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Effect of Ankle Taping on Dynamic Balance and Perception of Stability

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Purpose: The purpose of this study was to examine the actual and perceived effect of taping on dynamic stability. **Methods:** 21 physically active subjects [12 females (age = 20.33 ± 1.44 years, height = 165 ± 0.05 cm, mass = 68.76 ± 12.69 kg), and 9 males (age = 21.33 ± 1.66 years, height = 180 ± 0.10 cm, mass = 86.54 ± 9.46 kg)] participated in this study. Dynamic stability and perception of stability were assessed barefoot and with the ankle taped. The taped ankle condition used a standard preventive tape application including two anchors, three stirrups, close downs, horseshoes, two heel locks per side and two figures of eight. The Biodex Balance System SD was used to measure medial-lateral and anterior-posterior stability. Dynamic balance was assessed in a single leg stance during three 20-second trials at stability level 4. A 30-second rest period was provided between trials. Perception of stability was assessed using a 4-point Likert scale (1 = very unstable, 2 = unstable, 3 = stable, 4 = very stable) after each test session. Independent variables were counter-balanced to minimize the effects of fatigue associated with the testing procedures. A Repeated measures ANOVA was used to analyze the difference between barefoot and ankle tape for medial-lateral and anterior-posterior dynamic stability indices and perception of stability. All tests of significance were carried out at an alpha level = 0.05. The Bonferroni post hoc test was used for all paired comparisons. **Results:** Significant differences were not found for medial-lateral stability (Barefoot = 1.24 ± 0.63 , Taped = 1.21 ± 0.72) nor anterior-posterior stability (Barefoot = 1.70 ± 1.07 , Taped = 1.50 ± 0.89). Significant differences were found for perception of stability (Barefoot = 2.57 ± 0.60 , Taped = 3.32 ± 0.67 , $p = 0.000$). **Conclusions:** The use of ankle taping had no influence on dynamic stability measures in this study. Ankle taping did cause an increased perception of stability suggesting that ankle taping may have more of a placebo effect in uninjured ankles.

INTRODUCTION

Ankle injuries are one of the most common injuries associated with sports participation.¹ Epidemiological studies have found an ankle injury rate of 3.85 incidents per 1000 basketball participants, and a recent study examining NCAA injury data found that ankle sprains were the most common injury in 15 sports studied, accounting for 14.9% of all reported injuries.^{2,3} Athletic trainers and other sports medicine professionals have used prophylactic ankle taping in an attempt to decrease injuries to the ankle. The exact mechanisms related to the effect prophylactic ankle taping has on preventing ankle injury are not fully understood.

One proposed mechanism is a mechanical effect causing a decrease in the amount of inversion and internal rotation of the rearfoot and plantar flexion at the talocrural joint.^{4,5}

The motions of plantarflexion, inversion, and internal rotation combined are the most common injury mechanism for lateral ligament sprains of the ankle.⁶ In studies that produced dynamic ankle inversion, ankle tape conditions had less ankle inversion when compared to a no tape condition.⁷⁻⁹ Lohrer et al. reported up to a 50% decrease in the amount of active inversion and up to a 63% decrease in active ankle plantar flexion following the application of tape to the ankle.⁷ In addition, a study examining differences in passive ankle ranges of motion between barefoot and ankle tape conditions found a 53% decrease in ankle inversion with the tape condition.¹⁰

It has also been proposed that tape applied to the ankle stimulate the cutaneous mechanoreceptors around the ankle causing a proprioceptive effect leading to increased

stability of the ankle joint.¹¹⁻¹³ Jerosch et al. found a decreased mean reproduction error in taped ankles in both injured and noninjured subjects when compared to an untaped condition.¹³ Other investigators have not found that taping of the ankle improved proprioception.^{14,15} Further, studies examining the effects of ankle taping during dynamic postural stability and balance testing did not find that taping affected dynamic stability.¹⁶⁻²⁰

An additional aspect of prophylactic ankle support may be that tape provides a placebo effect by causing a perception that additional stability is being provided. In a qualitative analysis, Hunt and Short found that the perception of participants in their study was that ankle taping resulted in a feeling of increased confidence while participating in their activity and that there was decreased anxiety for injury or re-injury when they were taped.²¹ Previous research examining the role of ankle taping during functional performance testing did not find a significant difference between non-taped and taped conditions.^{17,19} Participants in the studies conducted by Delahunt et al. and Sawkins et al. reported improved stability and confidence in the performance of functional tests.

Little information is available regarding the effect of commonly used ankle taping techniques on dynamic balance and the perception of stability provided by taping. Therefore, the purpose of our study was to examine the effect of ankle taping on dynamic stability, as well as the participant's perception of stability during barefoot and taped testing conditions. We hypothesized that ankle taping will improve dynamic balance indices and provide a perception of increased stability.

METHODS

Participants

21 physically active subjects [12 females (age = 20.33 ± 1.44 years, height = 165 ± 0.05 cm, mass = 68.76 ± 12.69 kg) and 9 males (age =

21.33 ± 1.66 years, height = 180 ± 0.10 cm, mass = 86.54 ± 9.46 kg)] participated in this study. Subjects did not have a history of severe injury to the ankle and were free from lower extremity injury for at least 6 months prior to testing. Subjects for this study also did not have a history of vestibular or balance disorders. All subjects signed an informed consent document approved by the university's institutional review board.

Ankle Appliance Application Procedures

Overall stability and perception of stability were assessed barefoot and with the ankle taped. Ankle taping was performed by the same investigator for all trials using a standard preventive tape application commonly used by athletic trainers as described by Arnheim including QDA tape adherent (Cramer Products, Inc., Gardner, KS), 3" x 3" lubricated heel and lace padding (Mueller Sports Medicine, Inc., Prairie du Sac, WI), 2 3/4" MWrap foam prewrap (Mueller Sports Medicine, Inc., Prairie du Sac, WI), and a taping procedure using 1 1/2 inch Zonas tape (Johnson & Johnson, New Brunswick, NJ) consisting of two anchors on the calf, three stirrups pulled from the medial to lateral side of the anchors, close downs around the calf, horseshoes covering the talocrural joint, two heel locks per side and two figures of eight.²²

Stability Testing Procedures

The Biodex Balance System SD (Biodex Medical, Shirley, NY) was used to measure each subject's overall stability index, which represents the variance of foot platform displacement in degrees in all motions during a test. Balance was assessed using the Postural Stability Test which emphasizes a subject's ability to maintain their center of balance. Dynamic balance was assessed in a stork stance during three 20 second trials at stability level 4 which allows for 20° of platform tilt in all directions. Between each trial, 30 seconds of rest was provided. During testing sessions, the display screen that provides the location of center of balance was covered to eliminate visual feedback to the

participants. The mean of the three trials of the stability index scores for medial-lateral and anterior-posterior were used for statistical analysis. Lower stability index scores indicate increased stability.

Perception of Stability Assessment

Participant perception of stability was assessed using a 4-point Likert scale (1= very unstable, 4 = very stable) following each test session. The use of a 4-point Likert scale has been shown to be a valid and reliable assessment tool.²³ Participants were asked to mark the level of stability they perceived based on how steady and controlled they felt during the balance test. Participants were blinded from their previous response to prevent the score of the prior test from influencing their response to the testing of each independent variable.

Test Procedures

Assignment of the independent variables was counter-balanced to minimize the effects of fatigue associated with the testing procedures. All testing was performed on the participant's non-dominant leg. Determination of the participant's non-dominant leg was made by asking what leg they would kick a soccer ball with, and testing the leg not identified as the kicking leg. Prior to testing, participants were familiarized with the balance device and provided practice sessions on the testing procedures to decrease the chance of a learning effect occurring during testing. Participants were provided a 15-minute rest period after the practice sessions. Following the rest period, participants completed the postural stability test in either the barefoot or taped condition. Following the test with the first independent variable, the participant was provided a 15-minute rest period prior to the testing of the second independent variable. Testing of the independent variables was counter-balanced between participants.

Statistical Analysis

A 2 (sex) x 2 (condition) repeated measures analysis of variance was used to analyze the difference between barefoot and ankle tape conditions on anterior-posterior and medial-lateral dynamic stability indices. A Bonferroni post hoc test was used for all paired comparisons. Subject perception of stability during dynamic balance testing was analyzed using the Wilcoxon signed ranks test. All tests of significance were carried out at an alpha level of $p < 0.05$. Statistical procedures were performed using the SPSS Statistics package (v 24.0).

RESULTS

Dynamic Stability Measures

Means and standard deviations for overall stability, anterior-posterior stability, and medial-lateral stability by condition (barefoot, taped) and sex are presented in Table 1. A statistically significant interaction effect between gender and anterior-posterior and medial-lateral stability ($F_{1,38} = 0.24, p = 0.63$) was not found. A statistically significant main effect for gender was also not found ($F_{1,38} = 0.03, p = 0.87$). An interaction effect between stability and condition (barefoot and taped) was not found ($F_{1,38} = 0.13, p = 0.72$). A main effect for condition ($F_{1,38} = 0.15, p = 0.70$) was not found. A significant main effect was found between anterior-posterior and medial-lateral stability indices ($F_{1,38} = 5.41, p = 0.03$) with the medial-lateral stability index (1.23 \square 0.67) demonstrating greater stability than the anterior-posterior stability index (1.60 \square 0.98) regardless of condition.

| | Anterior-Posterior | | Medial-Lateral | |
|---------------|--------------------|-----------|----------------|-----------|
| | Barefoot | Taped | Barefoot | Taped |
| Male | 1.60±0.78 | 1.72±1.16 | 1.17±0.44 | 1.22±0.66 |
| Female | 1.78±1.27 | 1.34±0.62 | 1.29±0.76 | 1.20±0.79 |
| Total | 1.70±1.07 | 1.50±0.89 | 1.24±0.63 | 1.21±0.72 |

Table 1. Mean \pm SD for anterior-posterior and medial-lateral stability index scores.

Perception of Stability

Means and standard deviations for perception of stability by condition are presented in Table 2. A statistically significant difference

was found between the barefoot and taped condition ($Z = -3.578$, $p = 0.000$). Comparison of perceived stability scores indicate that participants identified the taped condition as more stable than the barefoot condition.

| | Perception of Stability | |
|---------------|-------------------------|------------|
| | Barefoot | Taped |
| Male | 2.67±0.71 | 3.67±0.50 |
| Female | 2.50±0.52 | 3.17±0.72 |
| Total | 2.57±0.60 | 3.32±0.67* |

Table 2. Mean ±SD scores for Perception of Stability (1 = very unstable, 4 = very stable)

*Ankle tape was significantly different from the barefoot conditions at the $p < 0.05$ level

DISCUSSION

The purpose of this study was to determine if taping of the ankle affected stability and if there was a difference in the perception of stability between the barefoot and ankle tape conditions. Results from the current study indicate that ankle taping had no effect on dynamic stability indices in healthy individuals. Participant perception of stability indicates that ankle tape does provide an increased sense of stabilization.

The exact mechanisms of how ankle taping may provide an increase in stability is not fully understood, with both mechanical and proprioceptive effects being proposed. The mechanical effects of taping have been well documented. Several studies have demonstrated a decrease in the amount of inversion and plantar flexion in the ankle following the application of tape.^{4,5,7-10} The current study did not specifically examine the mechanical aspect of taping. A review of the mean stability indices does show a slight improvement in medial-lateral and anterior-posterior stability for the taped condition (1.21 ± 0.72 , 1.50 ± 0.89 respectively) compared to barefoot (1.24 ± 0.63 , 1.70 ± 1.07 respectively). The lack of a statistically significant difference between barefoot and tape in the current study do not support the use of ankle taping to improve stability in individuals without an ankle injury. In a similar study to ours, Kinzey et al. did not find

significant differences between braced and control conditions in total sway, AP sway, or ML sway while performing a stork stance on a foam cushion placed on top of a force plate.¹⁸

Proprioceptive changes due to taping and bracing are thought to be caused by increased activation of the cutaneous afferent receptors in the ankle region. Although the current study did not specifically examine common measures for proprioception, balance is a component of proprioception and a brief discussion of the current findings to studies of proprioception is warranted. Jerosch et al. did not find a difference in inversion reproduction sense following the application of ankle tape in injured and uninjured ankles.¹³ Refshauge et al. did not find a significant difference in movement perception into plantarflexion and dorsiflexion between taped and untaped conditions.¹⁵ The lack of a significant difference in the anterior-posterior and medial-lateral stability indices between the barefoot and taped conditions in our study is comparable to the findings of Refshauge et al. In contrast to the findings that prophylactic ankle support does not improve proprioception in the ankle, Heit et al. did find an improvement in joint reproduction sense in healthy individuals for a taped condition when compared to the control condition.¹² The results of our study, however, found that the medial-lateral and anterior-posterior stability indices for the dynamic balance test did not differ significantly between the barefoot or tape condition. The findings of our study and those of Jerosch et al. and Refshauge et al. would seem to indicate that prophylactic ankle supports do not improve nor decrease proprioception of the ankle in healthy subjects.^{13,15}

The findings of the current study indicate that although there is no effect on dynamic stability measures, there is a perception that taping does cause improved stability of the ankle. Perception of stability results indicate that participants felt more stable with the tape (3.32 ± 0.67) than the barefoot condition (2.57

± 0.60) on the perception of stability question measured using a 4-point Likert scale. In a qualitative study analyzing the perception of ankle taping in collegiate athletes, it was found that taping resulted in feelings of increased confidence and decreased anxiety that an injury or reinjury would occur.²¹ Delahunt et al. examined the effects of a lateral subtalar sling and fibular repositioning tape application on dynamic balance and the perception of balance.¹⁷ Results from their study did not find a significant improvement in dynamic balance for either tape condition, but subjects did report an increased perception of stability with both tape conditions. The findings of our investigation are in agreement with the findings that taping does not affect dynamic stability in healthy individuals, but that there is a perception that tape provides an increase in stabilization of the ankle.

LIMITATIONS

The current study only assessed dynamic balance and perception of stability immediately following application of tape to the ankle. Tape has been shown to be less effective at limiting range of motion following exercise which may affect perception of stability following activity in a taped condition.²⁴ An additional limitation of this study was that only perception of stability was assessed. Additional measures similar to those used by Sawkins et al. and Delahunt et al., perception of confidence and reassurance, may provide a more complete understanding of the perceived effects of common ankle taping procedures.^{19,17}

FUTURE RESEARCH

There is a need for additional research on the effects of tape on actual and perceived stability. Future research should be directed towards assessing actual and perceived dynamic stability following an exercise protocol that simulates sport activities. As noted previously, tape has been found to be less effective at limiting motion of the ankle joint following exercise. Examining actual and

perceived stability following exercise should provide a more complete picture of the efficacy of taping in the prevention of ankle injury.

CONCLUSION

In conclusion, the use of ankle taping had no influence on either medial-lateral or anterior-posterior stability measures in this study. Ankle taping, however, did cause an increase in the perception of stability. These findings suggest that ankle taping has more of a placebo effect in uninjured ankles. The results from this study may assist athletic trainers in the decision to use tape for preventative measures. Although previous research has demonstrated that ankle taping does limit the amount of inversion and plantarflexion, the role of proprioception in ankle stability and the effect of taping on dynamic balance is questionable. Given that a placebo effect was demonstrated by the increased perception of stability with the taped condition, an individual's perception of improved stability should be a component in the decision to use prophylactic ankle support on uninjured ankles.

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