THE EFFECTS OF ANKLE TAPING ON DYNAMIC POSTURAL CONTROL AFTER ACUTE ANKLE SPRAINS

THESIS

Presented to the Grauduate Council of
Texas State University-San Marcos
in Partial Fullfillment
of the Requirements

for the Degree

Master of SCIENCE

By

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San Marcos, TX
May 2010

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank my committee members Dr. Ting Liu, and Dr. Kevin McCurdy and especially my chair, Dr. Luzita Vela. Without your guidance and expertise, I would not have been able to complete this project and master degree. I appreciate all of the comments, revisions, and timelines given to me throughout this process. Without those and the pressure to make you proud, this project would not have turned out as well.

David Gish was also a huge asset to this project. The data collection would not have been completed as efficiently had it not been for his flexible schedule and ability to meet with the participants unexpectedly. His emotional support and encouragement as well as that of my family and friends helped to keep me motivated.

Lastly, I would like to continuously thank my committee, chair, David Gish, family, friends, athletes, and students for being understanding of my stress level and urgency to complete this project. Thank you all for your support, understanding, kind words, and help along the way. I appreciate everything you have done and I could not have completed this project or degree without you.

This manuscript was submitted on March 22, 2010.

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CHAPTER I

INTRODUCTION

Ankle sprains are the most common lower extremity injury in sports and physical activity,[1, 2] accounting for as much as 15% of all sports related injuries.[3] Furthermore, of all foot and ankle injuries, ankle ligament sprains and capsular problems account for 86% of injuries.[4]

After initial injury to the ankle, injury recurrence or chronic ankle instability (CAI) can occur. It is suggested that the recurrence rate of lateral ankle sprains after initial injury could be as high as 80%.[2] CAI is defined as "unsatisfactory functional outcome after the primary treatment of an ankle inversion injury"[5] and has both mechanical and functional contributors. One explanation for the high rate of re-injury is poor ligament healing after the initial injury leading to mechanical insufficiency. It has been found that significant ligament laxity still occurs greater than eight weeks after initial injury.[6] In addition, participants with CAI may experience feelings of the ankle "giving way," and/or pain or swelling of the ankle after activity for months after the injury has occurred.[5] Functional ankle instability has been said to be associated with feelings of giving way and recurring ankle injuries.[7] Therefore, prevention of the first ankle sprain and appropriate care for the acute ankle injury is crucial.

After injury, ankle sprains are often taped, braced, or both in order to prevent further injury and allow for greater protection of the injured area during the initial phases of healing. Ankle taping and bracing is thought to provide mechanical support to the ankle while also restricting potentially dangerous motions at the ankle including excessive inversion and plantar flexion that can lead to additional stresses on injured ligaments. For example, a recent study demonstrated that participants with lateral ankle sprains have significantly greater ligament laxity at 3 and 8 weeks post injury when compared to healthy matched controls.[6] Thus, external protective devices are important for safely returning participants back to sport activity while the tensile strength of healing ligaments is still compromised for an extended period of time after return to participation.[6] Most individuals with ankle injuries (80%) are allowed to return to play in less than 10 days from injury.[8] Ligament healing can take up to several months to occur completely and with individuals returning to competition in less than 10 days, it is reasonable to assume that external support is necessary to improve stability.[6]

Ankle braces have become widespread because of their availability, cost effectiveness, and ease of use.[9] Both bracing and taping have been found to reduce ankle injury rates and frequency.[4] The use of ankle taping or bracing is actually most effective and requires fewer numbers needed to treat in individuals with previous history of ankle injury.[9] In this case, numbers needed to treat is defined as the number of ankles needing to be taped or braced in order to prevent one ankle sprain.[9] Some studies have documented that ankle taping positively influences balance by aiding in proprioception while other have shown decrements in dorsiflexion range of motion which has led to decrements in balance ability.[10, 11]

The use of ankle taping during dynamic tasks, such as jumping, sprinting, and other agility activities may have a small negative effect on performance.[12] This is largely due to the restrictions in dosiflexion range of motion that ankle taping provides. Contradictory to this information, ankle taping has also been shown not to affect jumping or balance tests.[10, 13] Some even suggest that ankle taping may increase the risk of ankle injury during jumping tasks but there is no evidence to substantiate these claims.[13]

Previous studies have examined the effects of ankle taping and bracing on static postural control, but fewer studies have investigated their effects on dynamic postural control. Static postural control can be defined as "attempting to maintain a base of support with minimal movement."[14] Static postural control tasks are typically completed with a single leg stance on a stable surface with eyes open. Dynamic postural control may be defined as "attempting to maintain a stable base of support while completing a prescribed movement."[14] These tasks can be instrumented as in the case of the Sensory Organization Test on the NeuroCom or field tests as in the case of the Star Excursion Balance Test (SEBT) or Balance Error Scoring System (BESS).[15-23]

Studies examining static balance and external ankle support have shown no differences in balance between participants who were taped versus those with no external support.[10, 13] Other studies have shown improvements in performances, while others have found impairments in performance with the use of ankle taping.[24] The different statistical findings may be due to the experimental procedures, taping styles, and whether or not the participant was accustomed to ankle taping.

Likewise, most studies have conducted research on healthy participants and expect readers to generalize the information to injured individuals. With the knowledge of tissue healing and ligament laxity after injury, this is not a feasible choice. Therefore, studies completed on healthy participants are not closely related to the injured athletic population.

Previous research examining dynamic postural control and the use of ankle taping procedures is extremely limited. Four studies have examined dynamic balance with external support, all of which investigated healthy individuals and little or no clinical significance was found between taping and no taping.[10, 13, 15, 25] Further research needs to be conducted examining dynamic balance with the use of tape versus no support on individuals with acute ankle sprains. This information will be useful to athletic trainers and other medical personnel who assess and prepare individuals with acute ankle sprains for return to activity.

It is important to determine whether ankle taping does influence dynamic stability because prophylactic ankle taping is often used in sports when a patient is returning back to activity after injury. In addition, sports activities are constantly changing so static measures of postural control cannot be generalized to activity. It is important to understand what can be used to add stability to dynamic movements in order to allow better, safer participation in sports after acute injury.

Purpose

There are four purposes of this study: 1) to determine the effects of acute lateral ankle sprains on dynamic postural control, as measured by the SEBT, in physically active participants, 2) to determine the effects of ankle taping when compared to no support on dynamic postural stability in physically active participants with acute lateral ankle sprains, 3) to evaluate perceived confidence, as measured by the Injury-Psychological

Readiness to Return to Sport Scale (I-PRRS) between the tape and no tape conditions on the injured limb, and 4) to evaluate perceived pain, as measured by the Graphic Pain Rating Scale (GPRS), between the tape and no tape conditions on the injured limb.

Null Hypotheses

It is hypothesized that...

1. Both injury and taping conditions will not affect dynamic postural control in participants with acute lateral ankle sprains.
2. Participants will report no differences in confidence and pain while completing a dynamic postural control task on the injured limb between tape conditions.

Operational Definitions

1. Physically active- individuals participating in "moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes on three days each week"[26]
2. Static Postural Stability- attempting to maintain a base of support with minimal movement[14]
3. Dynamic Postural Stability- attempting to maintain a stable base of support while completing a prescribed task[14]
4. Chronic Ankle Instability (CAI)-individuals with CAI may have:
    a. Laxity proven by clinical tests of the involved ankle ligaments
    b. Recurrence of ankle injury to the same side

c. Feelings of "giving way" that may withhold the subject from full activity

d. Pain or swelling during or after activity[5]

Delimitations

1. This study was delimited to participants between the ages of 18-35. These individuals are fully developed, old enough to provide proper consent, and at an age to avoid natural declines in proprioception or balance.
2. This study was delimited to physically active participants as defined by the American Heart Association. This will allow the findings of this study to be generalized to the athletic and physically active populations.
3. This study was delimited to confirmed grade I or II ankle sprains. Although these injuries are structurally different in the amount of swelling, pain, and ligament laxity, they are more similar than dissimilar. For the purpose of this study the difference between grades I and II ankle sprains will not be distinguished.
4. This study was delimited to participants that were evaluated and tested within five days of injury. Although ligament healing does not occur fully within this time frame, athletes and physically active individuals often return to some physical activity before full tissue healing.
5. This study measured dynamic postural stability through valid and reliable field tests. Although machinery and computer generated testing was available to determine dynamic stability, athletic trainers must often conduct on-field assessments to determine an athlete's ability to return to play.

Limitations

1. Grade I and II ankle sprains are not the same in severity, ligament laxity, etc. For the purpose of this study, they were be used without distinction. Grade III sprains will be determined and are means for exclusion from the study.

Assumptions

1. This study assumed participants were honest in all self reports of pain, previous injury, medical history, and current health.
2. This study assumed that using a Certified Athletic Trainer (ATC), an allied health care practitioner with 20 years of experience, would allow for successful assessment of ankle sprain severity.
3. This study assumed the functional tests used for exclusion would adequately filter out potential participants who would not successfully perform the dynamic postural tests.
4. This study assumed the participants would perform the tasks required for this study with maximal effort.

Significance of the Study

There are inconclusive findings on the effects of ankle taping on dynamic postural control. Furthermore, no studies have investigated the role of ankle taping on dynamic postural control in participants with acute lateral ankle sprains. This study will help athletic trainers and other sports medicine personnel understand ankle taping effects on dynamic postural control as measured by the SEBT. By examining common interventions used by athletic trainers and other sports medicine personnel, we can gain a better understanding of best practices. The use of dynamic postural control field tests will allow for the findings to be more generalized to sports activity. The findings of this study may lead athletic trainers to rethink their daily procedures or give support to the continued use of ankle taping after acute lateral ankle sprains.

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CHAPTER II

MANUSCRIPT

Effects of Ankle Taping Versus no Support on Dynamic Postural Control in the Physically Active: A Systematic Review

Context: Ankle sprains are the most common injury related to sports. Ankle taping and bracing is often used to add support to the newly injured joint and allow the individual to return to play far before the ligament has fully healed. **Objective:** To answer the following question: Is ankle stability as measured by dynamic postural control in physically active adults between the ages of 18 and 35 affected by prophylactic ankle taping when compared with no external support? **Data Sources:** Medline with Full Text, SPORTDiscus, CINHAL Plus entries from 1800's to October 2009 were searched using a combination of the terms ankle, ankle sprain, ankle support, taping, ankle stability, balance, dynamic balance, dynamic postural control, and dynamic stability. A total of 344 possible articles were identified using combinations of the search terms. **Study Selection:** Only studies that assessed dynamic stability with taped and untaped ankle conditions in physically active participants between the ages of 18 and 35 were included. Studies must have investigated dynamic postural control to be included because of their generalizability to sports. **Data Extraction:** Four articles based on title, abstract and article content were included for analysis. Two individuals independently assessed the articles that met all the inclusion criteria. These articles had an average Physiological Evidence Database (PEDro) scale score of 5.0 ± 1.41 (range: 4-7) and the overall qualityof the articles was a 2B on the Strength of Recommendation Taxonomy (SORT). Effect sizes (ES) were estimated using Cohen d with 95% confidence intervals (CI) for differences between the tape and no tape conditions. A positive ES indicated improved dynamic postural control with the tape condition. **Data Synthesis:** Effect size and confidence intervals were calculated for all articles (ES range: -.58 to 0.29). CIs crossed the zero point for all studies except for scores on the Balance Error Scoring System (BESS) in Broglio et al. and the Vicen et al. time condition. Scores in the Broglio et al. study were worse for the taped ankles under two dynamic balance conditions: 1) in single leg stance (d=-0.24, CI=.-0.75 to 0.28) and 2) tandem stance (d=-0.42, CI=-0.73 to -0.16) and the timed condition for the Vicen et al. study (d=-0.58, CI=-0.72 to -0.45). **Conclusions:** Ankle taping had no clinically positive influence on dynamic postural control when compared to no support in three of the four studies included. One study reported a negative, but small, effect of ankle taping on dynamic balance. A major weakness of these studies is that all testing was done on healthy participants. More research needs to be completed with injured participants in order to definitively answer whether or not ankle taping has an effect on dynamic postural control in the injured population. **Word Count:** 465

INTRODUCTION

Ankle sprains are the most common lower extremity injury related to sports.[2] Recurrence of ankle injury and chronic ankle instability (CAI) often occur after initial injury and is estimated to be as high as 80%.[2] This is thought to be from poor healing of the ligaments after the initial injury.[5] Therefore, prevention of the first ankle sprain and appropriate care for the acute ankle injury is crucial.

In order to prevent further injury, ankle sprains are often taped or braced to give greater support. Initially, ankles may be taped or braced to prevent an ankle sprain from occurring. Often, athletes may be prophylactically braced and then taped and/or braced following an injury to the ankle. It has been reported that ankle taping decreases joint range of motion, increase balance, and decreases the rate and frequency of ankle injuries.[10, 11] In addition, ankle braces are widely available, can add external support, and are cost effective.[9, 12]

Research has examined different ankle supports and static stability, but the area of ankle taping versus no taping and their effects on dynamic ankle stability has not been explored in depth. Dynamic postural control can be defined as "attempting to maintain a stable base of support while completing a prescribed movement."[14] Most previous research has been conducted on healthy subjects and using static balance tests. Static postural control can be defined as "attempting to maintain a base of support with minimal movement."[14] Motions like these are not related to sports or daily activities and therefore cannot logically be generalized to individuals competing or coming in contact with environmental factors.

It is important to determine whether the use of ankle taping can increase dynamic stability because prophylactic ankle taping is frequently used in sport. Sports are not static activities, and therefore researchers need to look at the use of ankle supports in more dynamic and functional activities. Athletes are constantly moving, changing directions, and responding unpredictably. During sports performance, it is important to understand what can be done to add stability to those dynamic movements in order to allow better, safer participation in sports.

Understanding the role of prophylactic ankle taping on dynamic postural control is important to athletic trainers who commonly tape ankles post injury. An important common question is whether the taping helps or hinders dynamic balance. Previous research has only targeted the healthy population. This systematic review attempts to determine if dynamic balance of physically active adults between the ages of 18 and 35 is affected by taping when compared with no support.

METHODS

Search Strategy

We searched Medline with Full Text, SPORTDiscus, and CINHAL Plus entries from the 1800's to October 2009 using a combination of the search terms: ankle, ankle sprain, ankle support, taping, ankle stability, balance, dynamic balance, and dynamic postural control, and dynamic stability. A total of 344 possible articles were identified through the search terms (see figure 1).

Criteria for Selecting Studies

Only studies that assessed dynamic stability with taped versus un-taped conditions in physically active participants between the ages of 18 and 35 were included. Articles that investigated taping versus bracing were excluded if they did not include baseline measurements without external support. We chose to only investigate studies that covered dynamic balance because of its importance in physical activity. Only studies that included all the inclusion criteria were chosen to undergo critical appraisal.

Assessment of Methodological Quality

All articles that met the inclusion criteria were evaluated using the PEDro scale. PEDro scores are used to give readers an indication of an article's rigor and usefulness in the clinical setting. Articles may receive a PEDro score between 0- 10 points, with a score of 10 indicating the highest rigor of a randomized controlled trial. Eight of the 10 points on the PEDro scale deal with internal validity while the other two have to do with statistical reporting.[27] The articles were separately evaluated by two people and in the case of a disputed score a common consensus was reached on the overall score.

Data Extraction and Statistical Analysis

Means and standard deviations were extracted from the statistical data for each study to calculate effect size (ES) using a Cohen's d. ES was calculated for differences in dynamic postural stability measurements between the taping condition and no support condition for each dynamic postural control measure in each article. In addition, a 95% confidence interval was calculated around the point estimates. According to Cohen, ES values of .4 or less are considered weak, .41-.70 has a moderate strength, and anything larger than .70 is considered strong.

All the articles were assessed and collectively a Strength of Recommendation Taxonomy (SORT) score was determined. The SORT algorithm assesses the body of knowledge regarding a topic for both strength and quality. An A, B, or C can be given for strength of the evidence while quality is assessed with a 1, 2, or 3 rating. An A is considered when the articles give good, consistent evidence, B is based on inconsistent or lower quality evidence that is still patient oriented, and a C is less than patient oriented evidence. The 1-3 ratings are paralleled to the A-C ratings but express the type and rigor of the study.

RESULTS

Four articles met the inclusion criteria to answer the question of interest (see table 1.) The mean PEDro score was a 5.0±1.41 (range= 4-7). Only one of the articles had a disputed score, which was discussed by authors and a consensus was reached. All four articles had sufficient data to calculate ES.

Procedures for data collection varied widely, making it hard to compare the results of the studies. Paris[10] had participants complete a battery of tasks, including sprinting, a static and dynamic balance test, an agility test, and a jump test. For the purpose of this review and dynamic postural control, we are only interested in the dynamic balance task. Dynamic postural control was measured in seconds. Participants were asked to stand up onto stepping blocks and then remain stable on one foot for 5 seconds. Therefore, a higher score is better. Participants were also tested under five support conditions, but the baseline and athletic tape were the only data used in this review. No significant differences were found among taping and the control.

Sawkins et al.[25] had participants complete a jumping task and the modified Star Excursion Balance Test (SEBT) with the use of tape, placebo tape, and control. For the purpose of this review and dynamic postural control, only the modified SEBT with the use of tape and the control was included. Reach distances on the SEBT were measured in centimeters in three different directions (anterior, posterior, and posterior medial) when normalized to leg length. Distance was measured in centimeters which a higher score indicated better performance. No clinically significant difference was found between reach distance between the taped and no-tape conditions.

Broglio et al.[15] used the NeuroCom Sensory Organization Test (SOT) and the Balance Error Scoring System (BESS) under braced, taped, and control conditions. The SOT is a test that tries to disrupt the participants' sensory inputs by altering their visual feedback and base of support. Through these tests, the participant was asked to maintain their balance as best as possible. A higher score indicated better balance.[28] The BESS is an examination consisting of six conditions. These conditions include foot position (double leg, single leg, and tandem) on a stable and unstable surface (firm ground and foam pad) for each stance. All conditions were completed with the eyes closed and the patients' hands on hips with each lasting 20 seconds.[22, 23] This review only used the data from the taped and barefoot conditions. A decrease in postural stability was found with the use of ankle support.

Lastly, Vicen et al.[13] had participants perform countermovement jumps, static balance and dynamic posturography tests with the use of tape and no support. Dynamic posturography and both conditions were included in this review. Participants were asked to look at a screen with illuminated circles. One dot represented their body position on the platform. They were then asked to move their body position to the respective circles as quickly as possible after they became illuminated and stay in that position until the next one lit up. These measurements were assessed in seconds and percentage of hits. No significant differences in hits during the dynamic posturography testing were found with the use of ankle tape and no support, although ankle taping was found to have a negative effect on time.

The point estimates for the ES ranged from -2.23 to 0.29 with a positive effect size indicating better dynamic postural control in participants with the taped condition. In over half the studies,[13, 15, 25] the CIs crossed the zero line indicating that there is not a strong clinical effect of taping on dynamic postural control. The findings suggest that taping does not aid with dynamic postural control. The studies[13, 15] that did not have CIs cross the zero line found that taping had a negative effect on dynamic postural control, although these effects were not clinically significant.

The SORT level of evidence is a B2. The strength recommendation of B was determined because although the articles investigated the effects of taping on patient-oriented evidence (quality of life/morbidity), the level of evidence was lower quality demonstrated by the low PEDro scores. A level of evidence score of 2 was awarded because of the low quality randomized control trials with inconsistent findings.

DISCUSSION

All studies included in this review met the criteria for answering the question of whether dynamic postural control of physically active individuals between the ages of 18 and 35 is affected by ankle taping when compared with no support. Because no previous research has examined dynamic balance in the injured population with the use of a taping condition and control, and related studies were on healthy participants, mainly using static balance, there is a need for future studies. The future studies should target individuals with acute ankle sprains and test their dynamic postural stability.

Results from the systematic review indicated that taping had no effect or a small negative, clinically insignificant effect on dynamic postural control in healthy individuals except with two measures in a study completed by Broglio. The measures could actually be classified as static balance measures since they were completed on a firm surface. Both of these had a relatively large negative effect and did not cross the zero, indicating that was clinically significant and impaired the participants' balance. With an overall SORT score of B2 and mean PEDro score of 5, the level of evidence was inconsistent and the quality of studies was low. With most of the confidence intervals crossing the zero line, or coming close, as indicated on the forest plot, no clinical or practical significance was noted for these studies. Therefore, these studies indicate that ankle taping has no effect on dynamic postural control or a very minimal negative effect.

Limitations found during this review include a small number of previous studies pertaining to the clinical question of interest. Only a total of four articles were found that met all of the inclusion criteria. This hindered the ability to properly research the topic for conclusive evidence. Most studies conducted on dynamic balance examined ankle bracing as opposed to ankle taping.[4] Other studies examined studied dynamic balance and only investigated healthy subjects. Lastly, there was a lack of consistency with the type of dynamic postural control tests used. Therefore, no true comparisons were made among studies.

CONCLUSION

The articles included in this systematic review had an overall PEDro score of 5.0 and a SORT score of B2. The lack of rigor of these studies and their findings leads to inconclusive findings. Inversion ankle sprains are the most common ankle injury in sports.[1, 2] Based on the articles in this review, ankle tape does not significantly affect dynamic postural stability and may actually cause negative effects on dynamic postural stability. Given the limitations of the studies more research needs to be completed on the effects of ankle taping on dynamic postural control in an injured, physically active population.

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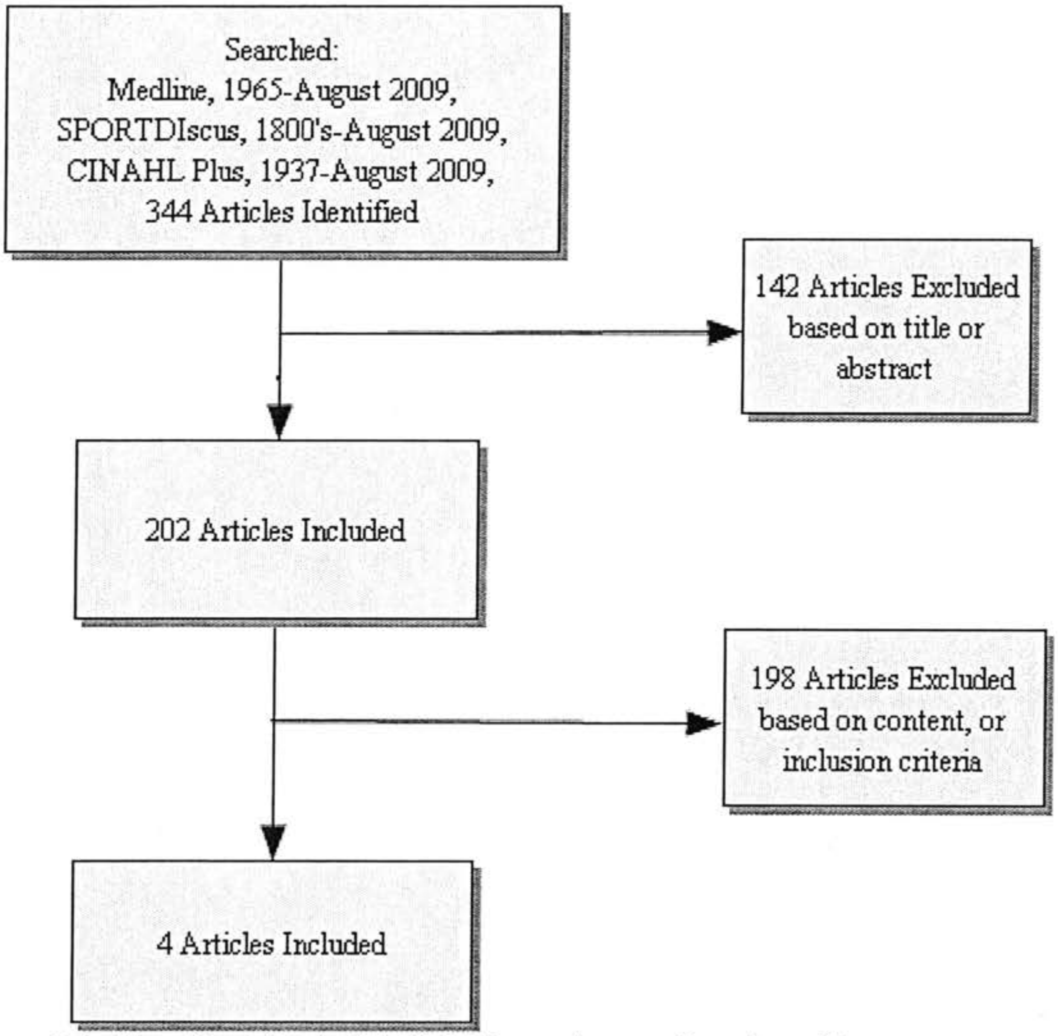

Figure 2.1: Flow Chart for Article Selection to Answer Question of Interest.

Table 2.1. Articles Included in Systematic Review.

Authors	PEDro Scale	Study Design	Total Subjects	Dynamic Postural Task (measurement)	Effect Size (95% CI)
Paris	4	RCT with crossover	18	Nelson Test (seconds)	0.29 (-3.63 to 3.73)
Sawkins et al.	7	RCT with crossover	30	Modified Star Excursion Balance Test (errors)	Anterior: 0.16 (-2.13 to 2.59), Posterior: -0.11 (-3.96 to 3.69), Posterior Medial: -0.02 (-3.37 to 3.51)
Broglio et al.	4	RCT with crossover	19	Balance Error Scoring System(errors)	Single Firm: -1.45 (-1.79 to -1.04), Tandem Firm: -2.23 (-2.32 to -1.85), Single Foam: -0.24 (-0.75 to 0.28), Tandem Foam: -0.42 (-0.73 to -0.16)
Vicen et al.	5	RCT with crossover	15	Dynamic posturography test (seconds, percent hits)	Time: -.58 (-0.72 to -0.45), Hits: 0.02 (-6.0 to 6.04)

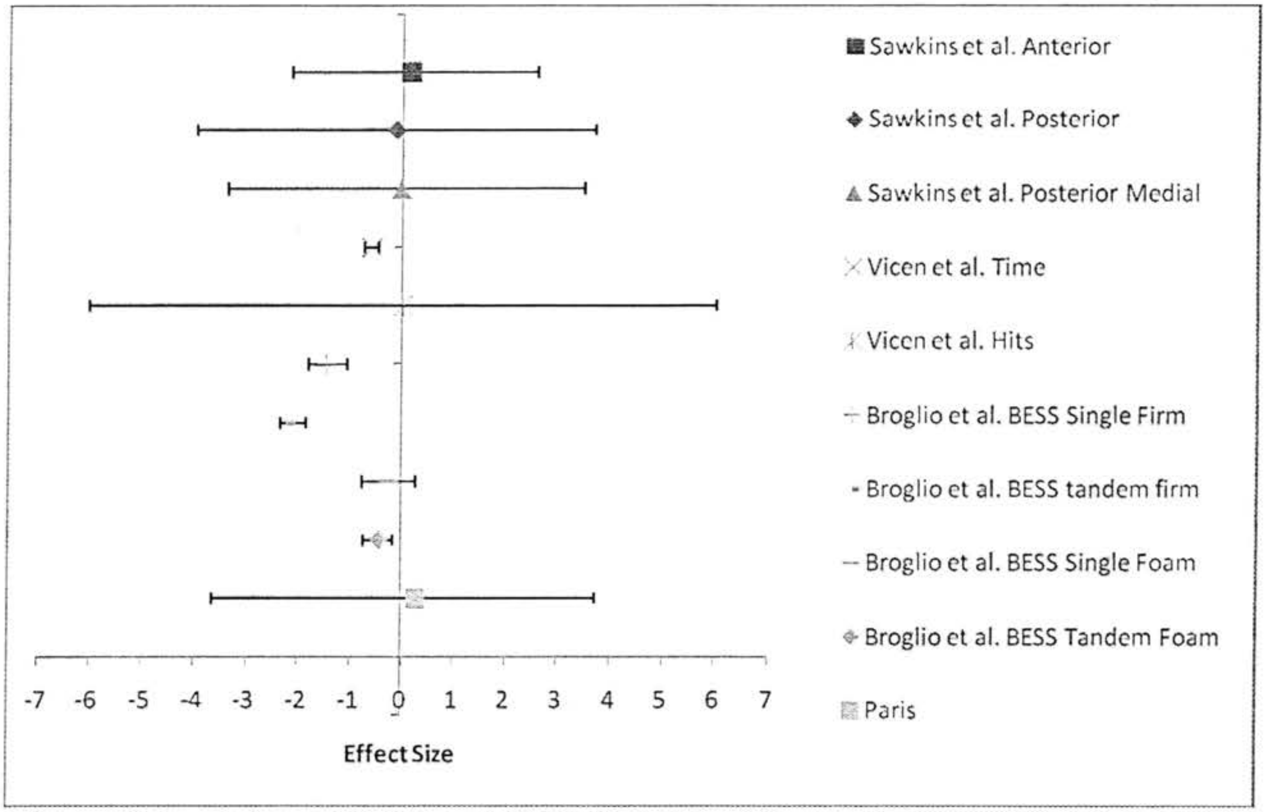

Figure 2.2. Plot of Effect Sizes and Confidence Intervals of Articles Used.

CHAPTER III

METHODS

Participants

Twenty-one physically active adult volunteers (16 males, 5 females, age= 20.43±1.54, mass=81.37kg ±20.72, height=178.21cm ±8.6), between the ages of 18-35 participated in this study. Volunteers were recruited from Texas State University-San Marcos intercollegiate athletics, intramural sports, Personal Fitness and Wellness classes, the Texas State University Student Health Center through the use of flyers, announcements, or by word of mouth. Incentives for participation included an injury assessment by an experienced Certified Athletic Trainer (ATC) and an at-home rehabilitation protocol with a piece of Theraband for use in the rehabilitation program.

No means and standard deviations from previous studies were available to determine sample size. Therefore, sample size was estimated based on previous ankle support research which generally used a sample size of approximately 20 participants.[1-4]

All participants included in the study suffered a grade I or II ankle sprain as determined by an athletic trainer, with 20 years experience, within 120 hours of injury onset. Each participant completed a modified Goddin Questionnaire and was considered physically active according to the American Heart Association crtieria.[5]

The participants were excluded from the study if their current function limited the performance of the following three tasks with self indicated pain less than 5/12 as interpreted from the Graphic Pain Rating Scale: 1.) walking 10 steps, 2.) going up and down 3 stairs, and 3.) completing a single leg squat (see Appendix B). Participants were excluded from the study if they were unable to obtain 20 degrees dorsiflexion while performing a stabilized one-leg squat with an acu-angle inclinometer attached to the tibia just inferior to the tibial tuberosity (see Appendix B).[18]

Participants were also excluded from the study if they self-reported lower extremity injury on the affected side within the past 6 months, history of lower extremity surgery on the affected side, concussion, visual/vestibular problems, inner ear infections, or upper respiratory infections at the time of testing.[5-9] Participants with a positive test indicated by either the bump or compression test were excluded from the study. Complete laxity or rupture with either the talar tilt or anterior drawer test was means for disqualification as a participant.

In addition, chronic ankle instability (CAI) was defined as unsatisfactory functional outcome after the primary treatment of an ankle inversion injury and has symptoms of 1) recurrent ankle sprains, 2) feelings of "giving way," and 3) swelling after activity.[5] None of the participants met the CAI criteria in this study.

<u>Instrumentation</u>

The Star Excursion Balance Test (SEBT) (see Appendix B) is a dynamic balance test where the participant stands on one leg while reaching with the contralateral leg in eight different directions. The participants were only asked to reach three different directions (anterior, posterior medial, and posterior lateral) as done in previous research.[16] The participant's foot was positioned equidistant from a horizontal axis point and the 2nd ray in line with the anterior-posterior line.[16, 17]

While performing the task, the participant was instructed to keep the hands on the hips.[17] The participant eccentrically controlled reaching in each of the three reach directions and gently tapped his/her toe along the line of reach. The participant performed three reaches in each direction. A reach was not used if the participant lifted their heel off the ground, took their hands off their hips, fell out of the stance, or stepped down on the reach foot rather than just tapped. The reach distance measurement was taken in centimeters and averaged over three reaches in each direction.

Furthermore, the reach distance was normalized to leg length. Leg length was measured in centimeters with the participant supine. Measurement was taken from the anterior superior iliac spine to the medial malleolus of the affected side.[18] This measurement allowed for standardization of each participant's reach distance on the SEBT. The SEBT has been reported to be helpful in clinical measurement of functional ability after injury because it challenges dynamic postural control.[16-19, 21] On multiple occasions, the SEBT has been suggested to be both valid and reliable.[15, 16]

Pain was measured in order to ensure participant function and ability to participate in the study without excessive pain or re-injury as well as to determine if the use of tape may affect pain during the performance of the SEBT. Pain was determined based on the Graphic Pain Rating Scale (GPRS).[2] GPRS is a 12 centimeter visual analog scale with 7 descriptors evenly spaced within the scale ranging from no pain to unbearable pain (see Appendix B). The participant was asked to draw a mark on the line closest to the description of pain they were experiencing at that moment. This test has been reported to be both valid and reliable. The participants completed the GPRS on 5 occasions: 1) three times upon entering into the study and completing each functional task, 2) once after completing the SEBT with the tape condition, and 3) once after completing the SEBT without tape.

Confidence was also evaluated in this study to determine the effect of tape on participant's confidence level while performing the dynamic balance task. The Injury-Psychological Readiness to Return to Sport (I-PRRS) (see Appendix B), a 10 point questionnaire with numeric answers between 0-100, was used to determine confidence before and after the SEBT under each condition. This instrument has been reported to be both valid and reliable.[22]

Ankle dorsiflexion was measured with the use of the acu-angle inclinometer (see Appendix B).[2, 10] Dorsiflexion range of motion with the knee bent, as in a single leg squat, allowed for a more accurate measurement of functional range of motion.[18] This form of range of motion measurement was more closely related to the task being completed and served as a test of the participant's function.

The possibility of a fracture was ruled out by the athletic trainer using the bump and compression tests (see Appendix B). These tests were completed with the participant's legs hanging off the end of the table. The bump test had the examiner use the heel of their hand to strike the bottom of the participant's foot on the calcaneus. Radicular pain from the strike on the bottom of the foot indicated a positive test. The compression test had the examiner grasp the lower leg with one hand on each side and compress the tibia and fibula together. Radicular pain from the compression of the lower leg indicated a positive test.

Ligament laxity tests were performed by the athletic trainer. The testing occurred with the participant's legs hanging off the end of the table. During the anterior drawer test (see Appendix B), the examiner stabilized the affected lower leg with the ankle neutral and applyed pressure to the posterior aspect of the ankle to pull the talus forward. The anterior drawer test has been suggested to be valid and reliable for ligament laxity of the anterior talofibular ligament, but not as sensitive for isolating the calcaneofibular ligament.[19] The talar tilt test (see Appendix B) was also performed with the ankle in neutral and the rearfoot pressed into inversion.[2]

Taping procedures followed general guidelines commonly used in athletic training (see Appendix B). A heel and lace pad was placed in front of the ankle and on the Achilles tendon. Prewrap was used to minimize friction during the tests. Two base strips were placed at the base of the ankle and base of the foot, just superior to the base of the fifth metatarsal. A basket weave of the stirrups and horse shoes was used, followed by heel locks (2 on each side) and cover strips for closure.[20]

Procedures

Each prospective participant completed a university approved IRB, signed a consent form, and completed a medical history form before participation. Participants were then tested to ensure they met the inclusion criteria and possessed no exclusion characteristics. The athletic trainer performed the anterior drawer, talar tilt, bump, and compression tests. The bump and compression tests were completed first to rule out fractures followed by the anterior drawer and talar tilt tests. Even though some participants were excluded from the study, they were provided with the rehabilitation program as well as the Theraband (see Appendix D).

After all inclusion criteria were met and exclusion characteristics ruled out, the participant's height, weight and leg length in centimeters were measured. Reach direction on the SEBT (anterior, posterior-medial and posterior-lateral) and tape condition (tape versus no tape) were randomized using the Williams Design Latin Squares, in order to offset for the learning effect and to ensure randomization.[21]

Following these measurements and tests, the participant performed the SEBT. Before the participant completed the SEBT under the taped condition, he/she was asked to warm-up on a bike for 5 minutes. The seat height was placed level with the greater trochanter of the femur and the participant was instructed to keep the ball of their foot on the pedal in order to allow for greater ankle movement. The participant was asked to complete the GPRS and I-PRRS after each condition (tape and no-tape). The SEBT, GPRS, and I-PRRS were also completed for the unaffected leg as long as this leg met all of the inclusion and exclusion criteria.

After the completion of all tasks the participants were given ice for their symptoms, unless contraindicated, and received an at-home rehabilitation program and a piece of Theraband. Participants were also instructed on the RICES principle and given contact information for the Texas State University Student Health Center in the case that further medical attention was warranted.

Data Analysis

All data were analyzed using SPSS (Chicago, Ill.) version 18.0. Pain and confidence levels of the participants' injured limbs under the taped and non-taped conditions were analyzed using paired t-tests. Because all three SEBT reach directions are related, the normalized SEBT average reach scores in the anterior, posterior medial, and posterior lateral directions were analyzed using a doubly multivariate MANOVA. Both independent variables, limb (affected and unaffected) and intervention (tape versus no tape), were treated as within group factors. The a priori level of confidence was set at $p=.05$. Paired t-tests were completed to analyze differences for pain and confidence. An independent t-test was used to analyze dorsiflexion range of motion.

Missing data were present in four cases when the uninjured limbs did not meet all of the inclusion criteria for the study. Data were imputed with a linear regression model to create a prediction equation to estimate the missing values in each reach direction.

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CHAPTER IV

MANUSCRIPT

The Effects of Ankle Taping on Dynamic Postural Control after Acute Ankle Sprains

Abstract

Context: Ankle sprains are the most common lower extremity injury in sports and physical activity accounting for as much as 15% of all sports related injuries. Studies have been conducted to understand the effects of external supports on dynamic postural control. However, no studies have been conducted in participants with acute lateral ankle sprains. **Objective:** To identify the effects of injury and ankle taping on dynamic postural control in participants with acute lateral ankle sprains. Secondarily, confidence using the Injury-Psychological Readiness to Return to Sport (I-PRRS) Questionnaire and pain, assessed with the Graphic Pain Rating Scale (GPRS), were assessed in both taped and non-taped conditions. **Design:** Crossover controlled trial. **Setting:** All tests were completed in the university athletic training room. **Participants:** Twenty-one, physically active, adult volunteers (16 males and 5 females, age= 20.43±1.54, mass=81.37kg ±20.72, height=178.21cm ±8.6), who had sustained unilateral acute mild or moderate lateral ankle sprain participated in the study within 5 days of injury. **Interventions:** Participants were tested under two conditions, taped and no support, on both the affected and unaffected leg. **Main Outcome Measurements:** Dynamic postural control was calculated using the Star Excursion Balance Test (SEBT) in the anterior, posterior medial, and posterior lateral reach directions on both injured and un-injured limbs. The I-PRRS and GPRS were administered after the SEBT under each condition. Dynamic postural control average reach scores in the anterior, posterior medial, and posterior lateral directions for each leg were analyzed using a doubly multivariate MANOVA. Pain and confidence were analyzed on the injured limb under both conditions using a paired t-test. The a priori level of confidence was set at $p=.05$. **Results:** Ankle taping was found to decrease pain ($t(20)=-2.37$, $p=0.028$) and increase confidence ($t(20)=2.83$, $p=.010$) during the SEBT when compared to no support. Injury affected dynamic balance ($F(3,18)=3.855$, $p=.027$) with the anterior reach ($F(1,20)=9.721$, $p=.005$) and posterior lateral reach ($F(1,20)=7.893$, $p=.011$) directions being significantly less in the injured limb. Dynamic balance was not significantly affected by the use of ankle tape while completing the SEBT. **Conclusions:** Ankle taping has been found to have psychological benefits although it did not greatly affect performance. Dynamic balance was not significantly affected by the ankle injury. **Key Words:** dynamic postural control, acute ankle sprain, ankle taping. **Word Count:** 385

INTRODUCTION

Lateral ankle sprains account for as many as 15% of all lower extremity sports-related injuries and are the most common injury in sports related activity.[1-3] Ligament damage occurs during acute lateral ankle sprains with increased laxity present up to 3-8 weeks after injury.[6] Athletes and physically active individuals often return to full activity before full ligament healing has occurred though. Most individuals with ankle injuries (80%) in intercollegiate sports return to sports less than 10 days after injury.[8] Ankle sprain recurrence rates are high after initial injury, possibly as high as 80%.[2] Often ankles are braced and/or taped in order to give additional external support during the time period when athletes return to physical activity and ligament tensile strength is compromised.

Ankle bracing and taping are proposed to reduce ankle injury rate and frequency.[4] Inconclusive evidence suggests that ankle taping positively influences balance by aiding in proprioception,[10] but decreases dorsiflexion range of motion which could lead to decrements in balance ability.[11] Studies evaluating static balance with the use of external ankle support have also shown no differences in balance between participants who are taped and those with no support.[10, 13] Some studies have shown improvements in performances with the use of ankle tape, while others have found impairments.[24] Cordova[12] indicates that external ankle support is used to decrease motion of the subtalar joint in the frontal plane, although it may also restrict sagittal plane movement and hinder athletic performance in sprint speed, agility speed, and vertical jump height.

Many studies have evaluated the effects of ankle taping and bracing on static postural control, but few have looked at their effects on dynamic postural control. Static postural control can be defined as "attempting to maintain a base of support with minimal movement"[14] and is usually performed with a single leg stance on a stable surface with eyes open or closed. Dynamic postural control may be defined as "attempting to maintain a stable base of support while completing a prescribed movement."[14] These tasks may consist of the Sensory Organization Test on the NeuroCom or field tests like the Star Excursion Balance Test (SEBT) or Balance Error Scoring System (BESS).[15, 17, 19, 22, 23, 30]

Previous research investigating dynamic postural control and the use of ankle taping is limited. All studies tested healthy individuals and demonstrated that little or no clinical significance was found on dynamic postural control in both conditions. [10, 13, 15, 25, 32] Further research should investigate dynamic balance with the use of tape and no external support on individuals with acute ankle sprains.

Therefore, it is important to understand whether dynamic postural control, as measured by the SEBT, pain, as measured by the GPRS, and/or confidence, as measured by the I-PRRS, in physically active individuals between the ages of 18-35 is affected by the use of ankle tape when compared to no support in participants with acute lateral ankle sprains.

METHODS

Participants

Twenty-one adult volunteers (16 males and 5 females, age= 20.43±1.54, mass=81.37kg ±20.72, height=178.21cm ±8.6) who sustained unilateral acute mild or moderate lateral ankle sprains participated in the study. All participants included in the study had a grade I or II ankle sprain as determined by an athletic trainer, with 20 years experience, within 120 hours of injury onset. Grade I and II acute lateral ankle sprains were not differentiated between, although a Grade III sprain and fracture were means for disqualification. Participants were excluded if the bump and/or compression tests were positive for radicular pain, indicating a fracture, or the anterior drawer and/or talar tilt were positive for complete rupture. Additionally, each participant met a "physically active" criteria according to the American Heart Association.[26]

Participants were excluded from the study if they reported lower extremity injury on the affected side within the past 6 months, history of lower extremity surgery on the affected side, concussion, visual/vestibular problems, inner ear infections, and upper respiratory infections at the time of testing.[5, 33-35] In addition, participants denied three symptoms associated with chronic ankle instability (CAI): 1) recurrent ankle sprains, 2) feelings of "giving way," and 3) swelling after activity.[5]

To ensure function, participants demonstrated 20 degrees of dorsiflexion range of motion while performing a stabilized single-leg squat. In addition the participants successfully completed three functional tasks reporting a pain level less than 5/12 on the GPRS: 1) walk 10 steps, 2) walk up and down 3 stairs, and 3) one legged squats.

Instrumentation

A SEBT grid was semi-permanently placed on the floor of the athletic training room to measure reach distance to calculate dynamic postural control. Distances were measured to an accuracy of 1 mm, completed in the anterior, posterior medial, and posterior lateral directions and repeated three times for each direction. The distances were normalized to leg length and averaged. The SEBT (see Appendix B) has been suggested to be both a valid and reliable measure of dynamic postural control.[36, 37]

Pain was measured using a Graphic Pain Rating Scale (GPRS) (See Appendix B). The GPRS is a 12 centimeter visual analog scale with 7 descriptors evenly spaced within the scale ranging from no pain to unbearable pain. The participant was asked to draw a mark on the line closest to the description of pain they were experiencing at that moment.

Confidence was measured using Injury-Psychological Readiness to Return to Sport (I-PRRS) Questionnaire altered to the language for before and after the SEBT (See Appendix B). The I-PRRS is a 10 point questionnaire with numeric answers between 0-100 that was used to determine confidence before and after the SEBT under each condition. The I-PRRS has been shown to be both valid and reliable.[38]

Ankle dorsiflexion range of motion was measured with the participant completing a single leg squat using an Acu-Angle Inclinometer attached to the proximal tibia just inferior to the tibial tuberosity (See Appendix B). Dorsiflexion range of motion with the knee bent rules out the gastrocnemius and allows for a more accurate measurement of functional range of motion.[39] This form of range of motion measurement was more closely related to the task being completed than traditional goniometry as well as serves as a test of the participant's function.

Protocol

All participants completed testing within 5 days of injury. Each prospective participant signed a university approved consent form (See Appendix A) prior to participation. Participants were then tested to ensure they met the inclusion criteria and possessed no exclusion characteristics. The athletic trainer performed the anterior drawer, talar tilt, bump, and compression tests (See Appendix B) to rule out fracture and the anterior drawer and talar tilt tests for laxity evaluation. Participants then completed the functional testing and GPRS.

Participants were asked to complete the SEBT in the anterior, posterior medial, and posterior lateral directions as supported by previous literature.[16] The participant's foot was positioned equidistant to the horizontal axis point and the 2nd ray in line with the anterior/posterior line.[16, 17] While performing the task, the participant was instructed to keep his/her hands on his/her hips.[17] Three reaches were given for each reach direction. The participant controlled reaching in each of the three reach directions and gently tapped his/her toe along the line of reach. The reach distance measurement was taken in centimeters and averaged over three reaches in each direction. A reach was not used if the participant lifted their heel off the ground, took their hands off their hips, fell out of the stance, or stepped down on the reach foot rather than just tapped. Reach directions on the SEBT (anterior, posterior-medial and posterior-lateral) and tape condition (tape versus no tape) were randomized using the Williams Design Latin Squares in order to offset for the learning and treatment effects.[42] A five minute bike warm up was completed after the tape procedure was completed for each limb but prior to the completion of the SEBT.

Participants performed identical testing procedures under both conditions as well as on the unaffected leg if all inclusion and exclusion criteria were met. The participants completed the GPRS and the I-PRRS after completing the SEBT on the injured limb.

Statistical Analysis

All data were entered into SPSS (Chicago, Ill.) version 18.0. Paired t-tests were used to analyze pain and confidence during completion of the SEBT on the injured limb under both test conditions. An independent t-test was used to analyze dorsiflexion range of motion. Since all three SEBT reach directions are related, the normalized SEBT average reach scores in the anterior, posterior medial, and posterior lateral directions were analyzed using a doubly multivariate MANOVA. Both independent variables, group (affected and unaffected) and intervention (tape versus no tape), were treated as within group factors. The a priori level of confidence was set at $p=.05$.

Missing data were present in four cases when the uninjured limb did not meet all of the inclusion criteria for the study. Data were imputed with a linear regression model to create a prediction equation to estimate the missing values in each reach direction.

RESULTS

Pain and Confidence

Means and standard deviations for pain and confidence measures were taken on the injured limb between the taped and non-taped conditions and are presented in Table 1. Confidence significantly increased in the taped condition when compared to the non-taped condition ($t(20)=2.83$, $p=.010$) for the injured limb. Pain was significantly lower while completing the SEBT in the taped condition when compared to the non-taped condition ($t(20)=-2.37$, $p=0.028$). Effect size calculations for confidence ($d=0.46$, 95% CI = -4.7 – 9.65) and pain ($d=0.35$, 95% CI = -.48 – 1.13) revealed medium and weak values respectively. Both pain and confidence measures crossed the zero point although both had a positive effect.

Dorsiflexion Range of Motion

Means and standard deviations for range of motion obtained on the injured limb between the taped and non-taped conditions are presented in table 1. At baseline, there were no significant differences between dorsiflexion range of motion of the injured and uninjured limbs (t(36)=-1.794, p=.081). However, there was a significant difference between the taped and non-taped conditions for dorsiflexion range of motion in the injured limb (t(20)= -2.302, p=.032). Although every participant demonstrated dorsiflexion range of motion 20 degrees or greater during the stabilized single-leg squat, there was a significant difference found with the t-test. Ankle taping has a negative effect on dorsiflexion range of motion and therefore decreases range of motion when compared to non-taped even after a 5 minute bike warm-up. Effect size (d=-0.3, 95% CI = -2.88 to 2.53) crossed the zero point, was small, and clinically insignificant.

Dynamic Balance

The doubly multivariate MANOVA revealed a significant difference in the within subject analysis for the limb (F(3,18)=3.855, p=.027) condition only. Post-hoc univariate testing revealed that anterior reach (F(1,20)=9.721, p=.005) and posterior lateral reach (F(1,20)=7.893, p=.011) were significantly greater in the uninjured limb than the injured limb. Further investigation shows that condition power (.416) was sub-par indicating that a larger sample size is needed.

An analysis of all reach directions between the taped and non-taped conditions on the injured limb was conducted and effect sizes were calculated. The largest effect size was calculated in anterior direction (d=-0.26; 95% CI = -3.72 to 2.6). Individuals with no support were able to reach further, but the effect was small and clinically insignificant.

DISCUSSION

It is important for athletic trainers and other sports related personnel to understand whether dynamic postural control, pain, and/or confidence, in physically active adults is affected by the use of ankle tape when compared to no support in participants with acute lateral ankle sprains. This information will help athletic trainers to know the effects of the ankle taping procedures used after injury. The purpose of this study was to determine the effects of ankle taping on dynamic postural control after acute ankle sprains.

Confidence was significantly greater in the taped condition for the injured limb while completing the balance task. Although no significant findings were found in dynamic balance, participants felt more confident while completing the task with the taped condition. This indicates that regardless of performance, the taped condition does have psychological influence on the participant. Athletes who return to participation before they are psychologically ready have a higher risk of re-injury, new injury, higher levels of anxiety and fear, and decreased performance.[43, 44] Athletes who have their injured ankle taped and indicate a higher level of confidence can therefore be assumed to be more psychologically ready to return to sports participation.

Pain has been associated with feeling of fear and anxiety and has the ability to alter behavior or lead to disability.[45] In this study, pain was shown to decrease with the use of ankle tape on the affected limb while completing a balance task. Participants who used tape reported having less pain and a higher perceived psychological readiness to play. Both of these factors may contribute to sports performance. This decrease in pain may allow athletes to participate in activities that they otherwise would not have been able to do because of pain, anxiety, or disability.

No significant findings on dynamic balance between taped and non-taped ankles were found. However, we cannot suggest that tape has no effect on dynamic balance in acutely injured ankles because this study was insufficiently powered (power =.416). Effect size calculations demonstrated that the taping condition has a weak, minimal effect on dynamic balance. Using the ES in the anterior reach direction, 95% CI and 80% power a sample size of 116 would be needed to find significance between the taping conditions on the injured limb. One must question the clinical importance of an intervention with such a small clinical effect and whether a subsequence study with an appropriate sample size should be pursued. To avoid a Type II error, we can suggest that tape is clinically insignificant. On the converse, the taped condition did not significantly diminish balance performance but did significantly increase confidence and decrease pain.

Dorsiflexion range of motion was not significantly different in the injured and uninjured limbs at baseline. However, individuals showed significantly less dorsiflexion under the taped condition in the injured limb when compared to no support. Effect size calculations indicated that effect sizes were clinically insignificant. Therefore, the difference in range of motion was not significant and most likely did not affect reach distances significantly. One may assume that a greater range of motion would give advantage to greater reaches, but this does not appear to be the case. Dynamic balance was found to be significantly different between the limbs. Therefore, the healthy limb had better dynamic balance than the injured limb with no relation to the taping condition.

Participants were purposely chosen who had mild or moderate ankle sprains with no symptoms of chronic ankle instability. The subject pool could also be enlarged to include participants with grade 3 ankle sprains or those with CAI, or a larger time frame may be warranted in order to include a wider variety and number of ankle sprains.

Future direction for research may be to assess functional balance because the findings for both static and dynamic balance with the use of taped conditions have been inconclusive and conducted on healthy individuals.[10, 13, 15, 25] Also, a different balance task, such as one that targets functional balance, or a more specific, less field oriented test, might be chosen in order to find more significance. A more functional test with external support may be chosen, because it is understood that external support adds proprioception effects during balance tasks[10] which has been reiterated in this study.

CONCLUSIONS

This study indicated that the use of ankle tape on an acute lateral ankle sprain has the potential to decrease pain and increase confidence while not significantly affecting dynamic postural control. Athletes who receive these psychological benefits may return to play more quickly and be my psychologically prepared for competition without having to compromise their level of function. Participants do receive psychological benefits from the ankle taping even if dynamic balance is not greatly affected.

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Data Tables

Table 4.1.Means and Standard Deviations of Variables for Taped and Not Taped Conditions.

	Mean	Standard Deviation
Confidence Injured Leg Taped	86.77	12.05
Confidence Injured Leg Not Taped	79.08	21.50
Pain Injured Leg Taped	2.24	1.81
Pain Injured Leg Not Taped	2.90	1.94
Injured Leg ROM Taped	28.89	6.03
Injured Leg ROM Not Taped	30.80	6.61

Table 4.2. Number of Days After Injury the Ankle was Tested.

Days Injured	Frequency
1	2 (9.5%)
2	4 (19%)
3	2 (9.5%)
4	4 (19%)
5	9 (42.9%)

Table 4.3. Frequency of Injury by Side.

Injured Limb	Frequency
Left	12
Right	9

Table 4.4. Means and Standard Deviations for Reach Direction for Taped and Not Taped Conditions.

Conditions	**Mean**	**Standard Deviation**
Anterior Injured Limb Taped	72.95	8.10
Anterior Injured Limb Not Taped	74.84	6.67
Anterior Uninjured Limb Taped	75.97	6.58
Anterior Uninjured Limb Not Taped	77.91	5.67
Posterior Medial Injured Limb Taped	88.57	10.29
Posterior Medial Injured Limb Not Taped	89.87	9.26
Posterior Medial Uninjured Limb Taped	89.96	10.59
Posterior Medial Uninjured Limb Not Taped	92.55	9.59
Posterior Lateral Injured Limb Taped	78.25	10.10
Posterior Lateral Injured Limb Not Taped	78.58	10.62
Posterior Lateral Uninjured Limb Taped	79.94	9.91
Posterior Lateral Uninjured Limb Not Taped	84.12	11.09

Table 4.5. Reach Distance by Direction and Limb.

Direction	**Limb**	**Mean**	**Standard Error**	**Lower Bound**	**Upper Bound**
Anterior	Injured	73.90	1.40	70.97	76.83
Anterior	Uninjured	76.94	1.17	74.49	79.39
Posterior Medial	Injured	89.22	2.01	85.04	93.40
Posterior Medial	Uninjured	91.25	2.15	86.78	95.73
Posterior Lateral	Injured	78.41	1.93	74.38	82.45
Posterior Lateral	Uninjured	82.03	2.22	77.40	86.66

Table 4.6. Reach Distance by Direction and Taped and Not Taped Conditions.

Direction	Condition	Mean	Standard Error	Lower Bound	Upper Bound
Anterior	Taped	74.46	1.49	71.35	77.57
Anterior	Not Taped	76.37	1.19	73.89	78.86
Posterior Medial	Taped	89.27	2.14	84.79	93.74
Posterior Medial	Not Taped	91.21	1.93	87.19	95.23
Posterior Lateral	Taped	79.09	1.96	75.00	83.18
Posterior Lateral	Not Taped	81.35	2.22	76.72	85.98

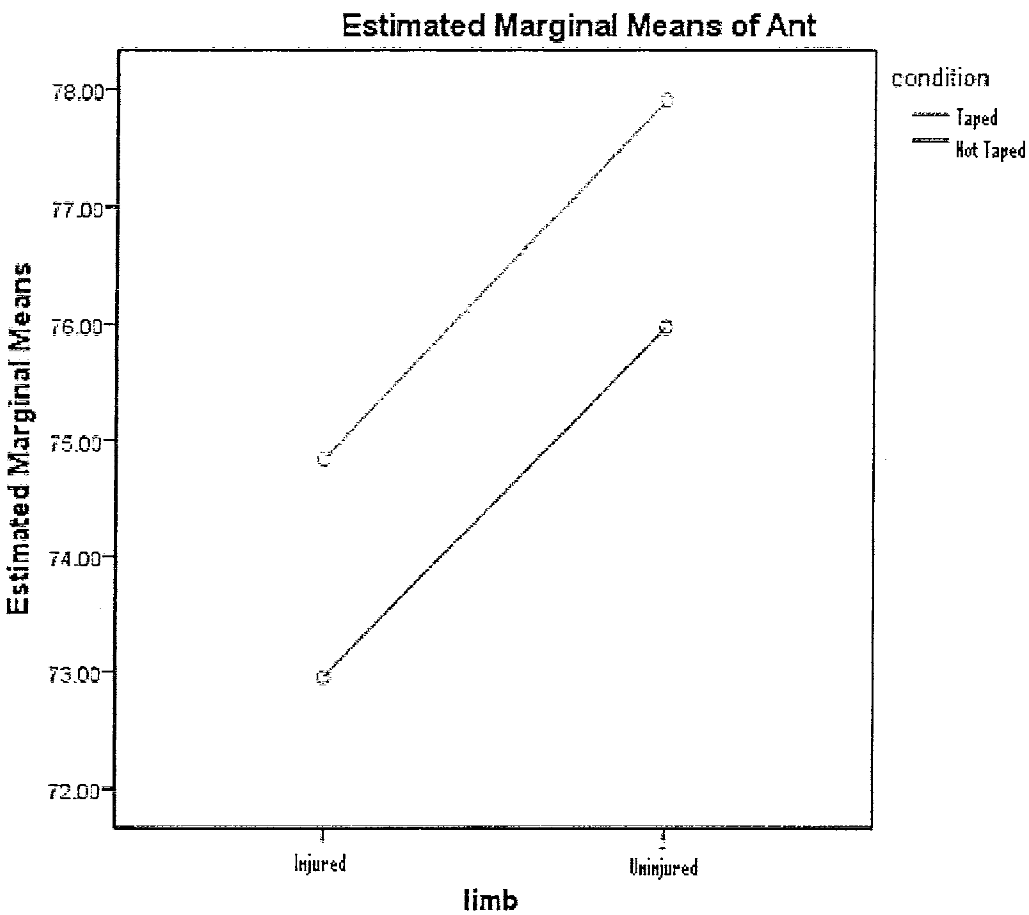

Figure 4.1. Estimated Means of Anterior Reach Direction.

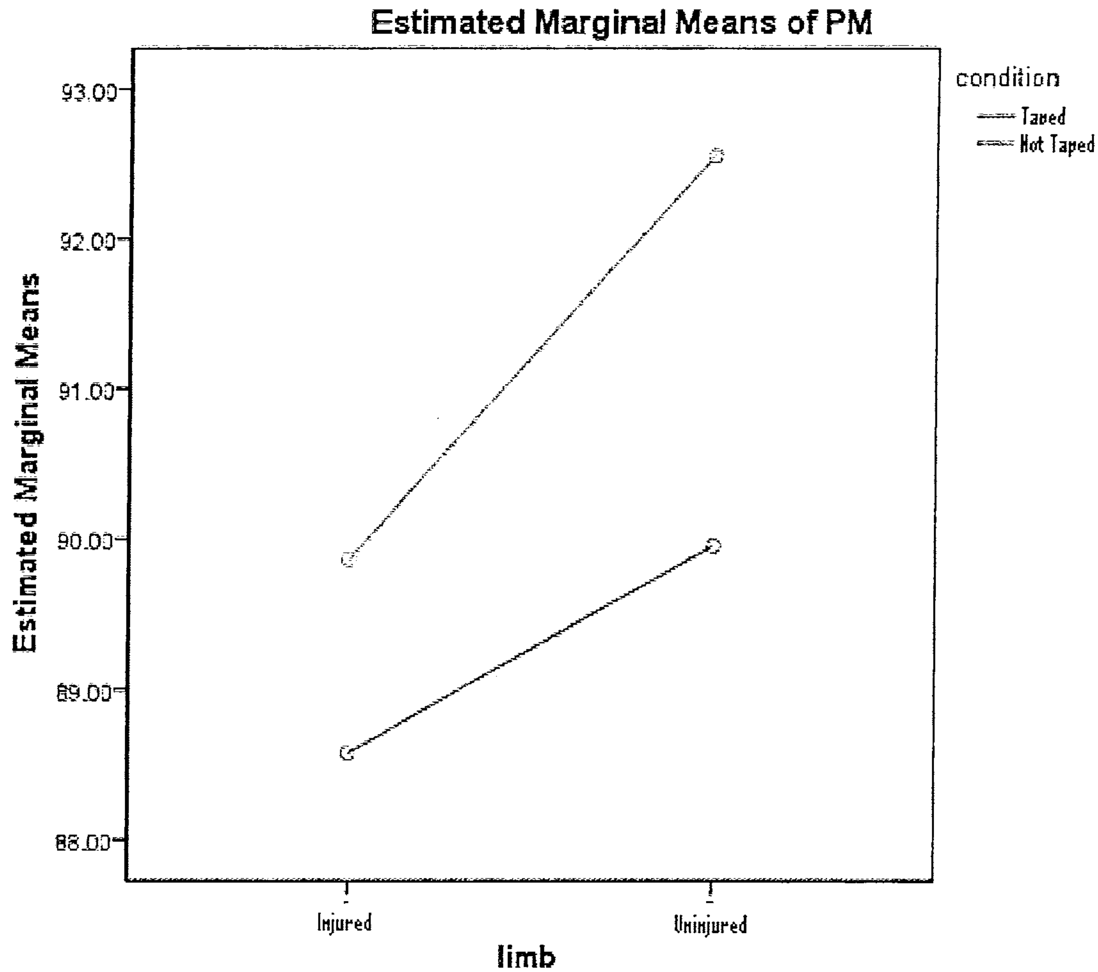

Figure 4.2. Estimated Means of Posterior Medial Reach Direction.

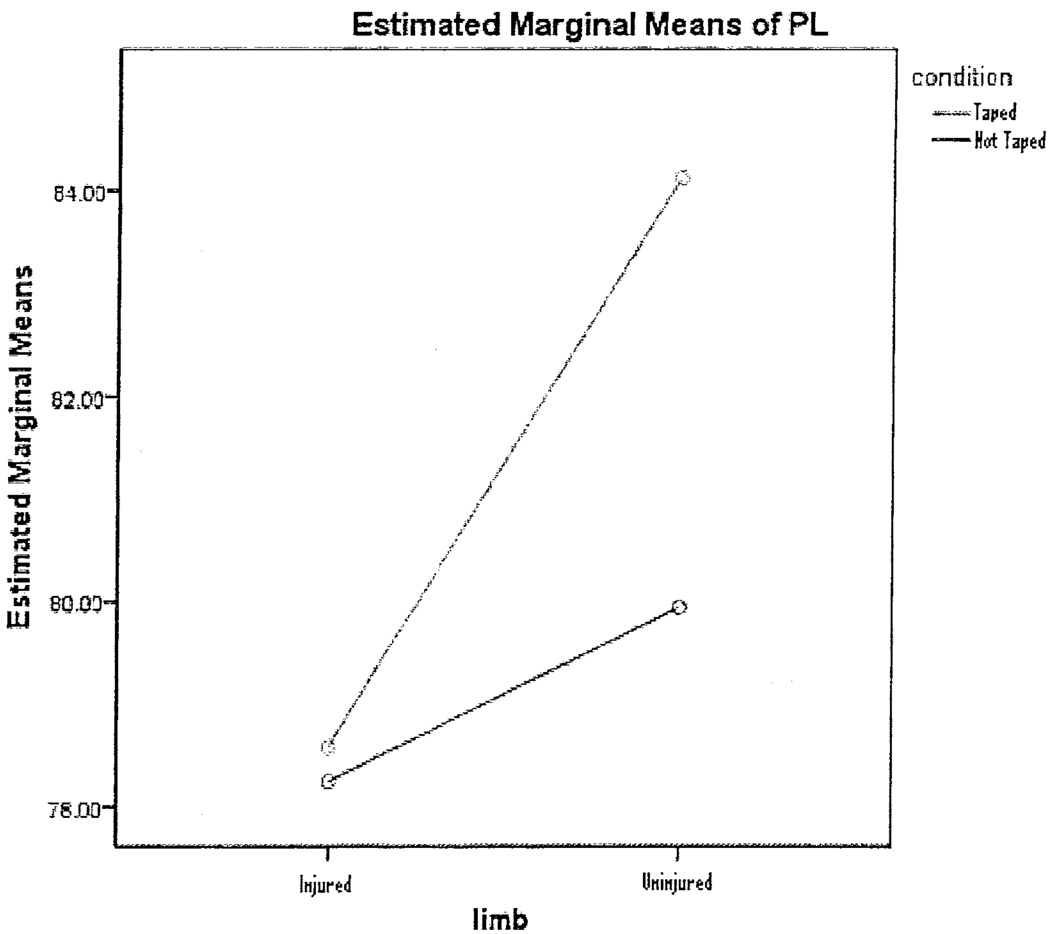

Figure 4.3. Estimated Means of Posterior Lateral Reach Direction.

APPENDIX A
TEXAS STATE UNIVERSITY CONSENT FORM

Texas State University Consent Form – IRB # 2009E4626
Title of Project: The Effects of Ankle Taping on Dynamic Postural Control after Acute Ankle Sprains
Principal Investigator:

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Purpose of the Study:
The purpose of this research study is to compare dynamic balance in participants with acute ankle sprains with the use of ankle tape and no support. You have been chosen to participate in this study because you have reported that you are physically active and that you have recently injured your ankle.

Procedues to be Followed:
After completing a university approved consent form for participation, you will be tested to ensure you meet the inclusion criteria and have no exclusion characteristics. You will be asked to complete a form with some basic personal and health information including questions about your physical activity, history of injury, current state of health, etc. Then, a Certified Athletic Trainer will perform tests to assess the severity of your ankle sprain. If any of these tests receive a positive response you will be excluded from the study to ensure your safety. Next, your range of motion and function will be tested to ensure that your pain during activity does not exceed a pre-determined pain level. After all inclusion criteria have been met and exclusion characteristics ruled out, your height, weight and leg length in centimeters will be measured.

Following these measurements and tests, you will be taught the two balance tests and given opportunity to practice. You will then perform 9 trials of one of the balance tests and 4 trials of the other with your ankle taped and then without external tape support on both legs. After each test you will be asked to complete a short questionnaire about your pain and confidence with the balance task at two separate times for each leg tested.

Discomforts and Risks:
There are few minor risks or possible discomforts associated with this study. There is a small chance that you would lose balance during the test and fall. You may also experience some mild levels of pain with the balance activity but the researcher will take every precaution to minimize the risks and discomforts by making sure that pain levels with simple functional tasks is minimal

prior to participating in the study. If at any time you are uncomfortable with participating in the study you may withdraw from the study with no fear of repercussions.

Benefits:
By participating in this study you will receive a take home rehabilitation program and piece of Theraband to help yourself return to full function more easily and quickly as well as for helping the researchers better understand the effects of ankle taping on dynamic postural balance in participants with acute ankle sprains.

Duration/Time:
Your participation in this study will consist of one session lasting less that 60 minutes in the EndZone Athletic Training Room.

Statement of Confidentiality:
Your participation in this study is confidential. Only the principal investigators will have access to your personal identifiers and to any information that may be linked with your identity. All information that you complete will have an identification number rather than your name to ensure your confidentiality. All data will be stored in a locked cabinet in the Athletic Training Research Lab for seven years. In the event of this study being published, none of your personal identifying information will be disclosed.

Right to Ask Questions:
You may ask questions about the research procedures at any time and will receive immediate responses. If you have any further questions, please direct these to Megan Haynes at MH1220@txstate.edu or (361) 532-9897 or Luzita Vela at lv19@txstate.edu or (512)245-1971.

Voluntary Participation:
Your participation in this study is completely voluntary. You may withdraw from this study at any time without any negative consequences from anyone associated with the study. Please notify Megan Haynes of your intent to withdraw from the study at any time.

Request for Further Information:
You are encouraged to discuss and/or express any concerns or questions regarding this study with the investigators at any time. You should feel confident and secure about your involvement in this study. You may also contact the IRB chairperson Dr. Jon Lasser at 512-245-3413 or 512-245-7975 to speak to Becky Northcut.

Compensation Statement:
All participants and potential participants who are excluded from the study or choose to withdraw from the study will be given an at-home rehabilitation program and a piece of Theraband for use with the rehabilitation program.

Medical Treatment:
Please be advised that medical treatment is available upon the event of physical injury resulting from the study. Medical treatment will be limited to first aid and ice. In the event that you sustain an injury needing medical treatment beyond that of first aid and ice, you will need to seek appropriate medical attention. Texas State University-San Marcos students may choose to

go to the Student Health Center free of charge. Please call 512-245-2161 to schedule an appointment or speak to a health care provider at the Student Health Center. The investigators will report any adverse events per institutional policy. In the event that you believe you have suffered injury not apparent immediately after testing, please contact the IRB chairperson Dr. Jon Lasser at 512-245-3413, who will review the matter with you and identify any other resources that may be available to you.

Disclosure and Funding:
The researcher has no financial or other potential conflict of interest in performing this project.
Summary findings will be provided to the participants upon request.

Approval:
This study has been approved by the Texas State University Institutional Review Board (IRB #2009E4626)

You have been given an opportunity to ask any questions that you may have and all have been answered to your satisfaction.

You must be 18 years of age or older to consent to this study. If you consent to participate in this study and to the above state terms, please sign your name and date below.

You will be given a copy of this consent form for your records.

____
Participant Name (please print in all caps)

________________________________ __________________
Participant Signature Date
I, the undersigned, verify that the above informed consent procedure has been followed.

________________________________ __________________
Investigator Signature Date

APPENDIX B
FORMS AND PICTURES

Demographic Questionnaire

To be completed by the investigator

Height:__________ Weight:__________ Leg Length:__________

To be completed by the injured participant as soon as possible after the injury.

1. Age:____________ Gender: Male Female
2. Date of Ankle Injury:_________ Approximate Time of Injury:__________
3. What side is the injury on? Left Right
4. Have you had any treatment for this injury? Yes No
   a. If so, what: ________________________________
5. Have you ever injured your ankle before? Yes No
   a. If so, how many times? Left: ___________ Right:___________
   b. If so, what were the date(s) these injuries? Left: __________ Right: __________
6. Do you usually have any feelings of your ankle "giving way" during normal activity? Yes No
   a. If so, which leg or both? Left Right Both
   b. If so, please explain:_____________________________________

7. Do you usually have any swelling in your ankle after physical activity?

Yes No

   a. If so, which leg, or both? Left Right Both

8. Have you ever injured a joint before? (knee, ankle, shoulder, etc) Yes No

   a. If so, which one and what side? (List all that apply)________________

   b. If so, when was this injury? ______________________

9. Have you ever had surgery? Yes No

   a. If so, what joint? (List all that apply)__________________

   b. If so, what side? ___________

   c. If so, when was the surgery? ________________________

10. Have you had a concussion within the past 6 months? Yes No

    a. If so, what was the date of injury? ___________

11. Do you presently have any visual/vestibular problems? Yes No

    a. If so, please list:________________

12. Do you presently have an inner ear infection? Yes No

13. Do you presently have an upper respiratory infection? Yes No

14. Are you physically active? Yes No

Modified Godin Leisure-Time Exercise Questionnaire*

15. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 20 minutes** during your free time?

    a) STRENUOUS EXERCISE **TIMES PER WEEK**

    ____

    (e.g., walking at a very, very brisk pace, running, jogging, hockey, football, soccer, basketball game, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling, tennis singles, competitive volleyball)

During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 30 minutes** during your free time?

b) MODERATE EXERCISE **TIMES PER WEEK**

____

(e.g., fast walking, tennis doubles, easy bicycling, volleyball (non-competitive), badminton, easy swimming, basketball (shooting around), golf)

* Modified using the AHA's & ACSM's physical activity classification and recommendations (Physical activity and public health: Updated recommendations for adults from the American College of Sports Medicine and American Heart Association)

ID__________________ Date:____________

Graphic Pain Rating Scale

Directions: Please make a single mark on the line below that best describes your pain.

Key

Dull Ache	A feeling of discomfort during activity
Slight Pain	An awareness of pain without distress
More Slight Pain	Pain distracts attention during physical exertion
Painful	Pain distracts attention from routine occupation such as writing and reading
Very Painful	Pain fills the field of consciousness to the exclusion of other events
Unbearable Pain	Comparable to the worst pain you can imagine

No Pain |————————————————————————| Unbearable Pain

Dull Ache Slight Pain More Slight Pain Painful Very Painful

Illustration 1. Graphic Pain Rating Scale.

Before SEBT

INJURY-PSYCHOLOGICAL READINESS TO RETURN TO SPORT SCALE

Please rate your confidence to return to your sport on a scale from 0 – 100.

0 = no confidence at all

50 = moderate confidence

100 = complete confidence

1. My overall confidence to perform the SEBT is ____________
2. My confidence to perform the SEBT without pain is ___________
3. My confidence to give 100% effort during the SEBT is ___________
4. My confidence to not concentrate on the injury during the SEBT is ______
5. My confidence in the injured body part to handle the demands of the SEBT is _______
6. My confidence in my skill level/ability to perform the SEBT is _________
7. My confidence in my ability to perform the SEBT in comparison to my other leg is ________
8. My confidence in my desire to participate is __________
9. My confidence to perform the SEBT under these conditions is __________
10. My confidence to be successful in the SEBT is ___________

Scoring: Add total and divide by 10 = _____

After SEBT

INJURY-PSYCHOLOGICAL READINESS TO RETURN TO SPORT SCALE

Please rate your confidence to return to your sport on a scale from 0 – 100.

0 = no confidence at all

50 = moderate confidence

100 = complete confidence

1. My overall confidence while performing the SEBT was ___________
2. My confidence while performing the SEBT without pain was ___________
3. My confidence to give 100% effort during the SEBT was ___________
4. My confidence to not concentrate on the injury during the SEBT was ________
5. My confidence in the injured ankle to handle the demands of the SEBT was ________
6. My confidence in my skill level/ability to perform the SEBT was _________
7. My confidence in my ability to perform the SEBT in comparison to the other leg was __________
8. My confidence in my desire to participate was_________
9. My confidence that I performed the SEBT under these conditions was _________
10. My confidence that I was successful in the SEBT was _________

Scoring: Add total and divide by 10 = _____

Illustration 2. Acu-Angle Inclinometer.

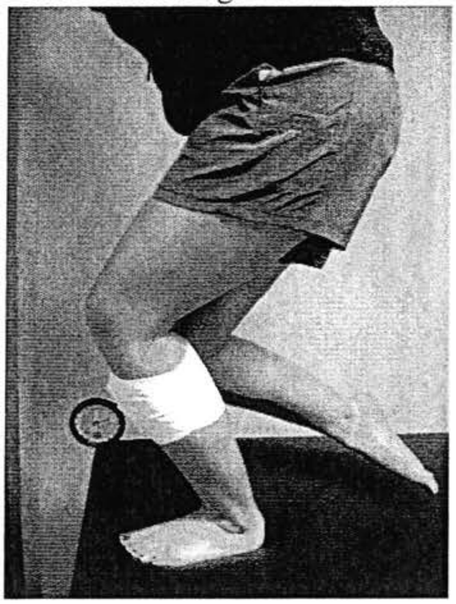


Illustration 3. Bump Test.

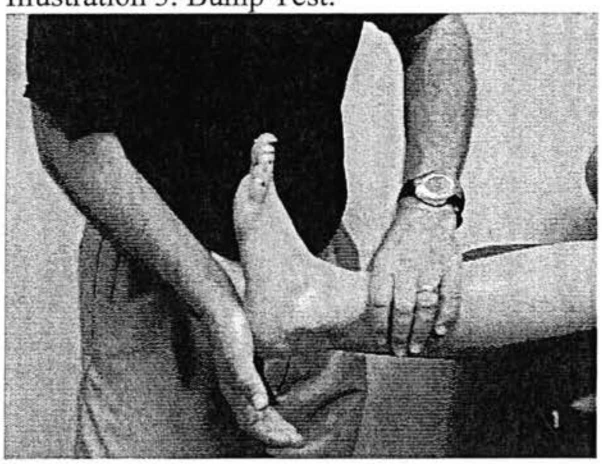


Illustration 4. Compression Test.

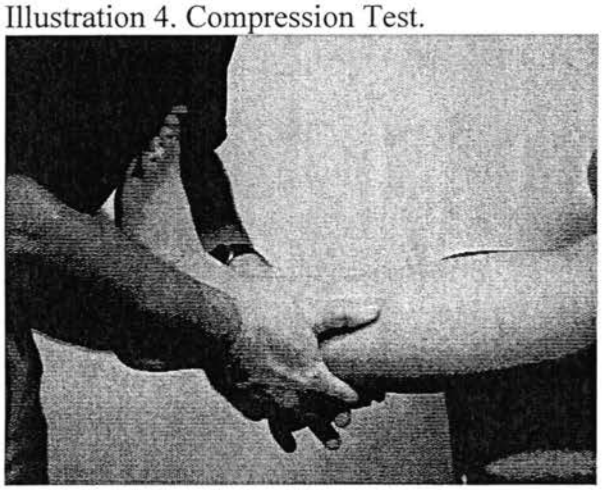


Illustration 5. Anterior Drawer Test.

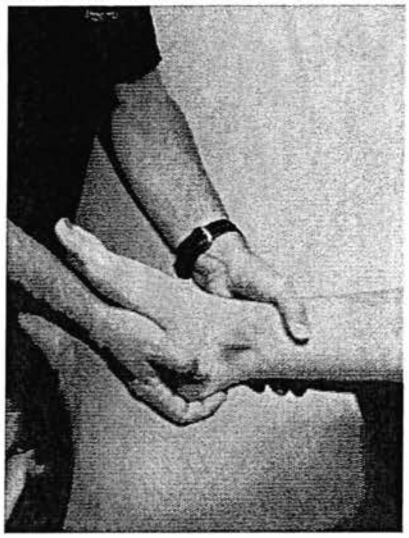


Illustration 6. Talar Tilt Test.

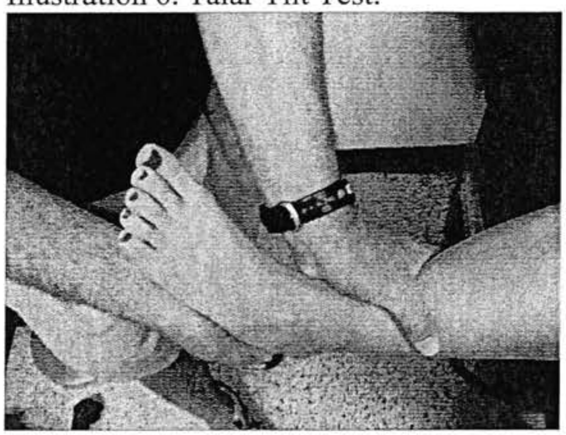


Illustration 7. Star Excursion Balance Test.

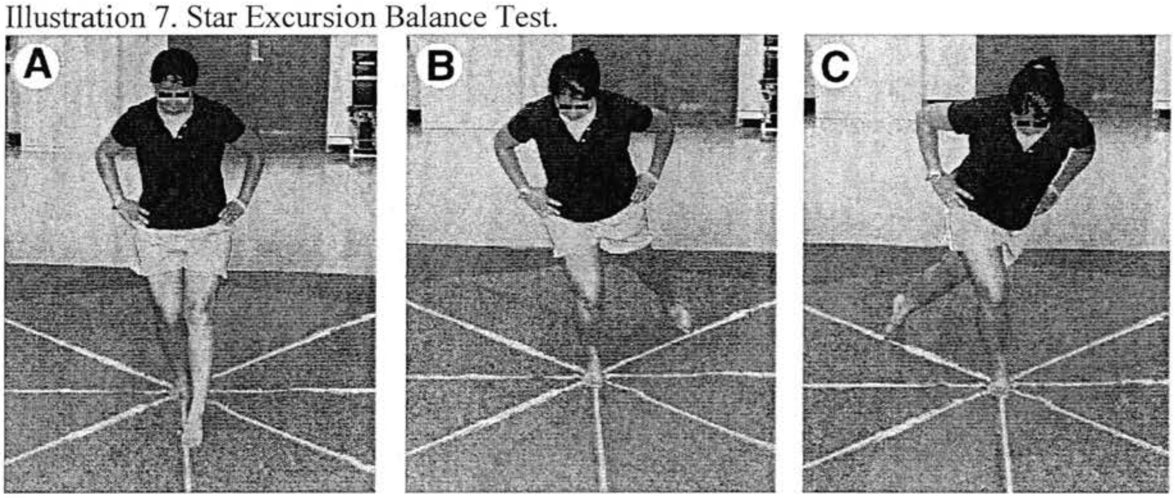
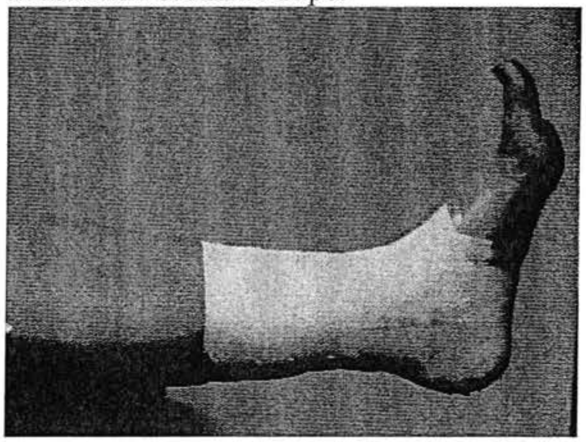


Illustration 8. Ankle Tape.



APPENDIX C
PARTICIPANT RESULTS FORM

Left	
Bump	
Compression	
Anterior Drawer	
Talar Tilt	

Height	
Weight	

Leg Length	

Tape				Mean
ROM				
Anterior				
Posterior Medial				
Posterior Lateral				

No Tape				Mean
ROM				
Anterior				
Posterior Medial				
Posterior Lateral				

Right	
Bump	
Compression	
Anterior Drawer	

Talar Tilt	

Leg Length	

Tape				
ROM				
Anterior				
Posterior Medial				Mean
Posterior Lateral				

No Tape				
ROM				
Anterior				
Posterior Medial				Mean
Posterior Lateral				

APPENDIX D

AT HOME REHABILITATION PROGRAM

At Home Ankle Rehabilitation Program

ABC's- Draw the ABC's in capitol and lower case letters with your toes.

Ankle pumps with Theraband- 3X10 (to make it harder, hold hand closer on Theraband to foot)

1. Push down
2. Pull up
3. Pull in
4. Pull out

Toe raises- 3 X 15 (Progress in the following order)

1. Double leg
2. Single leg

Marble pick up- keep heel on ground. Pick up Marbles with toes and move them to other side. Use approximately 10 marbles. Repeat 3 times.

Towel pulls- place towel on ground. Scrunch toes to pull towel in each direction. To make it harder add weight (a can of soup, a soda, etc) to the edge of the towel.

1. Pull towards you
2. Pull left
3. Pull right

Balance- 3 X 30 seconds (start each surface with eyes open then progress to doing the exercise with your eyes closed before moving to next surface)

1. Hard ground with shoes on
2. Hard ground with shoes off
3. Carpet with shoes on
4. Carpet with shoes off
5. Pillow with shoes on
6. Pillow with shoes off

*If at any time you experience pain or become sore, rest for a while or quit the exercises until tomorrow.

*If you are able to complete any particular exercise with ease, move on to a more difficult stage of that exercise.

*If you have any questions about the exercises, feel free to email me at mh1220@txstate.edu.

*If you are sore after these exercises, apply an ice pack for no more than 20 minutes and elevate your ankle.
*If you get worse or feel that you need to see a doctor, contact the Texas State Student Health Center at 512-245-2167.

VITA

Megan Brooke Haynes was born December 20, 1984 in Victoria, Texas to the parents of Stephen F. Haynes and Laura A. Williams. After completing all requirements at Industrial High School in Vanderbilt, Texas, in 2003, she enrolled at Texas State University-San Marcos to obtain her Bachelor of Exercise Sports Science, major in athletic training in May 2007. She then continued her education, received her teaching certification, and completed her Master of Education in May 2009.

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