# THE EFFECT OF TAPE ON THE AMOUNT AND RATE OF ANKLE INVERSION BEFORE, DURING, AND AFTER 60 MINUTES OF EXERCISE

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Eighteen (9M, 9F) college students were randomly assigned to a treatment order (T-TA-RT or T-RT-TA) to determine the effect of tape (T), tape added (TA), and re-tape (RT) on the amount and rate of ankle inversion before (B), during (D), and after (A) 60 min of exercise when an inversion platform unexpectedly dropped the right ankle into 35 deg of inversion. Individual ANOVAs for the dependent variables (amount and rate of inversion) revealed significantly greater values for the T condition compared to the TA and RT conditions and for the B condition compared to the D and A conditions. Although interaction effects were not statistically significant, the results of this study suggest that adding tape (TA) and re-taping (RT) after 30 min of exercise are equally effective in reducing the amount and rate of ankle inversion from 30 to 60 min of exercise (B to A).

**KEY WORDS:** inversion platform, ankle taping, functional drills, kinematics.

**INTRODUCTION:** Inversion ankle sprains are among the most common sport related injuries. Although not life threatening, they result in lost playing time for the athlete and increased pressure on athletic trainers to reduce an athlete's risk of injury. The human body has a built-in protective strategy to accommodate joint stress, but the extent to which these mechanisms are able to protect the ankle from inversion injury is unclear. Konradsen, Voigt, & Hojsgaard (1997) used EMG to identify an average delay of 54 ms in the activation of the peroneal muscles at the onset of sudden ankle inversion and an electromechanical delay of 72 ms between initiation and completion of muscular contraction from a standing position. The total time of 126 ms for the peroneal muscles to produce a force that could prevent injury, however, was greater than the average time of 80 ms for the ankle to reach maximal inversion. These results led the researchers to suggest three conditions that help prevent ankle inversion injuries: (a) prior knowledge of motion to induce anticipated pre-inversion muscle activity, (b) increased strength of static stabilizing muscles, and (c) use of external support devices to restrict the ankle from excessive inversion that causes injury.

Taping is a common and widely used external support device for two reasons. First, tape mechanically restricts the ankle from reaching the excessive inversion range of motion that causes injury to the ligament fibers and surrounding structures (Garrick & Requa, 1973). Second, taping slows down the movement time for the ankle to reach full inversion, thereby allowing the body additional time to employ its built-in protective mechanisms to decrease the risk of inversion ankle injury. Investigators have indicated a reduced amount and rate of inversion motion when athletes' ankles are taped before and after exercise compared to no-taping situations (Pederson, Ricard, Merrill, Schulthies, & Allsen, 1997; Ricard, Sherwood, Schulthies, & Knight, 2000). However, the duration of exercise time used in these investigations to induce stress on the taping application was limited to 30 min, a time limit that might not adequately portray the real-world setting of athletic events. To date, only one study has evaluated the effect of tape on ankle range of motion before, during, and after 60 min of exercise (Paris, Vardaxis, & Kokkaliaris, 1995), but passive rather than active range of motion was used to measure ankle range of motion.

Because the effectiveness of taping has been shown to diminish by approximately 21% after a short bout of exercise (Bunch, Bednarski, Holland, & Macinanti, 1985), athletic trainers are faced with the decision of if and when to re-tape an ankle during athletic activities of longer durations. Judgments concerning re-taping or adding additional tape can be compromised by financial resources and/or the availability of athletic trainers to add additional tape or re-apply taping applications during competition.

Therefore, the current investigation was designed to combine methods used in previous studies to better represent the effects of taping on the amount and rate of ankle inversion in more realistic athletic environments. Specifically, the purpose of this investigation was to compare the effects of conventional tape application (T), application of additional tape (TA), and re-application of tape (RT) before, during, and after (B, D, and A) 60 minutes of exercise on the amount and rate of ankle inversion.

**METHODS:** Eighteen (9M, 9F) college-aged students (avg age = 21.6 + 2.8 yrs) who met the following criteria volunteered to participate in this study: (a) no previous history of ankle surgery, (b) no history of ankle injury in the past six months, and (c) no demonstration of lateral ligamentous laxity based on screening by an NATABOC certified athletic trainer. After participants signed an informed consent form approved by the WIU IRB, they were randomly assigned to one of two treatment conditions (T-TA-RT or T-RT-TA) and reported for testing on three different days over a three-week period. Assignment to the treatment conditions was counterbalanced to control for order effects. All participants completed the T condition during the first treatment session to record baseline measurements.

Each treatment session began with the same NATABOC certified athletic trainer taping the participant's right ankle using a Gibney closed basketweave technique. Four anatomical landmarks were then located: (a) the midline of the belly of the gastrocnemius muscle was marked directly on the skin, (b) the midline of the junction between the gastrocnemius muscle and Achilles tendon was marked on the tape, and (c) the axis of ankle rotation and (d) calcaneal tuberosity were marked on the shoe. Each participant then stepped onto an inversion platform (Pederson et al, 1997) where five trials of the posterior view of sudden ankle inversion were videotaped with a Panasonic AG-450 video camera operating at 30 Hz. The video camera was positioned 5 m directly behind the participant with the center of its camera lens positioned 60 cm above the floor to videotape frontal plane motion.

Following the first measurement session (B), participants completed the first 30 min exercise bout. Five additional trials on the inversion platform were then videotaped (D), followed by a 15 min rest period. During the rest period, the taping application was adjusted according to the corresponding treatment condition to which the participant was assigned. No adjustments were made during the first treatment condition (T). During the second and third conditions, either tape was added to the initial application (TA) or the original tape application was removed and the ankle was completely re-taped (RT). Each participant then completed the second 30 min exercise bout, followed by videotaping the third measurement session (A) to capture the final 5 trials of sudden ankle inversion on the inversion platform.

Each of the 30 min exercise bouts consisted of a 5 min warm up and 10 min of treadmill running at a 6 mph pace at zero grade. Fifteen minutes of functional drills performed at maximal intensity with 30 sec to 1 min rest periods between each repetition followed the treadmill running: (a) figure-eights (10 x 5 m, 3 sets, 5 reps), (b) shuttle run (10 m, 3 sets, 4 reps), (c) grapevine running (10 m, 3 sets, 4 reps), and (d) bilateral toe raises (3 sets, 25 reps). The total exercise time for each treatment condition (T, TA, RT) was 60 min.

The four anatomical landmarks were digitized using a PEAK Motus Video Analysis System Version 6.0 for each trial videotaped during the three measurement sessions of each of the three treatment conditions for each participant. The Motus software program generated two lines that intersect to create an angle from the four digitized markers. This angle was measured at the start of inversion motion and at the greatest amount of inversion motion for each of the recorded trials. The amount of inversion was calculated by taking the difference between the inversion angle at the start of the motion and the greatest amount of inversion. Rate of inversion was calculated by dividing the amount of inversion by the time it took to reach the greatest amount of inversion for each trial. The three most consistent trials of the five were averaged for each of the nine possible combinations of taping and exercise measurement sessions: T-B, T-D, T-A, TA-B, TA-D, TA-A, RT-B, RT-D, and RT-A.

**RESULTS:** SPSS 10.0 software tested the simultaneous effect of the two dependent variables of amount and rate of inversion among the 18 participants using a 3 x 3 Multiple Analysis of Variance (MANOVA). Significant main effects were revealed for taping (Wilks' Lambda=.823,

p=.000) and exercise session (Wilks' Lambda=.785, p=.000).
Post hoc univariate analysis of variance (ANOVA) tested for significant main and interaction effects using Tukey's test of significance. Means and standard deviations for amount of inversion by taping condition and exercise condition are presented in Table 1. ANOVA results revealed significant differences for the main effects of taping (df=2, F=15.334, p=.000) and exercise condition (df=2, F=18.782, p=.000), but not for the interaction effect of tape x exercise (df=4, F=.327, p=.859). Tukey post hoc comparisons revealed significant differences between the T and TA taping conditions (p=.000) and between T and RT (p=.000), but not between TA and RT. Post hoc analysis also revealed statistically significant differences between the B and D exercise conditions (p=.000) and between B and A (p = .000), but not between D and A.

**Table 1 Means and Standard Deviations for Amount of Inversion (deg) by Taping and Exercise Conditions (Mean + SD).**

| | Exercise Conditions | | | |
|---|---|---|---|---|
| | Before Exercise (B) | After 30 min (D) | After 60 min (A) | Grand Mean |
| Taping Conditions | | | | |
| Taped (T) | 26.0 + 6.4 | 31.0 + 5.8 | 32.6 + 6.7 | 29.87 |
| Tape Added (TA) | 20.8 + 6.5 | 27.5 + 5.6 | 26.2 + 6.5 | 24.83 |
| Re-Taped (RT) | 19.2 + 6.2 | 26.4 + 5.7 | 25.7 + 7.0 | 23.77 |
| Grand Mean | 22.0 | 28.3 | 28.17 | |

Means and standard deviations for rate of inversion by taping condition and exercise condition are presented in Table 2. ANOVA results revealed significant differences for the main effects of taping (df=2, F=5.470, p=.005) and exercise condition (df=2, F=9.591, p=.000), but not for the interaction effect of tape x exercise (df=4, F=1.238, p=.298). Tukey post hoc comparisons revealed significant differences between the T and TA taping conditions (p=.044) and between T and RT (p=.005), but not between TA and RT. Post hoc analysis also revealed statistically significant differences between the B and D exercise conditions (p=.001) and between B and A (p=.001), but not between D and A.

**Table 2 Means and Standard Deviations for Rate of Inversion (deg/s) by Taping and Exercise Conditions (Mean + SD).**

| | Exercise Conditions | | | |
|---|---|---|---|---|
| | Before Exercise (B) | After 30 min (D) | After 60 min (A) | Grand Mean |
| Taping Conditions | | | | |
| Taped (T) | 340.6 + 62.3 | 428.1 + 88.2 | 459.1 + 109. | 409.27 |
| Tape Added (TA) | 326.9 + 81.8 | 393.5 + 80.3 | 378.0 + 98.8 | 366.13 |
| Re-Taped (RT) | 306.3 + 114.9 | 382.1 + 99.99 | 353.4 + 103.4 | 347.27 |
| Grand Mean | 324.6 | 401.23 | 396.83 | |

**DISCUSSION:** Since rate of inversion (i.e., angular velocity) is the first derivative of amount of inversion (i.e., angular displacement), significant MANOVA results for the two treatment variables (tape and exercise) when the two dependent variables (amount and rate of inversion) were considered simultaneously was expected.
Significant individual ANOVAs for amount (Table 1) and rate of inversion (Table 2) for the main treatment effect of exercise revealed that the greatest differences occurred during the first 30 min of exercise. Specifically, amount and rate of inversion increased 28.6% and 23.6%, respectively, from B to D, with similarly small, but non-significant, differences in mean values occurring from D to A. These results suggest that the lowest range of motion values measured immediately following the application of tape in the B condition may not be desirable for athletes participating in dynamic activities. Moreover, the small differences between D and A the highlight the importance of athletes warming up ( i.e., the 30 min from B to D ) before

participating in athletic events. The increase in range of motion that occurred during the first 30 min of exercise may have resulted from a combination of the mechanical breakdown process of tape and the warm-up effect of the body's muscles and tendons. A 30-min warm up, therefore, may be beneficial to achieving a normal range of motion for a taped healthy ankle while still limiting excessive motion that may cause injury.

Although significant individual ANOVAs for amount (Table 1) and rate of inversion (Table 2) for main treatment effect of taping were also revealed, inspection of the means for the interaction effects suggest a learning effect may have occurred over the three weeks of this investigation. In theory, the means for both dependent variables should be similar for all three taping conditions (T, TA, RT) in the B and D exercise conditions, as well as for the A condition for the RT treatment. However, means for the T conditions were consistently higher than for the TA and RT conditions for all three exercise sessions (B, D, A). Recall that all participants received the T condition during their first testing session. The order of the treatment conditions (TA, RT) for the second 30 min of exercise were then counterbalanced across participants. Therefore, the lower mean values for both amount and rate of inversion in TA and RT, compared to T, may suggest that participants subconsciously adapted to the inversion platform during the first treatment session (T).

Leaving the original tape application on for the second 30 min of exercise in the T condition resulted in a slight, but not significant, increase in range of motion from D to A. Likewise, means for both the TA and RT conditions revealed small decreases from D to A, suggesting that both the TA and RT treatment conditions were equally effective in limiting range of motion during the second 30 min of exercise. The addition of two heel-locks and two figure eights in the TA condition following 30 min of exercise may account for the decrease in range of motion from D to A because of the increased amount of tape on the ankle. Completely removing the tape application after 30 min of exercise in the RT condition and applying a new application identical to the first, however, did not account for any appreciable reduction in range of motion compared to the other two conditions (RT to T or RT to TA).

**CONCLUSION:** The results of this investigation suggest that keeping the same tape application on for a 60 min exercise bout, adding tape after 30 min of exercise, and re-taping an ankle after 30 min of exercise are equally effective in limiting amount and rate of inversion in healthy ankles. Therefore, coaches and athletic trainers should consider financial constraints (i.e., cost of tape), access to an athletic trainer, and psychology of the athlete (i.e., sense of comfort and/or security) when developing taping regimes to reduce an athlete's risk of injuring a healthy ankle.

**REFERENCES:**

Bunch, R.P., Bednarski, K., Holland, D., & Macinanti, R. (1985). Ankle joint support: A comparison of reusable lace-on braces with taping and wrapping. The Physician and Sports Medicine, 13(5), 59-63.

Garrick, J.G., & Requa, R.K. (1973). Role of external support in the prevention of ankle sprains. Medicine and Science in Sports and Exercise, 5, 200-203.

Konradsen, L., Voigt, M., & Hojsgaard, C. (1997). Ankle inversion injuries: The role of the dynamic defense mechanism. The American Journal of Sports Medicine, 25, 54-58.

Paris, D.L., Vardaxis, V., & Kokkaliaris, J. (1995). Ankle ranges of motion during extended activity periods while taped and braced. Journal of Athletic Training, 30, 223-228.

Pederson, T.S., Ricard, .D., Merrill, G., Schulthies, S.S., & Allsen, P.E. (1997). The effects of spatting and ankle taping on inversion before and after exercise. Journal of Athletic Training, 32, 29-33.

Ricard, M.D., Sherwood, S.M., Schulthies, S.S., & Knight, K.L. (2000). Effects of tape and exercise on dynamic ankle inversion. Journal of Athletic Training, 35, 31-37.

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