The Effect of Prophylactic Ankle Support During Simulated Soccer Activity

Hollie Forbes, Sarah Thrussell, Nick Haycock, Monika Lohkamp, and Matthew White

Objective: Ankle injuries are common in soccer and may result in ongoing functional deficiency. Ankle-joint prophylactic support is hypothesized to reduce the risk of injury. Analysis of the effects of prophylactic support has so far lacked application to soccer. Therefore, the purpose of this study was to illustrate the effects of tape and brace on selected proprioceptive components and range of motion (ROM) before, after, and during a soccer-match-simulation protocol. Design and Setting: A crossover study design was used to investigate plantar-flexion (PF) ROM, inversion (INV) ROM, and joint-position sense (weight bearing and non-weight-bearing [NWBJPS]; ± ⁰ error) in tape, brace, and control conditions. Measures were gathered from the dominant leg in a biomechanics laboratory at 0, 15, 30, and 45 min of a soccer-specific aerobic field test 90-min (SAFT90) protocol. Participants: Eight healthy male subjects (age 20.5 ± 0.5 y) experienced the 3 conditions in random order with 7 d between conditions. Intervention: The tape condition used an open basket-weave technique; the brace was an AirCast AirSport brace. For the control condition no prophylactic support was applied. Results: Application of prophylactic support significantly decreased active ROM in PF and INV (P < .05), with tape performing better than the brace (0 min). Tape lost its restrictive benefits by 15 min (P < .001) and was no different than control, while the brace maintained some effect until 45 min. Application of prophylactic support increased NWBJPS performance (P < .01; 0 min); by 15 min the tape had lost its proprioceptive benefit (P < .01) compared with the brace. Conclusions: Our findings suggest that the clinical usefulness of ankle-joint prophylactic support is limited if the aim is to restrict ROM and improve proprioceptive capability under soccer-specific conditions. The relative benefits of each type of support need to be considered in the context of the time-specific nature of the activity.

Keywords: tape, brace, ankle injury, range of motion, proprioception

The physical demands of soccer place players at a high risk of injury.¹-³ This has been quantified as 1.3 injuries per player per season,⁴ or 10 to 35 injuries every 1000 playing hours.² Of these injuries, 17% are to the ankle joint and 67% of these are ligament sprains, specifically, to the lateral complex (80% of the ligament sprains¹), which suffers from limited anatomical congruity and restraint in the “risk” position of combined plantar flexion and inversion.⁴ There has been debate as to the lasting effects and risk of recurrence of ankle injury, with some authors claiming postinjury proprioceptive, neuromuscular, and stability deficits,⁵,⁶ while others deny the existence of the same.⁷ Overall it would appear that history of ankle-ligament injury is an influential risk factor for further ankle injury.⁵-⁹

Prophylactic support of the ankle aims to reduce injury risk and reinjury by providing increased mechanical support and/or additional proprioceptive information such as joint-position sense (JPS). Prophylaxes consist mainly of taping (rigid or nonrigid adhesive applied directly to the skin or via underwrapping) and/or bracing (rigid or nonrigid and affixed using straps or laces) that is administered by the athlete, a coach, or a therapist. Prophylaxes may affect range of motion (ROM),¹⁰-¹³ proprioceptive components such as angle reproduction,¹⁴ foot-position awareness,¹⁵ ankle JPS¹⁶,¹⁷ and postural stability,¹⁸ basic functional tests,¹⁹ and motor performance in sport.²⁰ Research has suggested that tape may initially decrease ankle plantar flexion (PF) and inversion (INV) ROM; however, after approximately 15 to 20 minutes of exercise this effect was negated,²¹-²³ but there is also evidence that a restriction is present after exercise.²⁴ There is also controversial evidence for the effect of tape and braces on proprioceptive performance. Lohkamp et al²⁵ found that tape initially caused a performance improvement; however, this was negated after 20 minutes of exercise. In contrast, Hamer et al²⁶ found no positive initial effect of tape and no change with exercise. In addition, an effect for improved JPS was reported by Robbins et al¹⁵ that lasted after exercise. Thus there is still considerable ambiguity concerning the effect of these prophylactic measures, especially regarding performance over time.
In the current literature researchers have used different modes of exercises to investigate the effects of prophylaxes before and after exercise, but these were either not sport specific, or included 2.5 to 3 hours of football practice, or were football-specific treadmill protocols. Recently, however, the Soccer-Specific Aerobic Diminish due to the soccer-specific exercise. Recently, however, the Soccer-Specific Aerobic Diminish due to the soccer-specific exercise.

The purpose of our study was to illustrate the effects of tape and brace on selected proprioceptive components and ROM before, during, and after a soccer-match-simulation protocol. We expected that before exercise, tapering and bracing would perform similarly in restriction of ROM compared with no prophylaxes, but during and after exercise the restrictive effect of the tape would be significantly diminished. We thought that JPS performance would improve with prophylactic support and with exercise in all conditions but would significantly diminish due to the soccer-specific exercise.

Methodology

Ten male amateur soccer players volunteered to participate in this study. All were actively participating in soccer training and games at least twice a week and had a dominant right foot that was used for testing. Participants were injury free during and in the 6 months preceding testing, had no history of ankle injury, and had the ability to actively dorsiflex the ankle to 20°. This was to allow successful testing of weight-bearing JPS through ensuring adequate range in the sagittal plane. The study was approved by the departmental and university ethics committee and followed the principles outlined in the Declaration of Helsinki. All participants gave informed consent and completed a preexercise medical questionnaire. Two were forced to withdraw from the study due to injuries sustained during their continued normal football activity, leaving data for 8 participants available for statistical analysis. Their demographics are shown in Table 1.

Table 1 Participant Demographics (N = 8)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>Age (y)</td>
<td>20.5 (0.5)</td>
<td>20–21</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>183.6 (7.8)</td>
<td>167–191</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77.2 (6.3)</td>
<td>70–91.1</td>
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</table>

Participants came to the indoor laboratory on 3 occasions with at least 7 days in between, once for each experimental condition (tape, brace, control) in random order. Diurnal variation was controlled to within 2 hours, and between testing participants were instructed to train and play as normal. Immediately before testing participants completed a 10-minute warm-up consisting of 5 minutes self-selected jogging/running/utility movements, followed by 5 minutes of the SAFT 90. This allowed for familiarization with the SAFT 90 procedure and course. The SAFT 90 includes a 20-m shuttle run with 4 poles, and commands for different agility movements and speeds are given via an audio CD. The SAFT 90 allows for measurement breaks (5 min) every 15 minutes; therefore, measurements were taken before the test (0 min) and at 15, 30, and 45 minutes. The participants completed the SAFT90 wearing indoor training shoes, which were removed for the measurement breaks; this was an attempt to control for changeable ground conditions throughout the study. Only 45 minutes of the SAFT 90 protocol were used to simulate one half of football match play. To ensure standardization of ROM and JPS measurements, taping and bracing were completed by the same researcher, who was a qualified graduate sports rehabilitator. As a further control measure the researcher was supervised by an experienced graduate sports rehabilitator (5 y) who ensured accuracy and consistency of the application.

Measurements

ROM at the ankle in the directions of PF and INV was measured in a seated non-weight-bearing (NWB) position using a goniometer. To measure PF the goniometer was aligned to the tip of the lateral malleolus, the fifth metatarsal, and midline of the fibula, and for INV it was aligned to the anterior talocrural joint line, second metatarsal, and midline of the anterior tibia. An average of 3 active end-of-range measurements was recorded as ROM.

Ankle JPS in the sagittal plane was tested by the recreation of angles in weight-bearing (WB; unilateral standing) and NWB (seated) positions without the use of visual feedback. The researcher used a goniometer to passively place the participant in a target position, which was randomly selected from 6 prespecified joint angles that were achievable in all conditions (2 more midrange, 2 more inner range, and 2 more outer range, increments of 5°, measured to the nearest whole degree). The angles were different for WB (90–115°) and NWB (95–120°). The participant was then asked to actively recreate the target angle after returning to a neutral ankle position, either by actively plantar-flexing/dorsiflexing (NWB) or by flexing/extending the knee (WB). Any deviation from the target angle (+ or –) was recorded as error. This procedure was repeated 3 times with inner, outer, and midrange target angles to avoid learning effects, and an average error was recorded. All participants experienced all target angles over the course of the study in a counterbalanced manner.

Interventions

After warm-up, tape, a brace, or no intervention was applied before the 0-minute measurement. The taping protocol used an open basket-weave using 5-cm zinc oxide tape (Figure 1), which was always applied by a...
competent researcher. The open basket-weave is commonly used by athletic trainers\textsuperscript{33} and other clinicians and does not benefit from the wealth of literature available for the closed version of the same protocol. The brace used was an AirCast AirSport brace (Figure 1), which was fitted to each subject using Velcro straps according to manufacturer guidelines.

**Statistical Analysis**

SPSS version 16 (SPSS Inc, Chicago, IL) was used to perform a mixed-model analysis of variance, which considered time and condition using a SIDAK correction. Where appropriate, interaction effects were investigated and reported. Significance was accepted at \( P \leq .05 \), and all data are presented as mean ± SD. For clarity, the \( F \) value is not reported if there was no significant finding.

**Results**

**ROM**

For PF there was a significant interaction effect between time (0, 15, 30, 45 min) and condition (\( F = 34.03, P < .001 \)). Post hoc investigation (Figure 2) revealed that there was no change in PF ROM for the control condition over time. For the tape condition, PF ROM was greater at 15, 30, and 45 minutes (\( P < .001 \)) than at 0 minutes, and a further increase in PF ROM was noted between 15 and 45 minutes (\( P < .05 \)). In contrast, the brace condition displayed more PF ROM at 30 and 45 minutes than at 0 and 15 minutes (\( P < .05 \)).

Figure 2 also shows that there was significantly more PF allowed by the control condition at 0 minutes than with tape (\( P < .001 \)) and braced (\( P < .01 \)) conditions. Taping restricted PF in comparison with the brace condition (\( P < .01 \)) at 0 minutes. At 15, 30, and 45 minutes only the brace condition restricted PF (\( P < .05 \)) compared with control. Finally, at 15 and 30 minutes the brace condition significantly restricted PF (\( P < .01 \)) compared with the tape condition.

For INV there was a significant interaction effect between time and condition (\( F = 26.45, P < .001 \)). Post hoc investigation (Figure 3) revealed that there was no change in INV for the control condition over time. The tape condition allowed significantly more INV ROM at each measurement (15, 30, and 45 minutes; \( P < .001 \)). There was also more INV ROM at 45 than at 15 minutes (\( P < .05 \)). The brace condition allowed more INV ROM at 45 minutes (\( P < .05 \)) than at either 0 or 15 minutes.

Figure 3 also shows that at 0 minutes the control condition allowed more INV ROM than tape (\( P < .001 \)) or brace (\( P < .01 \)) conditions. In addition, at 15, 30, and 45 minutes the brace condition restricted INV ROM compared with control and tape (\( P < .01 \)).

**JPS**

For NWB JPS, there was a significant interaction effect between time and condition (\( F = 3.87, P < .01 \)). Post hoc investigation (Table 2) revealed that there was no change in NWB JPS for the control condition over time. For the
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tape condition NWB JPS performance was decreased after 15, 30, and 45 minutes (P < .05) compared with 0 minutes. For the brace condition NWB JPS performance was decreased after 45 minutes (P < .05) compared with 0 minutes.

Table 2 also shows that at 0 minutes both tape and brace conditions showed increased performance in NWB JPS compared with the control (P < .01), and at 15 minutes the brace condition showed increased JPS performance compared with tape (P < .01). No further differences were observed.

For WB JPS there was no significant (P > .05) interaction effect and no main effects for time.

Discussion

The current study aimed to investigate the effect of prophylactic support on ROM and JPS during simulated soccer match play. We expected that taping and bracing would perform similarly in restricting ROM, although the restrictive effect of the tape was expected to diminish before that of the brace. In addition, we expected that WB and NWB JPS would improve with the addition of prophylactic support but would diminish with longer exercise duration. In the first case our findings largely met with our expectations, as the application of a prophylactic support did decrease active ROM in PF and INV (Figures 2 and 3). This decrease then varied according to condition and time point. Overall, the effect of the tape was significantly reduced, meaning it was not different from no support after only 15 minutes of exercise (P < .001), while the brace tended to maintain its effect until 30 minutes of exercise for PF (Figure 2) and until 45 minutes of exercise for INV (Figure 3). In addition, application of any prophylactic support did significantly increase NWB JPS performance preexercise (P < .01). This effect then reduced quickly, especially in the taped condition, which showed significant performance decrements compared with the control condition over time and with the brace condition at 15 minutes (Table 2). Our expectations were not met for WB JPS, as this did not show any significant difference between conditions or over time.

The reduction in ROM after the application of prophylactic support seen in the current study shows agreement with previous authors.10–13,23,24 Also in agreement with previous authors34,35 was our finding that the tape condition allowed significantly more ROM and was statistically similar to no intervention after only 15 minutes of SAFT exercise. In contrast, the ankle brace maintained a level of restriction that was significantly different from the control condition until 30 minutes (PF) and 45 minutes (INV) of SAFT exercise. This links well to the majority of previous findings.22,23,35 A possible reason for the early loss in restrictive capability for ankle taping is that perspiration of the skin decreases the adhesive quality of the tape.35 Another is that tearing, stretching, or separation of the tape fibers decreases integrity.22 These possible reasons were likely to be exacerbated in our study since the SAFT 90 is a high-intensity protocol and effectively reproduces the physiological and multidirectional aspects of a soccer game,29 meaning that our

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Table 2 Joint-Position Sense (JPS) and Standard Deviations for All Conditions at All Time Points

<table>
<thead>
<tr>
<th>Test</th>
<th>Condition</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPS, non-weight-bearing (° error)</td>
<td>control</td>
<td>2.29 ± 1.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.42 ± 1.68</td>
<td>2.04 ± 1.58</td>
<td>2.08 ± 0.79</td>
</tr>
<tr>
<td></td>
<td>tape</td>
<td>0.37 ± 0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.04 ± 0.51&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.29 ± 0.90</td>
<td>2.33 ± 1.04</td>
</tr>
<tr>
<td></td>
<td>brace</td>
<td>0.46 ± 0.18&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.88 ± 0.50</td>
<td>1.08 ± 0.81</td>
<td>1.08 ± 0.53</td>
</tr>
<tr>
<td>JPS, weight-bearing (° error)</td>
<td>control</td>
<td>1.92 ± 1.56</td>
<td>1.79 ± 1.73</td>
<td>1.42 ± 1.36</td>
<td>2.17 ± 1.88</td>
</tr>
<tr>
<td></td>
<td>tape</td>
<td>0.29 ± 0.12</td>
<td>1.04 ± 0.70</td>
<td>2.08 ± 1.91</td>
<td>1.67 ± 0.76</td>
</tr>
<tr>
<td></td>
<td>brace</td>
<td>0.62 ± 0.45</td>
<td>0.71 ± 0.45</td>
<td>0.79 ± 0.50</td>
<td>0.75 ± 0.24</td>
</tr>
</tbody>
</table>

<sup>a</sup>Decreased control JPS compared with tape and brace (P < .01); <sup>b</sup>Decreased taped JPS compared with brace (P < .01); <sup>c</sup>Greater taped JPS than 15, 30, and 45 min (P < .05); <sup>d</sup>Greater braced JPS than 45 min (P < .05).
protocol was somewhat more challenging than those used in previous research. In contrast, other studies reported a significant restriction in ROM after exercise. It is probable that the different exercise protocols and duration explain those differences. Another interesting finding of our study was that the tape condition initially reduced PF ROM significantly more than bracing; this has not been reported by other authors and could fit with evidence that athletes prefer tape.

Our JPS data, in agreement with others, suggested that initial application of a prophylaxis improved NWB performance. Burgess et al suggested that mechanoreceptors (regardless of type and location) could be stimulated by application of adhesive tape or any type of brace leading to improved joint-position awareness, which may explain this effect. Of interest was the fact that for the taped condition this positive effect was only short lived when considered over time (at 15 min JPS was significantly reduced compared with 0 min). JPS performance while taped was therefore no different from control after 15 minutes of SAFT 90 exercise. In comparison, at first application the brace also increased JPS performance relative to the control condition (Table 2) but then did not display significantly reduced JPS (compared with 0 min) until 45 minutes. The different temporal patterns may be again related to the possible detrimental effect on adhesive tape of perspiration and loss of integrity of tape due to stretching, tearing, and separation of fibers caused by exercise, seemingly leading to less stimulation of mechanoreceptors. The brace may not have been as susceptible to these factors due to the inherent structural difference in design and mode of application.

A possible reason for loss of any positive effect of prophylaxis was that participants may have started to become fatigued. Although this was not measured, it is plausible since the SAFT 90 is based on data from championship-level rather than amateur-level soccer players. Exercise alone has been shown to decrease positional sense, but this was not apparent from the control group data in our study, and therefore it is unlikely that fatigue was a factor for the JPS observed for either prophylaxis.

In addition, at 15 minutes the brace condition displayed significantly improved JPS performance compared with the tape condition, with no differences in tape or control JPS performance. A possible reason for the lack of significant differences between conditions is likely to be the high standard deviations observed in the control group (Table 2), suggesting high individual variation in JPS performance without prophylaxes. Another interesting point from our data was that at 45 minutes the standard deviations seen for NWB JPS measures in the tape condition were very similar to those shown throughout the control condition (Table 2). Thus, overall it appears that application of any prophylactic support may reduce individual variability in NWB JPS earlier in a soccer match.

The pattern was very similar for WB data (Table 2), but this did not reach significance (interaction \( P = .057 \)). A possible reason for the nonsignificant difference in WB might be that additional proprioceptive information was provided via the sole of the foot and the position of the knee, which changed with different foot positions. However, in contrast to the findings of the current study, Robbins et al did report an increase of WB JPS even after exercise. A possible reason for the different findings of Robbins et al may be the method in which JPS was quantified. Robbins et al used identification of slope gradient in increments of 2.5° with a larger sample of 24 participants. This may have allowed for greater specificity and possibly lower standard deviations than our study, meaning that a type II error would be less likely.

The findings of our study have implications for sports health care practitioners, athletes, and coaches who may be concerned about preventing injury. Our findings suggest that under high-intensity soccer-specific exercise conditions tape had no restrictive benefit and also no positive proprioceptive effect after 15 minutes of exercise, meaning that any attenuation of injury or reinjury risk could also disappear at this point. It may even be possible that the initial tape restriction of ROM is misleading and could increase injury risk due to misconceptions regarding the prophylactic effectiveness over time, especially since most soccer injuries are known to occur toward the end of halves of play.

Of further concern is that the brace condition also showed a significant decrease in the level of support provided after 30 or 45 minutes (PF or INV), losing approximately 25% of its restrictive capability between 15 and 30 minutes for PF; and furthermore the proprioceptive effect was negated after this time. This would suggest that under replicated “match” conditions practitioners should not place undue confidence in any prophylactic support to prevent injury. Of course we must note here that the effectiveness of bracing and taping may depend heavily on the design, type, application, and material used and that psychological effects can have influence on the prophylactic effect of ankle tape and braces. However, further discussing these aspects is beyond the scope of this article.

In summary, our findings suggest that the clinical usefulness of prophylactic support of the ankle joint is limited if the aim is to restrict ROM and improve proprioceptive capability under soccer-specific conditions. The relative benefits of each type of support need to be considered in the context of the time-specific nature of the activity. For clinicians this may be an important consideration for the planning of team and individual injury-prevention strategies.

References


