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Effects of Ankle Taping on Postural Stability

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EFFECTS OF ANKLE TAPING ON POSTURAL STABILITY

by

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This Scholarly Project, submitted by Jessica Brown, Andrea Foley, Michelle Hager and Andrea Kresel in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)

(Chairperson, Physical Therapy)

PERMISSION

Title Effects of ankle taping on postural stability.

Department Physical Therapy

Degree Doctor of Physical Therapy

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Signatures Andrea Tdey

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Date 12-15-04

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT

Ankle taping is a common practice used to support the ankle joint after injury when engaging in activities. Balance is a crucial component of athletic performance that relies on input from the vestibular, somatosensory, and visual systems. Proprioception plays a role in the somatosensory portion of balance and postural control. Ankle taping, which is used to improve performance, may alter a person's proprioception, balance, and postural control.

The purpose of this study is to determine if ankle taping has an effect on postural control in an individual free of chronic or acute ankle dysfunction. Thirty-two subjects were tested on a balance assessment device in two different tests; the step quick-turn and the single leg stance. These tests were completed with the ankle taped and also without any tape, with the untaped ankle acting as a control. This study showed a significant increase in postural sway with ankle taping during unilateral stance with eyes closed.

This study did reveal that there is less postural sway without ankle tape; however, further research is warranted to determine the full negative effects of ankle taping on postural sway with eyes closed. Based on the results, the physical therapist can address the potential for decreased postural control while using ankle taping following an ankle sprain or instability problem.

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Postural control is an important part of athletic performance, contributing to improved balance and safety. Ankle sprains are the most frequent injury sustained in sports, and are often accompanied by instability.[1] Ankle sprains and other joint injuries have been found to interrupt ankle position sense, and this position sense, or proprioception, is important to prevent athletic injuries.[2] Following an ankle injury, athletes' ankles are often taped or braced to provide support and stability, increasing the ability to safely perform in athletics. It has been found that ankle supports reduce ankle sprains and re-injury.[3] Also, ankle taping and semirigid bracing have been shown to increase proprioception both before and after exercise.[4,5] By increasing proprioception, postural control may be increased, resulting in improved performance and safety.

Problem Statement

There is a high prevalence of ankle sprains and chronic ankle instability in athletes. Often times taping is used to provide support to the injured ankle to decrease the chance of re-injury. Since balance, proprioception and postural control are very imperative for the safety and performance of an athlete, it is important to know what effects ankle taping has on the aforementioned physical components of athletics, specifically postural control. There needs to be a balance in ankle taping in order to promote performance and stability without hindering an athlete's postural control. These

are important components of a rehabilitation protocol, specifically focused on reducing the current problem while preventing re-injury.

Purpose of Study and Research Question

The purpose of this study is to address the effects of ankle taping on postural control in subjects with normal ankles, free of acute or chronic ankle instability. This will be addressed via a series of tests on the Balance Master 8.0. The research question being asked is: Does ankle taping affect postural control?

Significance of Study

Research has shown that ankle injuries cause instability that can be countered through the use of ankle taping.[1,3] It has also been shown that taping and bracing may improve proprioception in the ankles of injured athletes.[4,5] However, more research is needed to know the specific effects on ankle taping on postural control in a normal ankle.[6] Based on this research, inferences can be made to similar effects in subjects with ankle injuries and instabilities.

Hypothesis

The hypothesis is that the use of ankle taping in patients with injury-free ankles will improve postural control, as measured by the Balance Master 8.0. The null hypothesis is that ankle taping will have no effect on postural control of the injury-free ankle.

The ankle is made up of two joints, the superior joint being the true ankle joint, the talocrural joint. This hinge joint allows for dorsiflexion and plantarflexion of the ankle and is composed of the tibia on the medial side, the fibula on the lateral side, and the talus underneath. Inferior to the true ankle joint is the subtalar joint, which allows for

inversion, eversion, supination, and pronation of the ankle. The subtalar joint is formed by the talus superiorly and the calcaneus inferiorly.[7]

The primary ligaments of the ankle joint are the deltoid and lateral collateral ligaments. On the medial side, the deltoid ligament is composed of the tibionavicular, tibiocalcaneal, and anterior and posterior tibiotalar ligaments which connect the medial malleolus to the tarsal bones and limit ankle eversion. The lateral side of the ankle is more commonly damaged in ankle sprains and contains the anterior and posterior talofibular ligaments and the calcaneofibular ligament. These ligaments connect the lateral malleolus to the tarsal bones and act to limit ankle inversion.[7]

Ankle taping has been a common intervention used in rehabilitation and prevention of ankle injuries.[8-17] Numerous studies have been performed looking at the effects of various taping methods,[8-12] duration of wear,[13,14] and pressure of applications.[15] The outcomes that different ankle braces have on athletic performance have also been studied.[11,12,16,17] Alterations of proprioception, muscle activation, balance, and postural sway are just some of the areas investigated when examining the effects of ankle taping and various bracing techniques.[9] According to Taber's Cyclopedic Medical Dictionary,[18] balance is "coordination and stability of the body in space." Normal balance depends on information from the vestibular system in the inner ear, from other senses such as sight and touch, from proprioception and muscle movement, and from the integration of these sensory data by the cerebellum. Proprioception, according to Taber's dictionary,[18] is defined as, "the awareness of posture, movement, and changes in equilibrium and the knowledge of position, weight, and resistance of objects in relation to the body."[18] Postural control is the ability to control and maintain the position of the body.[18]

Mechanoreceptors that control the foot during muscle contraction and movement are located in the ligament and capsular tissue about the ankle. Damage to receptors as a result of ligament and capsular injuries will result in proprioceptive deficiencies.[19]

Ankle sprains are extremely common in sports today and account for 38% to 45% of all athletic injuries.[20] Ankle sprains remain the most common injury in the ankle-foot region, making up approximately 85% of all injuries reported to this area.[21] Inversion ankle sprains have been reported to make up 85% of all ankle sprains.[22] The lateral ligament structures of the ankle are reported by Garrick[22] to be "the most frequently injured single structure in the body." Inversion ankle sprains occur when the foot "rolls" inward causing damage to the lateral ankle ligaments, most commonly the anterior talofibular ligament.[23] It has been stated that the reasoning behind the high incidence of inversion sprains is the decreased bony stability on the medial side of the leg in that once inversion is initiated at the ankle, stability decreases at the ankle and the medial malleolus may act as a fulcrum causing further inversion.[10]

Among the many intervention techniques such as RICE (Rest, Ice, Compression, Elevation), range of motion exercises, and peroneal strengthening, [20] ankle taping remains a common part of the protocol following an inversion ankle sprain.[11, 22] A common goal of all ankle sprain protocols is to improve stability of the ankle. The concept of ankle stability encompasses three neuromechanical elements. These elements are referred to as the passive mechanical, active (muscular), and neural systems.[15] Repetitive damage to these systems can lead to impaired joint position sense and increased risk for ankle injury.[15]

With torn or stretched ligaments, the ankle loses stability. Athletes with functional instability display decreased postural control during testing on a force plate.[24] This same study found that athletes with functional ankle instability have increased peroneal reaction time, which may lead to a proprioceptive reflex defect, causing instability.[24] However, in a study performed by Feuerbach et al,[25] it was found that when the anterior talofibular and calcaneofibular ligaments were anesthetized, subjects were able to compensate for a lack of ankle joint proprioception with afferent feedback from skin, muscle, and other joint receptors.

The use of external ankle support has been reported to decrease incidence of ankle injuries by restricting mechanical motion or by enhancing neuromuscular response.[26, 17] Feurerbach et al[25] hypothesized that the increased cutaneous feedback from the use of an ankle brace may lead to improved ankle joint position sense. A force platform test by Baier and Hopf[27] found that mediolateral postural sway was reduced with the use of both rigid and flexible ankle orthoses in athletes with functional ankle instability. Verbrugge[28] reports that ankle taping has no significant effect on agility, sprinting speed, or vertical jumping in athletes.

Some studies have found tape to negatively affect balance and postural control when compared to controls. A study using a modified Romberg test found tape to have an adverse effect on postural control when tested on seventeen football players.[26] In a study performed by Bennell and Goldie, [26] tape decreased postural control when used on subjects with eyes closed. This study reported that with the eyes open, there were no differences between taped subjects and controls indicating that visual input may be able to compensate for adverse effects of tape. In addition to the ankle joint, the hip and knee

may be affected by ankle bracing in athletes. Santos et al[29] found that ankle bracing causes increased knee axial rotation and may lead to knee injuries during athletics.

A study performed by Tropp et al[19] did not find any differences between stabilometric measures of controls and taped subjects. Stabilometry is defined by Tropp et al [17, 19] as a modified Romberg test that is an objective and quantitative method for studying postural control. Subjects consisted of 38 male soccer players using stabilometric data derived from a force plate and processed on a laboratory computer. The taping technique used by the researchers was a stirrup and horseshoe followed by a figure eight and heel lock.[19]

In both studies by Tropp et al, [17, 19] pathological stabilometric readings were able to predict future ankle injuries. In a second study by Tropp et al[17] on soccer players, an ankle orthosis was compared with ankle disc training to decide which is more effective in preventing ankle sprains. It was found that ankle disc training is superior but an ankle orthosis should be used until ankle disc training has been utilized enough to benefit the player. Ankle disc training was also found to be an effective intervention to improve postural control measured with stabilometry in a study performed by Gauffin et al.[30] Following acute lateral ankle sprain, postural control has been shown to be decreased at day 1 and week 2, but normal by week 4 post injury.[31] Balance training following acute inversion sprains has been shown to improve postural control with eyes open and eyes closed at 8 weeks post injury.[32]

One obvious drawback of ankle taping is the loosening that occurs during activity. Range of motion in the ankle joint has been measured in various studies to examine the tape's effectiveness to support the ankle throughout activity. Talar tilt with taping has

been measured to increase 48% to 84% of the available range following exercise.[33] However, despite this loosening, inversion remained less than the normal ROM available without tape.[33] A study performed by Glick et al[16] reported a decrease of ankle range of motion of 26%. Studies done by Garrick[21, 22] and Glick[16] both report that ankle taping can reduce ankle sprains' severity and frequency. Garrick's[21] study found a decrease in ankle sprain occurrence of up to two thirds.

A limiting factor in studying effects of ankle taping and/or bracing is the vast number of studies performed on varying methods and brace types. Despite the large number of studies performed on ankle stability and effects of tape/bracing, no single study has been able to report the most efficient way to stabilize an ankle. Numerous studies[33-35] have been performed to compare tape to a semirigid, reusable ankle orthosis. The ankle braces not only provided equal or greater ankle stability, but were reported to be more economical and convenient.

A study looking at the effectiveness of taping and bracing on frontal plane balance was performed in Greece by Barkoukis et al.[36] The results were based on the balance of 30 subjects under varying bracing conditions (lace-up, tape, semi-rigid, and no tape). The study reported no significant differences in frontal plane balance in the varying conditions. This supports that balance is not negatively affected by use of ankle stabilizers.[36]

CHAPTER II

METHODOLOGY

Setting

Subjects were asked to report to the research room in the Physical Therapy Department of the University of North Dakota. The research was conducted in a remote room, free from distractions. Only the subject and the researchers were in the room during the testing.

Participants

Thirty-two participants volunteered to participate in this study, with an age range of 18 to 36 years. The mean age was 22 years old. All subjects were required to be healthy adults with no prior history of balance disorders or recent or chronic ankle pathologies. Other exclusions included current pregnancy and/or allergies to athletic tape or prewrap.

The subjects were randomly divided into groups for which ankle to tape, to be tested with or without tape first, and the order in which the tests would be performed. All subjects gave their consent in accordance with the University of North Dakota's policy on testing of human subjects (see Appendix). The study was reviewed and approved by the University of North Dakota's Office of Research and Program Development (see Appendix).

The subjects' confidentiality was maintained by using a numerical identification system to link consent forms with computer data. All consent forms and data were stored separately in locked cabinets within the Physical Therapy Department at the University of North Dakota. This information is available only to researchers and will be destroyed after three years.

NeuroCom® Balance Master

This study was designed to assess the effects of ankle taping on postural sway using the NeuroCom® Balance Master 8.0 (NeuroCom® International, Inc; Clackamas, OR). The Balance Master is a computer software system that is commonly used in physical therapy practice to assess balance, postural sway and mobility skills. The system consists of two moveable plates that measure the forces exerted by the subject's feet. This information is then sent to the computer where it is interpreted. The computer analyzes the information and creates a screen display and printed report of the subject's performance. A computer screen facing the subject prompts the subject to start the test with a visual and auditory signal.

Procedure

One leg for each subject was tested using two Balance Master tests, once with tape on the selected ankle and once without tape. Subjects were randomized by drawing letters from three piles representing which leg would be tested, whether they would be tested first with tape or without, and the order of the tests. Subjects were asked to remove their socks and shoes for the testing. The intrarater reliability of the tester was established earlier in a pilot study for the tests used in this study.

Balance Master tests included the unilateral stance (US) and the step quick turn (SQT). The US consisted of standing on the selected foot for three 10-second trials with the subjects' eyes opened, followed by three 10-second trials with eyes closed. The subjects' feet were aligned on the Balance Master force plates according to the Balance Master Version 7.1 Operator's Manual. Instructions were given to keep their hands on their hips, to stand as steadily as possible, and to not allow their legs to come in contact with each other during the test. Subjects were then asked to lift their nonselected foot and balance on their selected foot for 10 seconds (Fig. 1). When tested with their eyes closed, they were asked to first lift their leg and then close their eyes, at which time the test would begin. A 10-second rest period was given between each trial. The subjects were given one practice 10-second trial for each testing condition and the first fall in each condition was not recorded. This series of trials was performed once with the selected ankle taped and once without taping. The data recorded during this test was the amount of postural sway the subject had (degrees/second).

For the SQT, the subjects were positioned on the Balance Master force plates according to the Balance Master Version 7.1 Operator's Manual. They were asked to perform three trials as rapidly as possible on the selected side. Subjects were instructed to begin the test by taking two steps forward, starting with the selected leg, to pivot to that side, and then take two steps back. The subjects then performed three recorded trials. This series of trials was also performed once with the selected ankle taped and once without taping. Prior to testing, the subjects were given a demonstration of the test and three practice trials. The data recorded during this test was turn sway while turning (degrees/second).

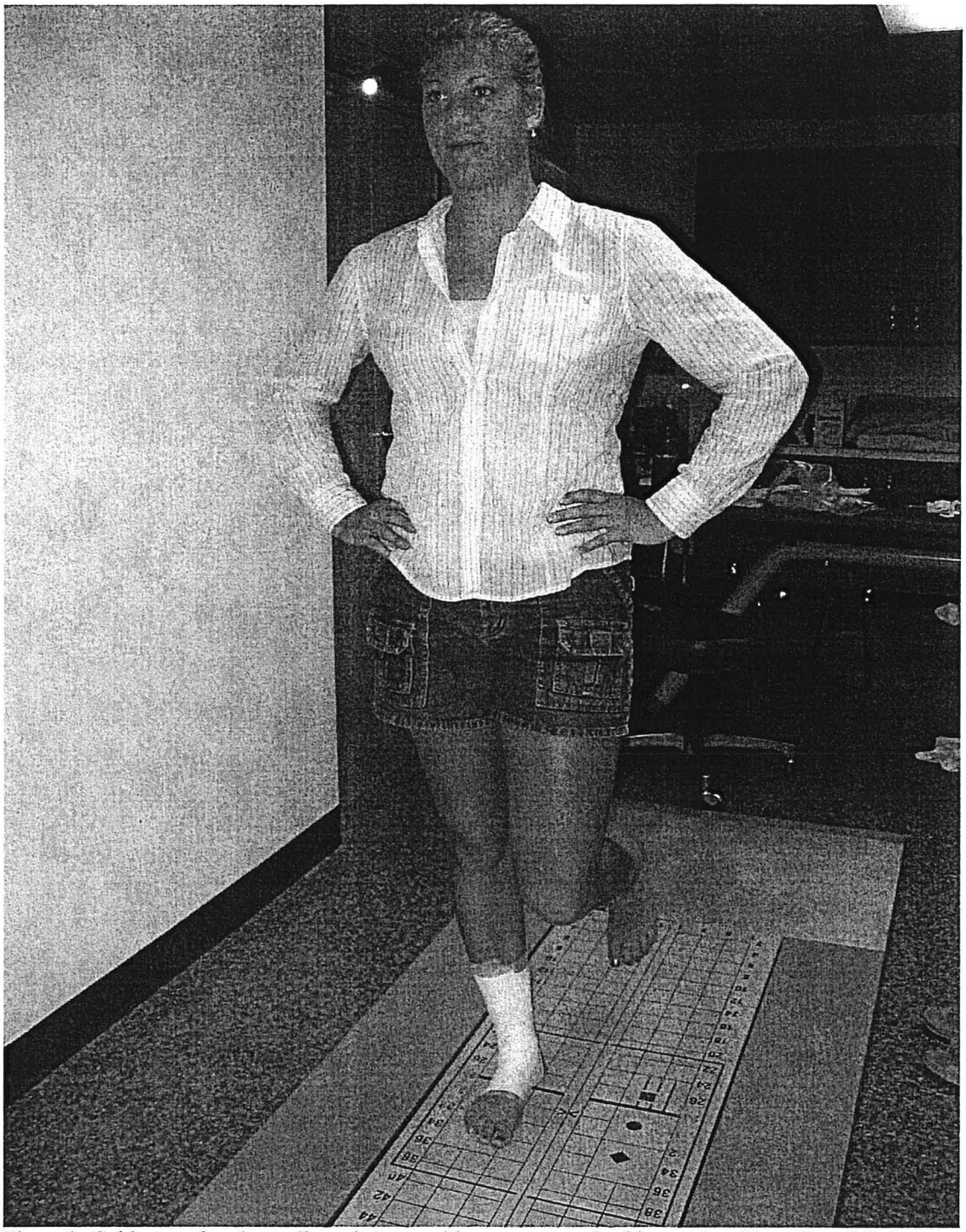

Figure 1. Subject performing unilateral stance with eyes open and ankle taped on NeuroCom® Balance Master.

A value of "12" was assigned to any subject who lost balance during the unilateral stance. A loss of balance was defined as lowering the non-weightbearing leg to the ground or allowing the stance leg to come in contact with the non-weightbearing leg.

Taping Technique

All subjects that participated in the study were taped using a closed Gibney technique (Figure 2). Common ankle taping techniques include the Open Gibney and the Modified Gibney.[12,37] The Open Gibney technique is used for acute ankle injuries to control swelling and to support the ankle joint.[37] The strapping includes a one-inch wide incomplete tape enclosure running along the anterior lower leg.[12,37] This "open" area allows for expansion of the joint due to swelling and decreases risk of circulation impairments. The modified Gibney technique is recommended for athletes returning to activity following rehabilitation of an ankle sprain or for those who have chronic ankle instability.[12] A closed basketweave is another option that may be used to support an ankle. This technique is often used on athletes who have a history of spraining their ankle.[37]

A position of long sitting with ankle to be taped slightly off the table was assumed by all participants. Their ankle was held in ninety degrees of dorsiflexion throughout the taping procedure. Ankle prewrap was applied to the lower leg/ankle region of each subject to protect the skin during tape removal. The tape used throughout the study was one half-inch Mueller athletic tape (Mueller Sports Medicine Inc, Prairie du Sac, WI). Two anchor strips were applied circumferentially around the lower leg at the base of the gastrocnemius muscle belly. A single anchor was placed around the foot just distal the base of the fifth metatarsal. After the three anchors were placed, three stirrups were

applied in a medial to lateral direction. The stirrups began on the medial side of the lower leg at the level of the proximal anchors and continued under the arch of the foot. Additional tension was added to the strip as it was pulled laterally to put the foot in slight eversion before ending at the lateral leg anchor. The eversion force from the tape has been found to counteract inversion at the ankle during activity to improve ankle stability.[8,10,12,20] Following the stirrups, tape was applied circumferentially around the leg starting at the lower leg anchors down to the talocrural joint. Four heel locks were then applied, alternating two in the medial directions and two in the lateral direction. The initial heel lock started on medial side of the ankle joint proximal to the medial malleolus. The strip crossed in front of the ankle joint and down the lateral side of the foot. The strip was brought across the plantar surface of the foot and continued posterior to the medial malleolus. This strip wrapped around the lower leg and ended on the lateral aspect of the lower leg. The second heel lock followed a similar pattern but was started on the lateral aspect of the ankle joint. After the heel locks were completed, a single strip of tape was used around the arch area to close off the loose ends of the heel locks. A total of eleven strips of athletic tape were used to complete this ankle taping method.

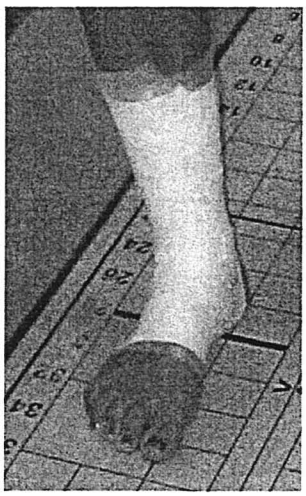

Figure 2. Taped Ankle.

Main Outcome Measure

Data collection from the Balance Master provided the velocity (degrees/second) of sway for the US and turn sway (degrees) and total turn time (seconds) for the SQT. Data was collected in these areas for all conditions tested: US with eyes open and eyes closed, with and without tape; and SQT with and without tape.

Postural sway and turn sway were measured during the testing. The postural sway recorded during the US test indicated how much movement occurred at the ankle during the testing. This data showed how much work the ankle had to do to maintain the subject's upright balance per second. Turn sway was measured during the SQT and indicated how many degrees of sway the subject had while turning. The greater amount of sway that occurred signified a less stable ankle.

Statistics

A paired samples two-tailed *t*-test was used to analyze the difference in performance between taped and untaped trials. Results of this analysis are reported as mean difference ± standard deviation, *t*-value, and significance. Differences were considered significant when $p<0.05$. Statistical analysis was performed with SPSS-11.5.0 software (Lead Technologies Inc, Chicago, IL). Results are reported for step-quick turn (turn time and sway) and unilateral stance (eyes open and eyes closed).

CHAPTER III

RESULTS

A total of 32 subjects participated in this study and all data were analyzed. The means and standard deviations for each of the tests performed for this study are listed in Table 1. Unilateral stance with eyes closed and tape yielded significant findings (Figure 3), but ankle taping did not result in significant results for any of the other tests, including Step Quick Turn in seconds (Figure 4), Step Quick Turn in degrees/second (Figure 5), and Unilateral Stance with eyes open (Figure 6). For Unilateral Stance with eyes closed (Figure 7) there was greater postural sway when performed with ankle tape compared to unilateral stance performed without tape and eyes closed. Results are displayed in Table 2.

Table 1. Mean and standard deviation for tests performed with and without tape.			
	Mean	**N**	**Std. Deviation**
SQT (sec)-tape	.474	32	.155
SQT (sec)-no tape	.473	32	.177
SQT (deg/sec)-tape	19.766	32	4.144
SQT (deg/sec)-no tape	20.041	32	4.536
Unilateral Stance (deg/sec)-tape with eyes open	.956	32	2.019
Unilateral Stance (deg/sec)-No tape with eyes open	.834	32	1.371
Unilateral Stance (deg/sec)-Tape with eyes closed	6.034	32	4.176
Unilateral Stance (deg/sec)-No tape with eyes closed	4.428	32	3.818
* Step Quick Turn (SQT), seconds (sec), degrees/second (deg/sec)			

Figure 3. Mean Differences after two-tailed paired-sample t-test Tape vs.No Tape

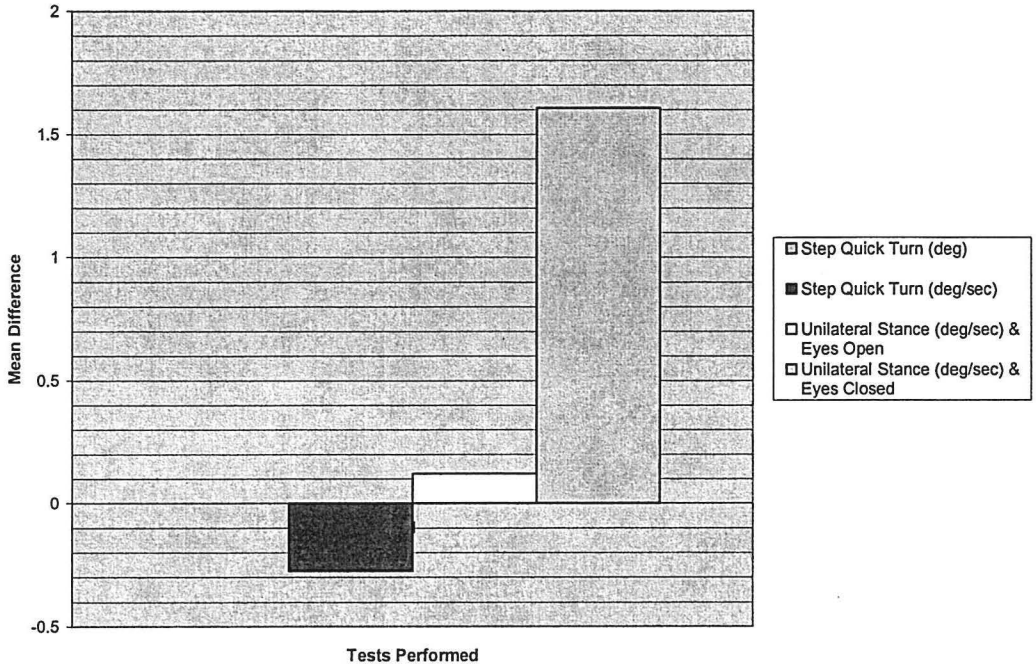

Figure 4. Mean and Standard Deviation for Step Quick Turn (sec) Tape vs. No Tape

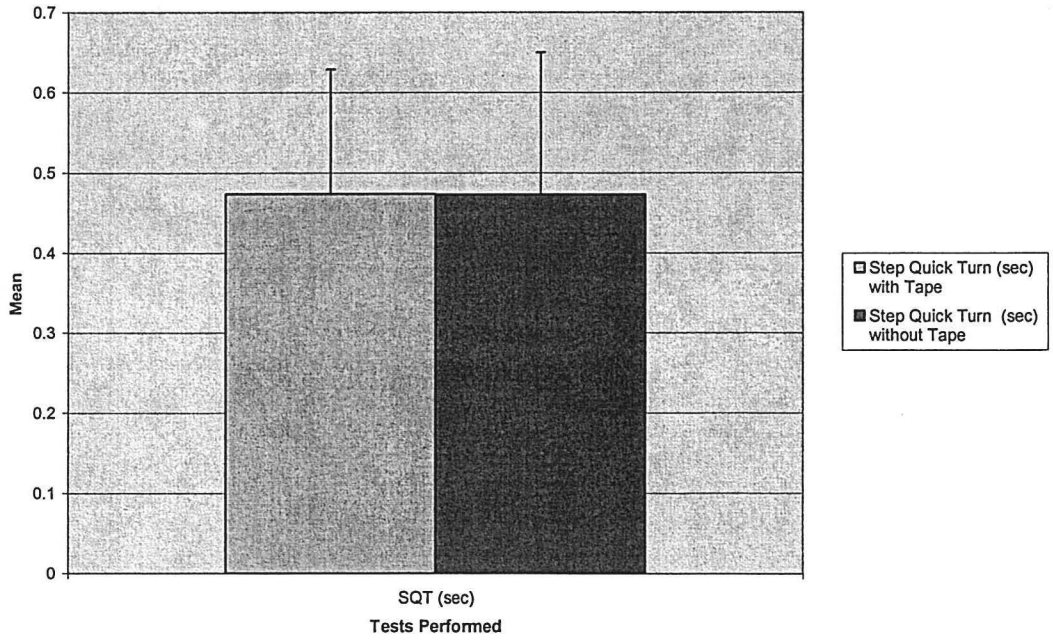

Figure 5. Mean and Standard Deviation for Step Quick Turn (deg/sec) Tape vs. No Tape

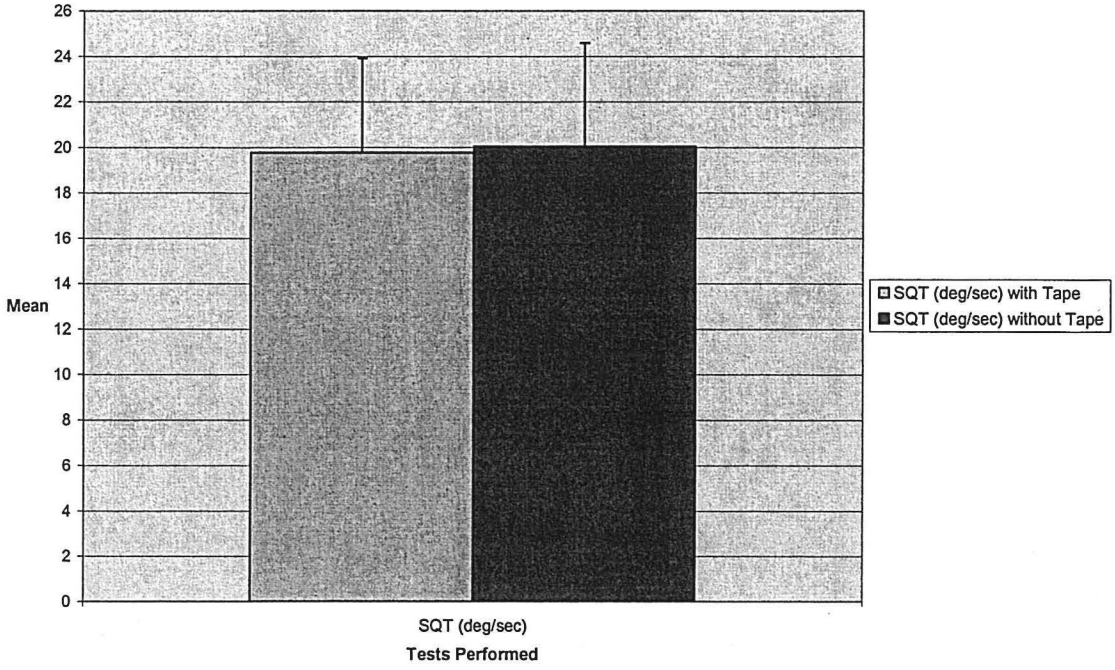

Figure 6. Mean and Standard Deviation for Unilateral Stance (deg/sec) Eyes Open Tape vs. No Tape

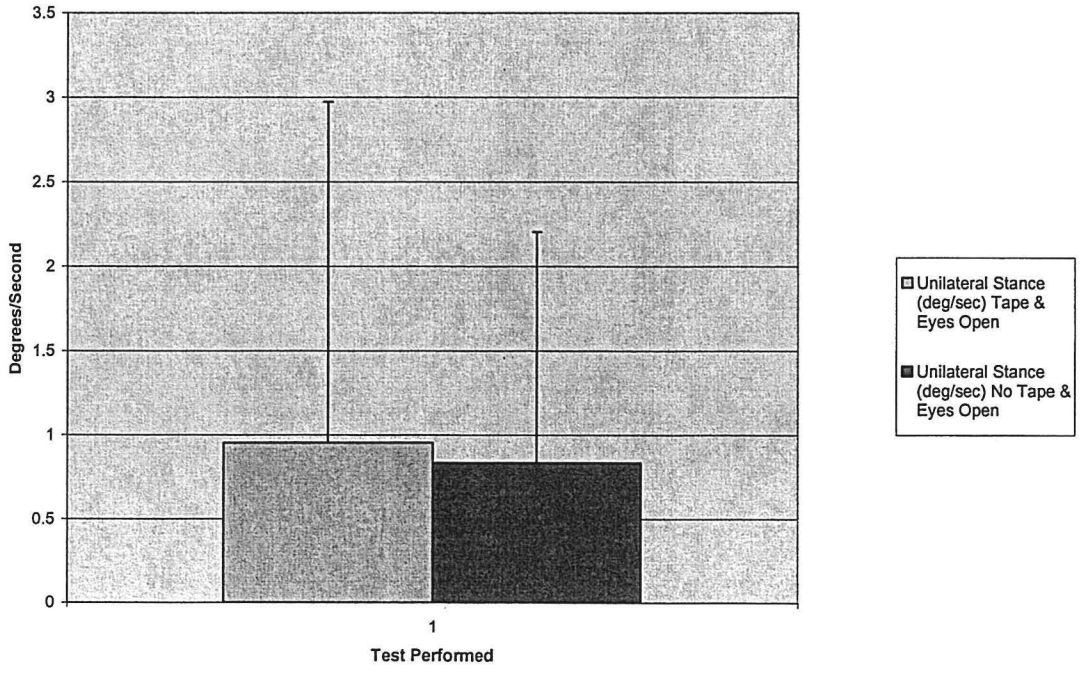

Figure 7. Mean and Standard Deviation for Unilateral Stance (deg/sec) Eyes Closed Tape vs. No Tape

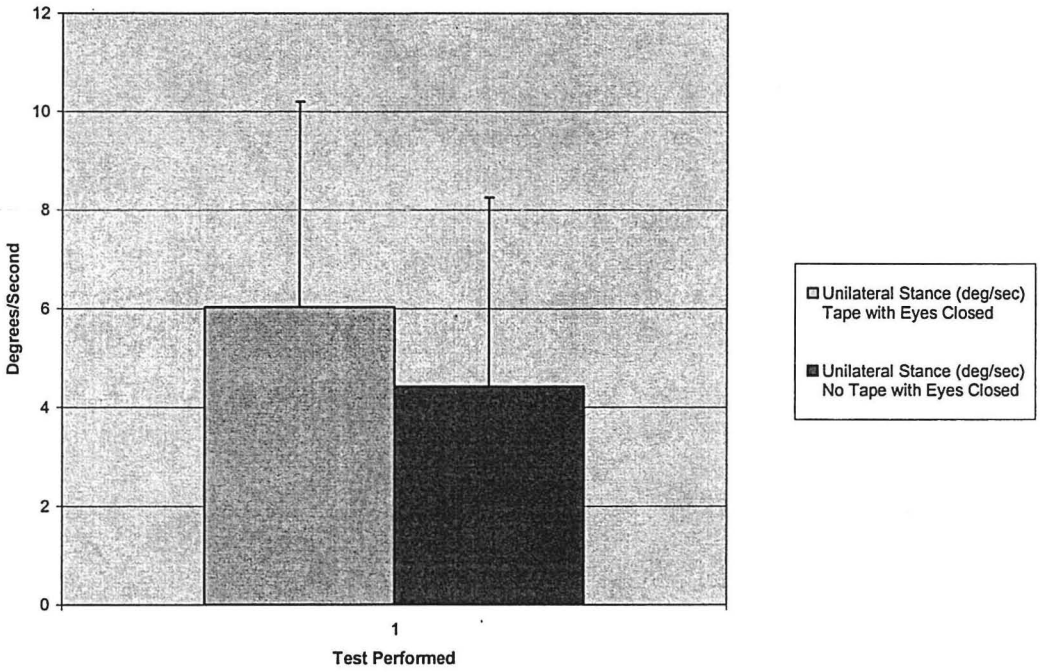

Table 2. Results for two-tailed paired-sample *t*-test.

	Mean Difference	Standard Deviation	t	Degrees of Freedom	P
SQT (sec) Tape vs. No Tape	.0006	.13744	.026	31	.980
SQT (deg/sec) Tape vs. No Tape	-.2750	3.68292	-.422	31	.676
Unilateral Stance (deg/sec) Eyes Open Tape vs. No Tape	.1219	.66708	1.034	31	.309
Unilateral Stance (deg/sec) Eyes Closed Tape vs. No Tape	1.6062	3.36739	2.698	31	.011

* Step Quick Turn (SQT), seconds (sec), degrees/second (deg/sec)

CHAPTER IV

DISCUSSION AND CONCLUSION

Discussion

This study examined many facets of ankle taping and postural control; however, only one component was found to be significant. The results of this study show a significant increase in postural sway with eyes closed and the ankle taped. By comparing the data collected in this study to previous research, interpretations of the results have been made and are described below.

During the performance of unilateral stance with the eyes closed and the ankle taped there was a significant increase in postural sway, indicating that the untaped ankle performed better. This is consistent with the results of a study by Bennel and Goldie[25] who found tape to decrease postural control with eyes closed. In addition, a study by Thompson[25] found tape to have an adverse effect on postural control when doing a modified Romberg test on football players.

Possible reasons for the significant findings in this study may be secondary to a decrease in visual input and limitation of fine ankle movements. Balance consists of three components, proprioception, vestibular sense, and visual input. By removing visual input (eyes closed), balance will be limited. Furthermore, when the ankle is taped, less fine ankle movement is allowed to help control balance, and therefore the knees and hips must compensate. This causes a subsequent increase in postural sway.

Due to the use of extensive exclusion criteria, all testing was performed on normal ankles. The tape may not have assisted these subjects in postural control the way tape may have on an unstable ankle. The additional stability that the tape provided may have just hindered normal postural reactions, whereas the tape on an unstable ankle may improve the postural reactions. The carryover of these results to an athletic population may be minimized since the testing was done on normal ankles. Also, all subjects participating in this study were healthy, active college students, a cohort which minimizes variability in the results.

Concerning the components of this study that showed no significant findings, a study by Tropp et al[19] also found no significant difference in stabilometric data derived from a force plate between control and taped subjects.

There are many different factors that may hinder balance, both intrinsic and extrinsic. Examples include: age, sex, previous history of trauma, comorbidities, strength, and joint integrity. Some extrinsic factors may include visual and auditory distractions during testing. During this study, all attempts were made to reduce negative effects on balance; however, it is impossible to eliminate all balance hindering factors.

Limitations that may also have affected this study include: variations in time of day, variations in taping application, variations in administration of test, auditory or visual distractions in the testing room, possible effects of a learning curve on the Balance Master and motivation of the subject.

All subjects were tested at various times throughout the day, with the majority of testing taking place in the morning. The differences in test time may have affected the

subjects' performance due to variations in fatigue levels and prior activities throughout the day.

A pilot study was performed which established intrarater reliability. This was completed to compensate for the tester's previous lack of experience operating the Neurocom® Balance Master 8.0. Despite this, variations in protocol and test administration were possible.

All ankle taping was done by the one researcher who had been trained in the closed Gibney technique. Prior to taping study subjects, the researcher's ankle technique was evaluated and approved by two separate certified athletic trainers.

The testing was performed in a closed environment within the Physical Therapy Department. Every attempt was made to maintain an environment free from distractions; however, at the time of data collection construction was taking place throughout the building, causing auditory distractions. Other minimal auditory distractions included background talking and arrival of other subjects knocking on the door. Possible visual distractions that may have altered the results of the study included movements of researchers within the room while testing was occurring.

There is the possibility of a learning curve influencing data results with increased numbers of trials for each test. In order to reduce this learning curve each subject participated in 3 training trials for each test.

Recommendations

There are several recommendations that can be made to improve the results of future studies. The following recommendations should be considered.

It is recommended to increase the number and variability of participants in future studies. A larger sample size would increase the power and significance of findings. Increasing the sample size would also serve to increase the variability of subjects. In this study, all subjects were healthy, active college students with similar demographic backgrounds. This does not provide a representative sample of the general population.

A study using a sample with ankle pathologies, recent and chronic, would help to make the study more applicable to that population. The exclusion criteria of this study did not allow for any ankle problems within the sample, limiting the generalization of our data.

Future studies on ankle taping and the effects on postural sway should include more functional activities, such as running, jumping, stepping and other common activities found in athletic populations. This will help to, again, increase the carryover of the study results to the targeted group.

Conclusion

This study found a significant increase in postural sway with the eyes closed and the ankle taped. This could be due to hindrance of fine ankle movements due to the application of athletic tape, lack of variability in population, or a learning curve. All other conditions did not reveal significant differences.

These results indicate that the use of tape for ankle support may not benefit the athlete's postural control at the ankle. This also implies that taping may not provide the external support that it is intended to provide, and optional interventions may need to be used. This indicates a need for further research into ankle taping and postural control.

APPENDIX A

IRB and Consent Forms

IRB

University of North Dakota Human Subjects Review Form

All research with human participants conducted by faculty, staff, and students associated with the University of North Dakota, must be reviewed and approved as prescribed by the University's policies and procedures governing the use of human subjects. It is the intent of the University of North Dakota (UND), through the Institutional Review Board (IRB) and the Office of Research and Program Development (ORPD), to assist investigators engaged in human subject research to conduct their research along ethical guidelines reflecting professional as well as community standards. The University has an obligation to ensure that all research involving human subjects meets regulations established by the United States Code of Federal Regulations (CFR). When completing the Human Subjects Review Form, use the "IRB Checklist" for additional guidance.

Principal Investigator: Mark Romanick, Jessica Brown, Andrea Foley, Michelle Hager, Andrea Kresel

Telephone: (701) 777-3668 E-mail Address: nromanic@medicine.nodak.edu

Complete Mailing Address: 501 North Columbia Road, P.O. Box 9037, Grand Forks, ND 58202-9037

School/College: University of North Dakota Department: Physical Therapy

Please provide the information requested below:

Student Adviser (if applicable): Mark Romanick

Telephone: Same as above E-mail Address:

Address or Box #:

School/College: Department:

Project Title: The effects of ankle taping on postural control.

Proposed Project Dates: Beginning Date: June 1, 2004 Completion Date: December 31, 2004

(A copy of the funding proposal for each agency identified above MUST be attached to this proposal when submitted.)

Does the Principal Investigator or any researcher associated with this project have a financial interest in the results of this project? If yes, please submit, on a separate piece of paper, an additional explanation of the financial interest (other than receipt of a grant)

___ YES or _X_ NO

If your project has been or will be submitted to other IRB's, list those Boards below, along with the status of each proposal.

_____ Date submitted: _____ Status: _____ Approved _____ Pending

_____ Date submitted: _____ Status: _____ Approved _____ Pending

Type of Project: Check "Yes" or "No" for each of the following.

X YES or NO New Project YES or X NO Dissertation/Thesis

___ YES or _X_ NO Continuation/Renewal _X_ YES or ___ NO Student Research Project

___ YES or _X_ NO Is this a Protocol Change for previously approved project? If yes, submit a signed copy of this form with the changes bolded or highlighted.

___ YES or _X_ NO Does your project involve medical record information? If yes, complete the HIPAA Compliance Application and submit it with this form.

___ YES or _X_ NO Does your project include Genetic Research? If yes, refer to Chapter 3 of the Researcher Handbook for additional guidelines regarding your topic.

___ YES or _X_ NO Does your project include Internet Research? If yes, refer to Chapter 3 of the Researcher Handbook for additional guidelines regarding your topic.

Subject Classification: This study will involve subjects who are in the following special populations: Check all that apply.

_____ Minors (< 18 years)
_____ Prisoners
_____ Persons with impaired ability to understand their involvement and/or consequences of participation in this research
_____ Other _____
_X_ UND Students
_____ Pregnant Women/Fetuses

For information about protections for each of the special populations, refer to Chapter 5 of the Researcher Handbook.

This study will involve: Check all that apply.

_____ Deception
_____ Radiation
_____ New Drugs (IND)
_____ Non-approved Use of Drug(s)
_____ Recombinant DNA
_X_ None of the above will be involved in this study
_____ Stem Cells
_____ Discarded Tissue
_____ Fetal Tissue
_____ Human Blood or Fluids
Other _____

I. Project Overview

Ankle taping is a common practice used to support the ankle joint after injury when engaging in activities. Studies have shown that taping is effective in increasing ankle stability, but more research is needed to determine the effects of taping on postural control. We plan to use the Balance Master, a computerized balance assessment device, to test these effects. In order to determine the effects of taping on postural control, human subjects must be used to infer the sample information to the population.

II. Protocol Description

1. Subject Selection.

a)Describe recruitment procedures

Healthy Young adults will be recruited via a sign-up sheet posted in the PT department (see enclosed attachment). In addition, an announcement will be made by the researchers to all physical therapy students, informing them of the volunteer opportunity; any other subjects will be obtained via word of mouth, if necessary. Recruitment will begin in May, 2004 and will continue until a sufficient number of subjects have signed up. We predict recruitment to be finished by August, 2004.

b) Describe your subject selection procedures and criteria.

Subjects included in this study will be healthy males and females between the ages of 18-39; this is the age category for

established norms of the Balance Master. Subject participation will be voluntary and non-compensated.

c) Describe your exclusionary criteria and provide a rationale for excluding subject categories.
All subjects must be between the ages of 18-39 based on established norms for the Balance Master. Subjects that will be excluded: pregnant women, those with a history of chronic ankle instability or recent ankle injury, those with known allergies to tape and/or pre-wrap, and those with a history of balance disorders. Exclusions are made for the safety of our subjects, and to be able to infer our results to a normal population (free of ankle instability or balance disorders).

d) Describe the estimated number of subjects that will participate and the rationale for using that number of subjects.
In order to assume a normal distribution for statistical purposes, the study will test up to 35 subjects.

e) Specify the potential for valid results.
Intra-tester reliability on the Balance Master 8.0 will be established in PT 583: Instrumentation. Validity and reliability of those Balance Master 8.0 tests that will be included in this study have been previously established.

2. Description of Methodology.

a) Describe the procedures used to obtain informed consent.
Subjects will read and sign the attached consent form prior to participating in the study. If subjects do not fully understand this written form, we will read and explain any necessary components.

b) Describe where the research will be conducted.
All research will be conducted in the Physical Therapy Department research room, located on the second floor of SMHS.

c) Indicate who will carry out the research procedures.
All Balance Master operation will be performed by Michelle A. Hager, SPT. Ankle taping will completed by Andrea J. Kresel, SPT. Additional procedures will be carried out by Jessica R. Brown, SPT, Andrea L. Foley, SPT, and Dr. Mark Romanick PT, PhD.

d) Briefly describe the procedures and techniques to be used and the amount of time that is required by the subjects to complete them.
Individual subject participation will be completed in one day. After signing the consent form, subjects will have one ankle taped using pre-wrap and cloth athletic tape followed by practice trials for each test. Subjects will then be taped again for data collection. All subjects will perform two tests on the Balance Master: "unilateral stance" and "step-quick turn." Each test will be performed twice by subjects; once with tape and once without. Randomization, via drawing cards out of a bowl, will be done to determine right or left ankle, the order of tests, and if the patient will be tested with or without tape first. The total estimated time per subject is approximately 30-45 minutes. The balance master platform will be disinfected after each subject. Subjects will not wear shoes or socks during testing procedures.

e) Describe the qualifications of the individuals conducting all procedures used in the study.
All individuals conducting this study have been trained on the Balance Master 8.0 by PT faculty member Meridee Danks as part of PT 583: Critical Inquiry 3- Instrumentation. Andrea Kresel has been trained in modified closed Gibney ankle taping by Dr. Mark Romanick, and will demonstrate proficiency before the beginning of the study. Instrumentation class instruction will be completed prior to official research to insure intra-rater reliability for Balance Master tester Michelle Hager.

f) Describe compensation procedures (payment or class credit, etc.).
Participation in this study is strictly on a voluntary basis and no compensation will be given.

Attachments Necessary: Copies of all instruments (such as survey/interview questions, data collection forms completed by subjects, etc.) must be attached to this proposal.

3. Risk Identification.

a) Clearly describe the anticipated risks to the subject/others including any physical, emotional, and financial risks that might result from this study.

This study includes a minimal risk for falling during Balance Master testing procedures. This will be controlled by always having a researcher within close proximity to the subject, ready to prevent a fall. Unknown allergies to taping materials pose a risk for allergic reaction; if a reaction occurs, the subject will be referred for the appropriate medical care.

c) Indicate whether there will be a way to link subject responses and/or data sheets to consent forms, and if so, what the justification is for having that link.

Subject data from testing will be linked to the consent forms via a numbering system. These two sets of information will kept in separate secured locations. The consent form will contain the subject name and number and will be stored in a locked file cabinet within the physical therapy department. Testing data will be identified solely by the subject number and will be stored on the research computer within the locked physical therapy department research room and a backup copy will be in a locked cabinet in Mark Romanick's office.

4. Subject Protection.

a) Describe precautions you will take to minimize potential risks to the subjects.

The consent form will inform subjects of the slight risk of falling associated with this research. Researchers will be near subjects acting as spotters to prevent a fall. Since patients will be barefoot during Balance Master testing, the testing surface will be disinfected between each subject.

b) Describe procedures you will implement to protect confidentiality.

Subject confidentiality will be protected by assigning a number coding system to consent forms and research data, eliminating the need for subject names on any data. Data and consent forms will be stored in separate locked locations to avoid any chance of matching data to identifying information.

c) Indicate that the subject will be provided with a copy of the consent form and how this will be done. Subjects will be informed that, upon request, copies of the consent form will be available.

d) Describe the protocol regarding record retention. Please indicate that research data from this study and consent forms will both be retained in separate locked locations for a minimum of three years following the completion of the study.

1) The storage location of the research data (separate from consent forms and subject personal data)

Data will be stored the computer in the locked PT research room and a backup copy will be stored in a locked cabinet in Renee Mabey's office.

2) Who will have access to the data

Jessica Brown, Andrea Foley, Michelle Hager, Andrea Kresel, and Mark Romanick will have access to the data. Renee Mabey (PT faculty member) will be assisting with statistical analysis, but will not have access to consent forms.

3) How the data will be destroyed

After completion of the study, all electronic data will be printed in paper form and then completely erased from the computer. All paper copies will be shredded three years after completion of the study.

4) The storage location of consent forms and personal data (separate from research data)

Consent forms will be kept in Mark Romanick's office, in a locked cabinet, separate from any data.

5) How the consent forms will be destroyed

Three years after study completion, consent forms will be shredded.

e) Describe procedures to deal with adverse reactions.

In the rare event that a subject falls, injuries will be assessed by the researchers and the subject will be referred to the appropriate health care facility. If emergency care is needed, 911 will be called. This incident will be documented in research data.

f) Include an explanation of medical treatment available if injury or adverse reaction occurs and responsibility for costs involved.

If a subject experiences an injury as a result of the study, he/she will go to the health care provider of his/her choice. The costs associated with treatment are the full responsibility of the subject; all subjects will release researchers and UND of any liability by signing the consent form.

III. Benefits of the Study

Clearly describe the benefits to the subject and to society resulting from this study.

Since some subjects will be physical therapy students, the research topic and process are relevant to their career field. By participating, subjects will further their knowledge of physical therapy research, specifically pertaining to the ankle. Societal benefits of the research include a chance for justification for the commonly used practice of ankle taping as it applies to functional and athletic activities, in particular, enhanced balance control.

IV. Consent Form

A copy of the consent form must be attached to this proposal. If no consent form is to be used, document the procedures to be used to protect human subjects. Refer to the ORPD website for further information regarding consent form regulations.

Please note: Regulations require that all consent forms, and all pages of the consent forms, be kept for a minimum of 3 years after the completion of the study, even if subject does not continue participation.

By signing below, you are verifying that the information provided in the Human Subjects Review Form and attached information is accurate and that the project will be completed as indicated.

Signatures:

(Principal Investigator) Date:

(Student Adviser) Date:

CONSENT FOR USE OF PICUTRE

I, Tara Mathern, do hereby give permission for the use of my photograph in this Scholarly Project, IRB # 200405-369.

Tara Mathern
(Signature)

12/01/04
(Date)

INFORMATION AND CONSENT FORM

A Balance Master Assessment of the Effects of Ankle Taping on Postural Control

Principal Investigators: Jessica Brown, Andrea Foley, Michelle Hager, Andrea Kresel and Mark Romanick from the Department of Physical Therapy at the University of North Dakota

You are being invited to participate in this study of postural control of the ankle during functional activities, both with and without ankle tape. The purpose of the study is to determine the effect of ankle taping on postural control. We hope that the results of this study will aid physical therapists in justification of the use of ankle taping during activities.

You were chosen because: 1) you are a healthy young adult between the ages of 18 and 39, 2) you are not pregnant, 3) you do not have a history of acute or chronic ankle injuries, 4) you do not have a known allergy to tape or pre-wrap, and 5) you do not have a history of balance disorders, such as Meniere Disease, motion sickneses syndrome, vestibular migraines, or inner ear trauma.

As a subject for this study, you will be asked to report to the Physical Therapy Department at the University of North Dakota, located in the Medical Science North Building. Your age, height, and weight will be recorded. Following this, you will be asked to remove your shoes and socks for testing and tape application. You will complete a practice set of tests on the Balance Master. These tests will involve standing on one leg with eyes open and eyes closed; you will then learn and perform a quick step turn. The quick step turn requires you to take two steps, make a 180 degree turn, then take two more steps. After the practice set, you will perform each test twice, once with tape and once without. The Balance Master will monitor your balance during testing. The entire testing procedure should take no longer than 45 minutes.

Although the process of physical performance testing always involves some degree of risk, the low intensity of the testing will keep injury risk level low. Since your balance is being tested, risk of falling is present but minimal with researchers nearby, acting as spotters. There is also a risk of unknown tape allergies and skin conditions associated with the use of tape and pre-wrap. UND, UND Physical Therapy Department, and the researchers will not be held liable for any injuries that may occur during this study.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The data will be identified by a number known only to the investigators. Only the researchers, adviser, and individuals who audit IRB procedures will have access to the data. Data and consent forms will be kept in separate locked cabinets for a duration of 3 years, after which they will be destroyed. The investigators or participant may stop the experiment at

1

any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his/her health. Your decision whether or not to participate is voluntary and will not prejudice your future relationship with the Physical Therapy Department at the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigators involved are available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Andrea Foley at (218)-779-5570 or Mark Romanick at (701)-777-2831. If you have any further questions or concerns, please call the Office of Research and Program Development at (701)-777-4279. At your request, you will be given a copy of this form for future reference.

In the event that this research activity results in a physical injury, medical treatment will be as available as it is to a member of the general public in similar circumstances. You and your third party payer must provide payment for any such treatment. The researchers and the University of North Dakota will not be held liable for any injuries.

All of my questions have been answered and I am encouraged to ask any questions that I may have concerning this study in the future. I have read all of the above and willingly agree to participate in this study as it is explained to me by Jessica Brown, Andrea Foley, Michelle Hager, and/or Andrea Kresel.

Subject's signature Date

University of North Dakota
Institutional Review Board
Approved on MAY 26 2004
Expires on MAY 25 2005

2

REFERENCES

1. Osborne MD, Rizzo TD. Prevention and treatment of ankle sprain in athletes. *Sports Med.* 2003; 33:1145-1150.

2. Laskowski ER, Newcomer-Aney K, Smith J. Refining rehabilitation with proprioception training: expediting return to play. *Physician Sportsmed.* 1997; 25: 89-90,92,95.

3. Handoll HHG, Rowe BH, Quinn KM, de Bie R. Interventions for preventing ankle ligament injuries. *The Cochrane Database of Systematic Reviews* 2001, Issue 2. Art. No.: CD000018. DOI: 10.1002/14651858.CD000018.

4. Robbins S, Waked E, Rappel R. Ankle taping improves proprioception before and after exercise in young men. *Br J Sports Med.* 1995;29:242-7.

5. Heit EJ, Lephart SM, Rozzi SL. The effect of ankle bracing and taping on joint position sense in the stable ankle. *Journal of Sport Rehabilitation.* 1996; 5:206-213.

6. Cordova ML, Ingersoll CD, Palmieri RM. Efficacy of prophylactic ankle support: an experimental perspective. *J Athl Train.* 2002;37:446-458.

7. Mercier L. Practical Orthopedics. 5th ed. St. Louis, MO: Mosby, Inc.:2000:200.

8. Karlsson J, Sward L, Andreasson G. The effect of taping on ankle stability. *Sports Med.* 1993;16:210-215.

9. Kinzey S, Ingersoll C, Knight K. The effects of selected ankle appliances on postural control. *J Athl Train.* 1997;32:300-303.

10. Mack R. Ankle injuries in athletics. *Clin Sports Med.* 1982;1;71-84.

11. Vegso J, Harmon L. Nonoperative management of athletic ankle injuries. *Clin Sports Med.* 1982;1:85-98.

12. Bonchi C. Adhesive strapping techniques. *Clin Sports Med.* 1982;1:99-116.

13. Alt W, Lohrer H, Gollhofer A. Functional properties of adhesive ankle tapping; neuromuscular and mechanical effects before and after exercise. *Foot Ankle Int.* 1999;20:238-245.

14. Cordova ML, Ingersoll CD, LeBlanc MJ. Influence of ankle support on joint range of motion before and after exercise: a meta analysis. *J Orthop Sports Phys Ther.* 2000;30:170-177.

15. You SH, Granata KP, Bunker LK. Effects of circumferential ankle pressure on ankle proprioception, stiffness, and postural stability: a preliminary investigation. *J Orthop Sports Phys Ther.* 2004;34:449-460.

16. JM Glick, Gordon RB. The prevention and treatment of ankle injuries. *Am J Sports Med.* 1976;4:136-141.

17. Tropp H, Askling C, Gillquist J. Prevention of ankle sprains. *Am J Sports Med.* 1985;12:259-262.

18. Venes D, Thomas CL, eds. *Taber's Cyclopedic Medical Dictionary.* 19th ed. Philadelphia, PA: FA Davis Co.;1997:216,1720,1764.

19. Tropp H, Eckstrand J, Gillquist J. Factors affecting stabilometry recordings of single limb stance. *Am J Sports Med.* 1984;12:185-188.

20. Lui S, Jason W. Lateral ankle sprains and instability problems. *Clin Sports Med.* 1994;4:793-809.

21. Garrick JG, Requa RK. Role of external support in the treatment of ankle sprains. *Med Sci Sports Exerc.* 1993;3:200-203.

22. Garrick JG. The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. *Am J Sports Med.* 1977;5:241-242.

23. Lynch SA, Renstrom PA. Treatment of acute lateral ankle ligament rupture in the athlete. Conservative versus surgical treatment. *Sports Med.* 1999;27:61-71.

24. Konradsen L, Ravn JB. Prolonged peroneal reaction time in ankle instability. *Int J Sports Med.* 1991;12:290-2.

25. Feuerbach JW, Grabiner MD, Koh TJ, Weiker GG. Effect of an ankle orthosis and ankle ligament anesthesia on ankle joint proprioception. *Am J Sports Med.* 1994;22:223-229.

26. Bennell K, Goldie P. The differential effects of external ankle support on postural control. *J Orthop Sports Phys Ther.* 1994;20:287-295.

27. Baier M, Martin MD, Hopf T. Ankle orthoses effect on single-limb standing balance in athletes with functional ankle instability. *Arch Phys Med Rehabil.* 1998;79:939-944.

27. Baier M, Martin MD, Hopf T. Ankle orthoses effect on single-limb standing balance in athletes with functional ankle instability. *Arch Phys Med Rehabil.* 1998;79:939-944.

28. Verbrugge, JD. The effects of semirigid Air-Stirrup bracing vs. adhesive ankle taping on motor performance. *J Orthop Sports Phys Ther.* 1996;23:320-325.

29. Santos MJ, McIntire K, Foecking J, Liu W. The effects of ankle bracing on motion of the knee and the hip joint during trunk rotation tasks. *Clin Biomech* (Bristol, Avon). 2004;19:964-71.

30. Guaffin H, Tropp H, Odenrick P. Effect of ankle disc training on postural control in patients with functional instability of the ankle joint. *Int J Sports Med.* 1988; 9:141-144.

31. Hertel J, Buckley WE, Denegar CR. Serial testing of postural control after acute lateral ankle sprain. *J Athl Train.* 2001;36:363-368.

32. Goldie PA, Evans OM, Bach TM. Postural control following inversion injuries of the ankle. *Arch Phys Med Rehabil.* 1994;75:969-975.

33. Arnold B, Docherty C. Bracing and rehabilitation – what's new. *Clin Sports Med.* 2004;23:83-95.

34. Vaes PH, Duquet W, Casteleyn PP, Handelberg F, Opdecam P. Static and dynamic roentgenographic analysis of ankle stability in braced and nonbraced stable and functionally unstable ankles. *Am J Sports Med.* 1998;5:692-702.

35. Leanderson J, Wredmark T. Treatment of acute ankle sprain. Comparison of a semi-rigid ankle brace and compression bandage in 73 patients. *Acta Orthop Scand.* 1995;66:529-31.

36. Barkoukis V, Sykaras E, Costa F, Tsorbatzoudis H. Effectiveness of taping and bracing in balance. *Percept Mot Skills.* 2002;2:566-574.

37. Kennedy R. *Mosby's Sports Therapy: Taping Guide.* St. Louis, MO. 1995;3-26.