The Effects of Spatting and Ankle Taping on Inversion Before and After Exercise

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Objective: To compare the effects of spatting, taping and spatting, taping, and not taping on the amount and rate of inversion of the ankle before and after exercise.

Design and Setting: We filmed subjects at 60 Hz while they stood on a platform that suddenly inverted the right ankle. Five trials were measured before and after a 30-minute period of drills.

Subjects: We tested 15 male rugby players with no history of lower-leg injury within the previous 6 months limiting activity for more than 2 days.

Measurements: The amount and rate of inversion in the four conditions were digitized and analyzed.

Results: The combination of spatting and taping was the most effective in reducing inversion rate and range of motion before and after exercise.

Conclusions: All three taping treatments were effective in reducing the amount and rate of inversion. Exercise loosened the tape, but there may be a functional restriction of the amount and rate of inversion after exercise.

Key Words: spatting, ankle taping, taping, sprain, inversion, ankle injury, video analysis, external supports

Sports-related injuries are common to the ankle, and the lateral ligaments of the ankle are the most commonly sprained.1,2 Taping the ankle is a common practice. Researchers examining the effectiveness of ankle taping suggest that taping reduces ankle injuries.3-5 Others, however, dispute the effectiveness of ankle taping.6-8 Researchers have addressed the effect of tape on the prevention of excess motion.7,9-14 Ankle taping can cause a significant reduction in the range of motion at the ankle when compared with the range of motion of an untaped ankle. A reduction in ankle range of motion caused by external support decreases the frequency of ankle injury.3,15,16 It must be noted, however, that the support provided by taping diminishes by approximately 21% after a short bout of exercise.17-20

Spatting is an ankle taping technique that involves the application of the tape over both the shoe and the sock of the athlete in an attempt to counteract the 21% diminishment in the support of the tape. This procedure is common among some athletic trainers who work with sports where cleats are worn, such as football, rugby, and soccer.

The purpose of this study was to compare the effects of spatting, combination of spatting and taping, conventional ankle taping, and not taping on the amount and rate of inversion of the ankle before and after exercise.

MATERIALS AND METHODS

The subjects were 15 male rugby players (age = 22.9 ± 3.3 yr, ht = 180.1 ± 6.1 cm, wt = 83.4 ± 10.5 kg) who volunteered for the study and had no history of lower leg injury within the previous 6 months limiting activity for more than 2 days. Subjects were not permitted to participate if they exhibited any of the following: lower extremity nervous system impairment, fractures or surgery of either ankle, or abnormal range of motion in the ankle joint as defined by Magee.21 Each subject read and signed an institutionally approved informed consent form before participating in the study.

Materials and Instrumentation

The platform we used (Fig 1) produced a sudden inversion of the right ankle to 35°. This platform is similar to platforms used in other studies.22-24 We positioned a shuttered video camera (Panasonic AG-450), set at 1/500 of a second, approximately 5 m behind the subject and 60 cm off the ground, to record motion in the frontal plane at 60 frames per second. We conducted a pilot test to verify that the shutter speed of 1/500 of a second and filming speed of 60 Hz were adequate to avoid blurring of the motion and to provide a sufficient number of frames to quantify the maximum rate of inversion.

Testing Protocol

We tested ankle inversion range of motion and rate of inversion under four conditions: untaped, taped, taped and spatted, and spatted. We randomly assigned the subjects a number and counterbalanced the order of the treatments to control for possible sequence and order effects. Each subject was then videotaped on an inversion platform (Figs 2 and 3) before and after a 30-minute period of rugby drills conducted by the rugby coach. The drills included different forms of lateral cutting and forward running. One-centimeter reflective tape markers were placed on the gastrocnemius, the Achilles tendon, and the top and bottom of the shoe on the right leg of each subject.25 These reflective markers were used to detect the

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Fig 1. Inversion platform used to produce sudden inversion of the ankle. Subjects stood on the platform balanced on the right leg. The string on the right was pulled out, which allowed the platform to drop through an angle of 35°.

inversion-eversion of the calcaneus relative to the lower leg when the subject was dropped into inversion. We positioned the subject on the platform with the lateral border of the right foot touching the side bar on the platform. Each subject was told to put all of his weight on the right foot and to just balance himself with the toes of his left foot to avoid shifting his weight to the left foot as the platform dropped. Before being tested on the first day, each subject was given two test drops to familiarize him with the protocol. We told the subjects to look forward while the platform dropped into inversion.

Taping Methods

We used Mueller (5 cm) elastic tape and foam prewrap (Mueller Sports Medicine, Inc, Prairie du Sac, WI), and Jaybird (5 cm) zinc oxide tape (Jaybird & Mais Athletic Products, Lawrence, MA) for taping and spatting. We used standard ankle taping techniques as described by Juvenal.26 These standard techniques included anchors, stirrups, heel locks, and figure eights. When spatting the subjects, we placed prewrap over the shoe and sock, then anchored with white tape just below the base of the gastrocnemius. We spiraled 5-cm conform tape down from the anchors to the ankle and then applied two heel locks around the ankle, making sure the conform fit between the cleats. We finished the spatting by covering up the conform with white tape using the same technique for taping the ankle. The same athletic trainers applied the ankle taping and spatting over the 4 days of testing.

Data Processing and Analysis

All video sequences were analyzed using an Ariel Video Analysis system (Ariel Dynamics, Inc, San Diego, CA). The Ariel hardware included a 486 AST computer, two video monitors, and a Panasonic AG-6750A VCR. We used version
6.5 of the Ariel Performance Analysis Software for frame grabbing and digitizing. The Ariel video analysis system was accurate to less than 3 mm for 3-D measurements and less than 0.3° for angular measurements.²⁷ Five trials per subject by condition (untaped, combination of spating and tapping, taped, and spatted) and exercise (before and after) were digitized beginning 5 frames before the drop of the platform until 20 frames after the platform dropped.

We calculated rearfoot angles from the raw x- and y-coordinates of the four body landmarks and smoothed them using a Butterworth second-order, recursive digital filter with a cutoff frequency of 10 Hz.²⁵ To find the rate of inversion we used the first central difference formula.¹² We calculated the inversion-eversion angles by subtracting the angle of the rear of the shoe to the right horizontal from the angle of the lower leg to the right horizontal. Positive angles represented inversion and negative angles represented eversion.

We filmed the subjects on four separate days, which made it necessary to report rearfoot angles as relative angles to account for differences in marker placement on the subject between testing sessions. For example, on day 1, a subject might have had an initial rearfoot angle of −5° while standing balanced on the inversion platform; after the platform dropped, the subject might have inverted to a final angle of +20°. The amount of inversion for this subject would be 25°. On day 2, the subject might have had an initial rearfoot angle of −7°, due to different marker placement, and a final angle of +18°. The amount of inversion would again be 25°. We determined the amount of inversion as the difference between the initial rearfoot angle, when the subject was standing balanced on the inversion platform, and the maximum inversion angle obtained by the subject after we released the platform (Fig 4). From the rearfoot angular velocity curve we calculated the maximum rate of inversion (Fig 5). We computed five-trial averages of the amount of inversion and the maximum rate of inversion for each subject and each condition before and after exercise.

**Statistical Analysis**

We performed a 2 × 4 factorial repeated measures analysis of variance to identify significant differences by levels of exercise (before and after) and condition (untaped, taped, spatted, taped and spatted) among the five-trial averages for rate and amount of ankle inversion. We did post hoc tests on significant interaction or main effects using a Tukey post hoc test with the Bonferroni correction to avoid possible Type I errors, with alpha set at 0.05.

**RESULTS**

Means and standard deviations for amount and rate of inversion are presented by treatment and exercise conditions in the Table. There was an interaction between condition and exercise on the amount of inversion [F(3,42) = 7.51, p = .00]. Before exercise, all pairwise comparisons of the amount of inversion were significantly different except for the tape condition (21.5°), which was not different from the spating condition (20.1°). All pairwise comparisons of the amount of inversion were significantly different after exercise. The 30-minute exercise bouts resulted in a significant increase in the amount of inversion for the taped, taped and spatted, and spatted treatments. The amount of inversion during the untaped condition changed from 32.9° before exercise to 33.5° after exercise.

There was a significant condition by exercise interaction for the rate of inversion [F(3,42) = 5.57, p = .003]. Before exercise, all pairwise comparisons of the rates of inversion were significantly different except the tape condition (268.7 deg/sec), which was not different from the spating condition (257.3 deg/sec). All pairwise comparisons of the rate of

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**Means and Standard Deviations for Amount of Inversion and Rate of Inversion by Exercise and Treatment Levels (Mean ± SD)**

<table>
<thead>
<tr>
<th>Amount of Inversion (deg)</th>
<th>Rate of Inversion (deg/sec)</th>
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<tbody>
<tr>
<td>Before Exercise</td>
<td>After Exercise</td>
</tr>
<tr>
<td>Untaped</td>
<td>32.9 ± 6.2 ± 33.6 ± 6.9</td>
</tr>
<tr>
<td>Taped</td>
<td>21.5 ± 5.2 ± 27.0 ± 5.4</td>
</tr>
<tr>
<td>Spatted &amp; taped</td>
<td>15.6 ± 3.7 ± 18.0 ± 3.4</td>
</tr>
<tr>
<td>Spatted</td>
<td>20.1 ± 3.4 ± 22.3 ± 5.0</td>
</tr>
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</table>
inversion were significantly different after exercise. The 30-minute exercise bouts resulted in a significant increase in the rate of inversion for the taped, untaped, and spatted, and spatted treatments. The rate of inversion during the untaped condition did not change from 460.1 deg/sec before exercise to 452.3 deg/sec after exercise.

DISCUSSION

Ankle taping significantly restricts inversion when compared with an untaped ankle. Tape loosens approximately 21% within a short period of exercise, leaving the ankle joint with only limited protection. Researchers have found that external support (eg, ankle taping or ankle bracing) reduces the number of ankle injuries. This is accomplished by a reduction in the range of motion (ROM) at the ankle joint. However, this reduction in ROM has been attributed to a decrease in performance. Ankle taping is effective in reducing ankle injuries and a reduction in the amount of tape applied to the ankle. In spattering, we apply the tape directly over the shoe. This procedure increases the perpendicular distance from the line of action of the tape to the subtalar joint. This increased perpendicular distance might account for a greater mechanical resistance to inversion when compared with a conventional ankle taping. The increased distance could result in a longer resistance arm that could in turn resist a greater force. Furthermore, in the taping and spattering condition, we applied a conventional ankle taping procedure and then applied additional tape over the shoe. This resulted in an increase in the amount of tape applied. It is possible that this additional tape application may explain the improved resistance to inversion observed in the taping and spattering condition, when compared with the taping condition.

The 30-minute exercise bouts resulted in an increase in the amount and rate of inversion. However, the tapping treatments limited the amount and rate of inversion. After exercise, tape restricted motion 6.5°, combined spattering and tape 15.5°, and spattering alone 11.2° compared with the untaped treatment. After exercise, tape restricted the rate of inversion 103.1 deg/sec, combined spattering and tape 216.2 deg/sec, and spattering alone 160 deg/sec when compared with the untaped treatment. All three tapping treatments were effective in reducing the rate and amount of inversion over the untaped treatment. A combination of spattering and taping is the most effective in reducing the rate and amount of inversion before and after exercise. Exercise loosens the tape, but there may be a functional restriction of the rate and amount of inversion after exercise, which may be beneficial in preventing injuries.

REFERENCES


