the 2.56 per 1000 in the braced group of collegiate players reported by Rovere et al (11).

Because of the curtailment of many high school athletic budgets, we also chose to examine, in a crude fashion, the financial implications associated with the choice of prophylactic bracing or taping. We calculated the cost to tape 1 ankle over a season to be $40.01 and compared this with the

wholesale cost of the AirSport ankle brace of $28.00. For a typical high school football squad, using the data obtained in this study, it is estimated that an annual savings of nearly $1000 per season could be achieved if prophylactic bracing was used instead of the traditional use of ankle taping. This estimate, moreover, is biased toward the null in that it does not take into account the additional material costs related to the use of tape, namely nonadherent spray, malleolar pads, and prewrap, and it does not take into consideration the additional costs related to the time spent by the athletic trainer taping ankles. Although these items were not calculated in the overall cost, they would substantially contribute to the overall expense of taping ankles.

The cost of taping is a direct result of the number of exposures and is therefore proportional to the length of the season. The cost comparison was based on bulk-purchased tape and the wholesale price of the ankle braces. All of the team athletic trainers that participated in this investigation were salaried employees of the Department of Education, and we only estimated the additional cost of taping related to the time required of the trainers for this intervention. Underestimation of the exact cost related to the salaries of the athletic trainers, therefore, biased our results toward the null, and the actual increase in the cost of taping compared with bracing would be greater than the estimate that we report in our results.

Our study represents a significantly lower exposure rate when compared with studies of collegiate athletes or high school athletes with a season longer than 10 weeks (11, 24–28). In a study of college football players, Rovere et al (11) calculated the cost of taping to be more than $400 per athlete over 1 college football season. Furthermore, a factor that is not easily quantified is the time required of the trainer to apply and remove tape for an entire squad at every practice and game. We calculated a mean time of over 3 hours for application of prophylactic taping to both ankles of a player during our season. Considering a 40-man squad, this would result in over 129 hours of work, time that theoretically could be spent addressing and rehabilitating injured players. The time to apply the brace was not associated with any intervention by the athletic trainers once proper application was ensured. Therefore, the time required of an athlete to apply the brace, which was negligible, was not a factor because it did not take time from the trainer who could then be attending to athletes with injuries or other tasks. Costs, as previously noted, would vary with the trainer's rate of pay, and that is why we looked at the theoretical effect, in essence a crude sensitivity analysis, of a pay rate ranging from $10 to $15 per hour for the trainer. Another potential factor to consider in a more rigorous, cost-effective analysis would be side effects, such as cutaneous irritation, pain, and attitudes toward use, experienced by those in either of the prophylactic intervention groups. Sitler et al (12) reported that the majority of athletes using the brace in their study had a positive or indifferent attitude toward the use of the brace, with few players expressing a negative response to its use.

Based on the current literature, as well as our own personal experience, we believe that there is sufficient evidence supporting the argument that the currently used methods of ankle sprain prophylaxis, namely taping or bracing, provide a significantly better measure of lateral ligament injury prevention in comparison with no preventive measures (15, 25, 29–32). For this reason, we chose to exclude a baseline group of athletes receiving no form of lateral ankle ligament injury prophylaxis from our investigation, on the basis of ethical reasons. One of the major strengths of our study was the use of a randomized method of treatment allocation. This methodologic technique is known to balance variables, both systematic and chance related, among the intervention groups and thereby limits bias. We also used a statistical hypothesis test for determining the significance of a difference in the outcome between our intervention groups that was appropriate for the type of data and the distribution of our data, namely, the Fisher exact test. A potential limitation of our study was the restriction of the sample to study subjects having a military affiliation. This restriction limited the number of potentially eligible participants and may have impacted our ability to detect a statistically significant difference between the intervention groups. We do not feel, however, that this restriction imparted a systematic bias related to the characteristics of these football players in comparison with their high school classmates who were not affiliated with the military. Another potential limitation of this investigation was the fact that the athletic trainers assessing the players for ankle injury were not blind to the form of prophylaxis being used by the athlete. This, we feel, was the biggest potential cause of bias in our results, despite the fact that none of the trainers participated in the design or analysis aspects of the study. Yet another potential limitation of this investigation was the lack of data related to a number of variables that may have had clinical significance in regard to ankle sprains in high school football players. Such potentially important variables include age, type of cleat, high-top versus low-top shoe gear, actual duration of practice and playing time, weight or body mass index, player position, starter versus substitute status, field condition (rain days or wet fields), degree of ankle ligamentous disruption, side effects from wearing either the brace or tape, and trainer experience, to name a few. Moreover, we only looked at the incidence of sprains over a single football season, and future investigations may consider these same factors over a longer period of time. Finally, because the braces were donated by Aircast Inc, there exists the potential for bias related to commercial sponsorship, although the decision to use this particular brace had already been made by the athletic teams before the design and commencement of this investigation.

Conclusion

In summary, to our knowledge, this is the first prospective, randomized comparison of taping and bracing for the prevention of ankle sprains in high school football players. Both of these prophylactic measures were well tolerated by the players, and the incidence of lateral ankle injuries was equal in both groups, whereas the cost to implement these measures was higher in the taping group. Based on the results of this investigation, high school football programs may justify the use of commercially available ankle braces instead of taping to decrease the incidence of ankle injuries.

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