THE EFFECT OF FATIGUE ON BALANCE IN ANKLE TAPE VS LACE UP BRACE CONDITIONS USING A STAR EXCURSION BALANCE TEST ON CHRONICALLY UNSTABLE ANKLES

A THESIS

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THESIS APPROVAL

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INTRODUCTION

One of the most common injuries that occur with sporting events or physical activity is a lateral ankle sprain.[1-6] The level of severity varies with each injury as well as the mechanism of injury. The majority of ankle sprains that occur are inversion injuries and can lead to residual symptoms such as pain, repeated sprains, and episodes of "giving way."[7] The result of recurring sprains producing these residual signs and symptoms can be expressed as chronic ankle instability (CAI). CAI is described as modified mechanical joint stability due to recurring disruptions to ankle integrity with secondary perceived and observed insufficiency in neuromuscular control.[6-8] These disruptions can be a result of ankle injury or repeated turning in of the ankle, especially on uneven surfaces.

Ankle sprains that occur most often do not develop lateral ligamentous instability, but those that do are thought to be due to a loss of mechanoreceptors.[23] Not all acute sprains result in chronic ankle instability, 80% of acute sprains make a full recovery with conservative management, and the other 20% develop mechanical or

functional instability resulting in CAI.[23] There is a recurrence rate as high as 80% among active individuals after an initial ankle injury.[6-8] In order to reduce these instances of injury, it has been recommended to use a prophylactic ankle brace or taping technique.[4,5] This bracing or taping method assists in limiting ankle range of motion that results in lateral ankle sprains.[4,5]

The ankle, as a joint of the lower extremity in close proximity to the base of support, plays an integral role in maintaining balance. Balance is generally defined as condition where the body's center of gravity (COG) is maintained within its base of support is defined as balance.[4,5,7-9] Dynamic and functional balance are similar where maintenance of the COG is within the limits of stability over a moving base of support.[14] What sets these two forms of balance apart is that functional balance includes sport-specific task such as throwing and catching.[14] Balance can influence athletic performance for athletes and other physically active individuals.[9] Dynamic balance is explained as sustaining center of mass over the base of support when that base of support is moving or when an external perturbation is applied to the body.[7,10] In other words, the individual is attempting to maintain their base of support while they complete a given movement.[8] CAI

can be an added restraint and cause difficulty in maintaining an individual's base of support when that base of support is moving, and could consequentially impede balance.[1,7,8] The use of prophylactic ankle braces and tape have become some of the more common ways utilized to provide added support to the ankle joint and prevent injury of the ankle during physical activity. Studies have found that, with the use of ankle braces or proprioception training programs, ankle sprains can be prevented.[4,5,12]

There are few dynamic balance protocols that assess dynamic balance control with the use of equipment, but one such test is the Star Excursion Balance Test (SEBT).[13] The SEBT is a test of dynamic postural control that involves having the subject maintain a base of support with one leg, while maximally reaching in different directions with the opposite leg.[10] This must be performed without compromising the base of support of the stance leg.[10] Studies have demonstrated high intratester and intertester reliability when using the SEBT as an assessment of dynamic balance.[22] Earl and Hertel et al[22] established the usefulness of the SEBT for recruitment of lower extremity musculature contraction. Evidence indicates that the SEBT is a sensitive test for screening musculoskeletal impairments such as chronic ankle instability.[10,13] Throughout an event

or athletic competition, fatigue may modify neuromuscular control and can decrease the body's ability to maintain stability.[4] Gribble[8] demonstrated that CAI produced an increased deficiency in dynamic postural control related to fatigue using a SEBT. Through the use of a fatigue protocol, there may be a reported drop in muscle force below 59% of peak torque, which may result in postural control deficits and an increased risk of musculoskeletal injury.[11]

Studies have examined how bracing has affected the SEBT and time to stabilization following a fatigue protocol with the use of bracing on healthy volunteers.[4,12] They concluded that prophylactic bracing did not disrupt lower extremity balance reach, but that Active Ankle® bracing was the best option for providing dynamic stability.[4,12] There have been no studies examining how fatigue can affect balance using the SEBT and utilizing a prophylactic bracing or taping condition in healthy volunteers, however. There have been various protocols demonstrated to induce fatigue but the more recent development of functional fatigue protocol has not been studied.[3,4,8] This fatigue protocol offers exercises that are more comparable to sport specific movements to stimulate the same fatigue symptoms that would occur during an athletic event.[4]

As of late, authors have used functional fatigue protocols with SEBT for dynamic balance data collection. However, the effect of prophylactic bracing and taping techniques has not been tested in combination with a functional fatigue protocol using a SEBT. Therefore, the purpose of this study was to examine the effects of functional fatigue on dynamic balance with the use of tape and lace-up bracing.

METHODS

The primary purpose of this study was to determine the effects of a functional fatigue protocol on dynamic balance while utilizing a prophylactic bracing technique and tape. The methods section will help present an overview of how this study was conducted. This section includes the following subsections: research design, subjects, instruments, procedures, hypotheses, and data analysis.

Research Design

This research was a quasi-experimental, within subjects, repeated measures design. Independent variables in this study were condition (brace or tape) and fatigue (fatigue or non-fatigue). The dependent variable was the measure of functional balance using the SEBT following a fatigue protocol during the application of both conditions. A limitation to this study is the inability to generalize the results beyond college-aged physically active students demonstrating CAI at a Division II University. Strength of this study was that the fatigue, non-fatigue condition was controlled by testing SEBT pre-and post-fatigue.

Subjects

Subjects included 15 volunteer students (7 males, 8 females), 18 years and older, termed physically active with CAI from California University of Pennsylvania. Physically active individuals were defined as accruing 60 minutes of daily physical activity or 30 minutes of moderate to vigorous exercise three to four days a week.[16] Subjects meeting these criteria were recruited from undergraduate classes in Health Science and NCAA Division II athletic teams. Subjects volunteered to participate in this study with no coercion from coaches or faculty after the researcher had explained the purpose.

A Data Collection sheet (Appendix C1) was used to report subject's criteria of physically active or NCAA athlete, and determine whether a participant reported CAI using the Ankle Instability Instrument (AII) developed by Docherty.[15] Two questions of the AII were used to determine qualification for CAI: "Have you ever sprained an ankle?", and "Have you ever experienced a sensation of your ankle 'giving way'?" Along with answering yes to these two questions, the subjects also had to answer affirmatively to at least one other question on the instrument.[6,15] The AII

has been observed to be a reliable measure of self-reported CAI.[6,15]

Any subject who experienced visual, vestibular, balance disorder, severe lower extremity injury, and/or a concussion within the last six months was disqualified from this study as these conditions may reportedly hinder an accurate balance assessment. In order to protect the subjects' identity, a number was used instead of their names in the study; this also assisted in blinding the researcher when checking the data collection sheet. Subjects were assigned to all four testing periods with at least three days between each session to prevent the presence of any delayed onset muscle soreness during testing times. Prior to any testing, subjects read and signed the Information Consent Form (Appendix C2).

Preliminary Research

Preliminary research was designed to help familiarize the researcher with bracing techniques, the fatigue protocol, SEBT, and for a determination of the time that was necessary for testing each subject under the different conditions. The procedure for the testing sessions was based upon previously performed research.[10,12] Scoring of

the SEBT using an average distance for the reaching limb in five directions(distance in centimeters)were the functional scores used for analysis. Testing procedures were performed on three adult volunteers who were studying or working at California University of Pennsylvania. These volunteers were within the same age range as the desired population. The pilot research helped to determine how many trials were adequate for the SEBT for the subjects to become familiar and minimize any learning effects. Previous research[4] found that six practice trials should be performed in order to minimize learning effects. However, our preliminary study showed that three practice trials in each of the five directions were adequate in minimizing learning effects.

Instruments

The following instruments were used in this study: Data collection sheet (Appendix C1), fatigue protocol (using a electronic metronome and the Vertec™ vertical jump tester)(Appendix C3), SEBT (Appendix C4), Johnson and Johnson Coach® Athletic Tape, and a lace-up ASO brace.

Data Collection Sheet

Data collection sheet (Appendix C1) included the subject number, age, gender, chronically unstable ankle (R/L), vertical jump maximum height, leg length, whether subjects NCAA athlete or physically active/recreational athletes, and all SEBT scores for each condition on all four testing sessions.

Fatigue Protocol

The fatigue protocol (Appendix C3) used for this study has been used in previous research.[4,8,12] Three stations were used in the fatigue protocol including a Modified Southeast Missouri agility drill (SEMO), stationary lunges, and quick jumps with the use of data collected from the subjects' vertical jump height.

The SEMO was composed of a series of forward sprints, side shuffles, and back peddling.[4] The SEMO was completed in a rectangle of 12 X 19 ft (3.6 X 5.7 m) as performed in Shaw and Gribble's[4] study. Following this station the subjects immediately began the stationary lunges that were timed with a metronome. The distance of lunge was determined by the measures of the subject's true leg length from the anterior superior iliac spine to the distal portion of the medial malleolus prior to the protocol.

Each lunge was performed five times equaling ten lunges total with alternating lunge legs.[4] One lunge was performed every two seconds using a metronome.[4] Starting with their feet together they would step forward with their lunging leg and place their leading foot firmly on the ground. Subjects had to avoid any sideways tilting or swaying in the upper body and bring the lower body to a position where the front thigh became parallel with the floor during hip and knee flexion, while maintaining an upright torso. They would then return to standing position while their hands remained on their hips. Proper technique was critical to fatigue the individual.

Finally, as the last step of the fatigue protocol, the subjects performed 10 quick jumps. To set up this station, the individuals maximal vertical jump height was recorded using the Vertec™ vertical jump tester. This system measures from 6 to 12 feet with color-coded vanes that offer half-inch measurements for immediate feedback. First, the subjects' standing height was measured by standing under the Vertec™ vertical jump tester and reaching up to touch the highest point possible while maintaining both feet flat on the ground. Second, participants performed a two-footed maximal vertical jump reaching to the highest point possible on the Vertec™.

From Shaws'[4] study, each participant was given three jump trials to determine their greatest jump height, that height was then recorded.[4] The standing reach height was then subtracted from the individuals maximal vertical jump height in order to get their $Vert_{max}$.[4] The quick jumps were performed double legged with both arms above the head reaching for a distance that was 50% of their $Vert_{max}$ previously recorded. This was done ten times reaching for a tape placement on the wall for the subject to hit each time with both hands.[4] Again, correct form was critical for fatigue to be reached and if the form was not correct, the jump was not counted. If the tape was not touched with both hands, the jump was not counted. Each subject was able to establish a baseline time with the first testing session to determine fatigue in the subsequent testing trials. Participants continued to complete each station until the time to finish the stations increased by 50% when compared to their baseline times.[4]

Star Excursion Balance Test (SEBT)

The SEBT (Appendix C4) is a functional test of dynamic balance in which the postural control system is challenged while the body's center of mass is moved in relation to its base of support.[8,10,13] The SEBT uses eight tape lines that

extend at 45° increments from the center grid point in the shape of a star(Appendix C4).[13,10] Five of the lines were used for the individual subject tests depending on the reach leg. The five lines were named as such; anterolateral (AL), anterior (A), posterior (P), posterolateral and lateral (L), according to the direction of excursion in relation to the stance leg.[10,13] In terms of the direction of excursion, the subjects always had the chronically unstable ankle as their stance leg and their reach was always lateral, never medial.[10] Previous studies have used three or five of the reaching directions, this is due to the fact that we were mainly concerned with sagittal-plane kinematics of the stance leg.[24] During the final test trial, the distance between center of the grid and the point the subject's leg touched was marked with a sticky tab, and measured with a tape measure, according to suggested test protocols. Markers were removed following pre-fatigue, non-fatigue conditions so that they did not serve as visual "markers" for the subjects.

Subjects' hands had to remain on the hips at all times, and if the subject used the reaching leg for support at any time, removed his or her foot from the center of the grid, or was unable to maintain balance on the support leg, the trial was discarded and repeated.[10] Participants wore

their own shoes versus standard testing shoes because during regular physical activity, their personal form of shoes would be worn with the ankle brace. The subjects each performed three trials of the SEBT as a warm-up for the recorded trial. The distance from the center of the grid to the reach point was measured and recorded on the data sheet for the directions of A, AL, L, PL, and P. Taking the average score of these five reach points for pre and post-fatigue offered a mean score for each excursion that was performed.[14] Higher scores in centimeters indicated better balance. The distance scores (centimeters) for each direction of the SEBT grid were averaged and normalized to leg length (reach distance/leg length x 100 = percentage of leg length).[10]

Tape and Brace

The Ankle Stabilizing Orthosis (ASO brace) is made up of a durable ballistic nylon material with an elastic cuff closure.[17-19] Advanced support is achieved through exclusive non-stretch nylon stabilizing straps that emulate the stirrup method of an athletic taping application.[18,19] The calcaneus is secured, which effectively locks the heel. Each participant was fitted for the brace according to the manufacturer's guidelines based on shoe size.[18,19] The

participants were instructed on proper application of the ASO brace and the brace was applied by the same certified athletic trainer according to the manufacturer's guidelines prior to each testing session.[17]

Johnson and Johnson Coach® Athletic Tape 1½ inch non-elastic adhesive tape was used for taping sessions. The tape was applied by the same certified athletic trainer for each session. The method of ankle taping that was chosen is comparable in support to an ASO brace. A closed basket weave taping technique was applied to the chronically unstable ankle. The technique consisted of applying non-elastic adhesive tape over the individual's skin. The basket weave contains a heel lock method which is implemented in the ASO brace. Subject's ankle position was at 90°, two anchors were placed at the top and one on the foot, through the arch. Three stirrups and three horseshoes were then applied followed by two figure eights and two sets of heel locks to complete the tape support.

Procedures

The study was approved by the California University of Pennsylvania Institutional Review Board (IRB) (Appendix C5). Prior to the study, the researcher met with all

potential subjects to explain the concept of the study and to offer the Informed Consent Form (Appendix C2) so that each subject was made aware and understood the requirements and risks of involvement in the study. The qualifications for these subjects, as mentioned in the subject section, requirements, testing dates, and approximate time frames for each session, ranging from 10 to 45 minutes, were also announced.

Previous to the first testing session, qualifications for the subjects were presented again. Once understanding the testing procedures and approving of them, subjects signed the Informed Consent Form and the researcher completed the Data Collection Sheet (Appendix C1) for each subject. Prior to beginning each test, the researcher explained the test procedure and methods. Following the collection of data on the subjects that performed the study, they were asked to report to the lab on four separate occasions. These testing days needed to be, at the minimum, three days apart to avoid delayed onset muscle soreness.

Fatigue Protocol

For the initial session, the subjects' maximal vertical height was determined to create the quick jumps

portion of the fatigue protocol. Next, both legs of the individual were measured for length from the anterior superior iliac spine to the medial malleolus while the individual laid in a supine position.[4] This length determined the reach distance for the lunging task portion of the fatigue protocol.[4] Lastly, the fatigue protocol was explained to the subjects and demonstrated during the initial session. The subjects were able to practice this protocol one time before they performed it for the study. The initial practice was only a walk through as to not fatigue the individual before the actual testing times were recorded. The second time through the fatigue protocol was timed and that timed trial was used for the other three testing sessions in order to establish a point of fatigue for each subject.

Star Excursion Balance Test (SEBT)

During each of the four testing sessions with the two different support conditions the subjects were tested with the SEBT before and after performing the fatigue, non-fatigue. Using their unstable ankle as their stance leg their center point and the first metatarsophalangeal joint was positioned on the center grid, they were instructed to use their reach leg (non CAI) and reach the maximal

distance possible to touch the line with the most distal component of the reach foot without any additional support.[10] The limb was then restored to the starting point at the center of the grid, while maintaining single-leg stance with the other leg. In any direction, leaning was allowed as long as the hands remained on subjects' hips and the reach leg did not touch the floor in any other place but the maximal reach. Distances in centimeters were recorded for all five directions for the chronically unstable ankle. The test needed to be repeated if the subject rose the stance foot from the center of the grid, if the reach foot was used to provide support when touching the ground, or if the subject lost his or her equilibrium at any point in the trial. The distance scores (cm) for each direction of the SEBT grid were averaged and normalized to leg length (reach distance/leg length x 100 = percentage of leg length).[10]

Hypothesis

The following hypothesis was based upon previous research and the researcher's intuition based on a review of the literature.

The use of a lace-up style brace will allow for better dynamic balance compared to tape as scored on the SEBT following a fatigue protocol.

Data Analysis

A within-subjects repeated measures ANOVA was used to determine the differences within subjects' SEBT scores on two tests (fatigue/non-fatigue) and between two conditions (lace-up brace and Johnson and Johnson Coach® athletic tape). All data was analyzed by SPSS version 18.0 statistical software package for windows at an alpha level of ≤ 0.05.

RESULTS

The purpose of this study was to examine the effects of functional fatigue on dynamic balance with the use of tape and lace up bracing. Subjects were tested using the SEBT before and after a stint of fatigue or rest and were tested under both levels of brace condition, lace-up brace or tape, depending on which session was being performed. The SEBT was used to measure dynamic balance and functional balance respectively. The following section includes: demographic information, hypothesis testing, and additional information.

Demographic Data

A total of 15 subjects (7 males, 8 females), mean age of 20.8y ± 1.52, completed this study. A total of 7 subjects testing positive for chronic ankle instability of the right ankle, and 8 testing positive for the left ankle using the AII (Appendix C1). All subjects were volunteers and physically active individuals at California University of Pennsylvania which included 14 physically active/recreational athletes and 1 NCAA Division II athlete. During the time of testing, the subjects who

completed this study did not experience any visual, vestibular, balance disorder, severe lower extremity injury, and/or a concussion within the last six months that may hinder an accurate balance assessment. Demographic data (Table 1) were collected by the researcher at the beginning of the study.

Table 1. Demographic Data

Male and Female (N = 15)					
		Minimum	**Maximum**	**Mean**	**SD**
Age	(y)	18	23	20.8	1.52
Leg Length	(cm)	81.3	99.1	90.98	5.78
$Vert_{max}$	(cm)	29.2	74.9	48.61	15.47
Male (N = 7)					
		Minimum	**Maximum**	**Mean**	**SD**
Age	(y)	18	23	20.86	1.68
Leg Length	(cm)	88.9	99.1	95.46	3.93
$Vert_{max}$	(cm)	33	74.9	60.41	14.62
Female (N = 8)					
Age	(y)	18	22	20.75	1.49
Leg Length	(cm)	81.3	91.4	87.06	3.99
$Vert_{max}$	(cm)	29.2	43.2	38.28	5.82

Hypothesis Testing

Hypothesis testing was performed using data from the 15 subjects who completed all four testing sessions. Descriptive statistics of the SEBT for the two prophylactic bracing techniques (lace-up brace and Johnson and Johnson Coach® Athletic Tape) are shown in Table 2. The distance scores (cm) for each direction of the SEBT grid were averaged and normalized to leg length (reach distance/leg length x 100 = percentage of leg length).

Using a within-subject repeated measures factorial ANOVA, the hypothesis was tested at an alpha level of $\leq$ 0.05. For final analysis, difference scores were computed between pre- and post- fatigue or non-fatigue conditions. A positive difference indicated maximized lower extremity reach distances, or better functional balance, with one limb while maintaining balance on the contralateral limb in the post-test. A negative difference indicates a decreased lower extremity reach distance, or an inferior quality of functional balance, in the post-test.

Table 2. Descriptive Statistics for Condition

		Minimum	Maximum	Mean	SD
Fatigue Condition					
Tape	(cm)	.40	9.56	3.56	2.61
Brace	(cm)	-3.30	8.16	2.29	3.57
Non-Fatigue Condition					
Tape	(cm)	-1.23	8.31	3.42	2.85
Brace	(cm)	-.02	9.45	3.18	2.34

Hypothesis: The use of a lace-up style brace will allow for better dynamic balance compared to tape as scored on the SEBT following a fatigue protocol.

Conclusion: The within-subjects repeated measures ANOVA was calculated comparing the two levels of prophylactic bracing conditions (lace-up brace and Johnson and Johnson Coach® Athletic Tape). No significant effect was found ($F(1,14) = 1.309$, $P \geq .05$).

Additional Findings

An additional repeated measures ANOVA was performed to examine the relationship among SEBT post-test scores and gender. There was no significant difference between gender for post-test SEBT scores ($F(1,14) = .360$, $P \geq .05$). The

mean for females was not significantly different (m = 2.718) than the males (m = 3.566), and the mean difference between the two groups was (m = .849). The average number of run-throughs each subject completed before reaching a point of fatigue was from three to five complete cycles. Fatigue time ranged from 57 seconds to one minute, fifteen seconds.

DISCUSSION

The following section is divided into three subsections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

The primary purpose of this study was to determine the effects of a functional fatigue protocol on dynamic balance while utilizing a prophylactic bracing technique (semi-rigid lace-up ASO brace) and tape. The researcher wanted to investigate this topic, as some controversy still exists on what preventative method for ankle injuries is most effective in providing stability and preventing ankle and lower extremity injuries. No significant differences were found between condition (tape and brace) following fatigue, non-fatigue conditions on balance as measured by the SEBT. This finding between brace and tape in a fatigue, non-fatigue condition on functional balance extends and is consistent with findings of previous studies.[5,8,20,21] Nonetheless, the use of a lace-up style brace was assumed to allow for better dynamic balance compared to tape as scored on the SEBT following a fatigue protocol. While the

results did not support the hypothesis that the lace-up brace would allow for better dynamic balance when compared to tape after fatigue, all second reaches were further in brace and tape condition when comparing the results of pre- and post fatigue. To note, a majority of the subjects stated that they worked harder on the second reach to exceed their original reach indicating that some form of visual feedback may have been used. Two components of visual feedback could potentially contribute to these second reaches including information about the position of the reach leg and the distance from which the subject had reached on the pre-fatigue condition.

These findings were similar to Gribble et al[8] who tested subjects with chronic ankle instability also showing no statistical significance for the influence of ankle brace application when testing dynamic postural stability with a time to stabilization technique. Wikstrom et al[20] also reported that when testing a semi-rigid and soft brace using a jump-landing protocol there was no significant difference observed between braced and no-braced conditions for any of their measures of dynamic stabilization in the anterior/posterior and medial/lateral directions in subjects with functionally unstable ankles. The components

of dynamic stability do not appear to be improved with the application of the ankle support.

Hardy et al[5] performed a study comparing three brace types, un-braced, semi-rigid, and lace-up using a SEBT. Their results were similar to the present study in showing that the bracing condition had no effect on any of the Star Excursion Balance Test directional measures. The actual reach differences due to bracing were less than 5.08 cm in length. They concluded that neither braces actually diminished dynamic balance when compared to the control condition (no brace).

Another study comparable to our results performed by Cordova and Takahashi et al[21] tested ankle range of motion for ankle-joint displacement with videography during drop-landing trials under three conditions (un-braced, semi-rigid, and tape). There were no differences observed between the tape and semi-rigid brace conditions when testing ankle range of motion. Their study revealed that not only did the ankle tape significantly restrict ankle-joint range of motion, but so did a semi-rigid ankle brace when performing a 1-legged drop landing.

It was expected that there would be a difference among brace conditions in SEBT directions due to previous findings that showed restricted ROM with semi-rigid and

lace-up ankle braces. The multidirectional nature of the SEBT and lack of significant findings in this study may suggest that performance on a dynamic balance task is maintained regardless of whether tape, brace, or nothing is worn as supported by the findings above. Athletes and physically active individuals vary in their opinions on which brace provides more stability and preventative measures to the lower extremity. How an athlete feels about a prophylactic ankle device is very important as well. To eliminate the chance of brace discomfort due to improper fitting, the researcher fit all braces to the subjects according to the manufacturer's instructions.

Conclusion

This study revealed that prophylactic bracing was no different than taping following a fatigue protocol in physically active healthy individuals demonstrating CAI. Also, reaching farther on all second tests may be the nature of balance tests using this method. In this case, the certified athletic trainer can inform the athlete or physically active individual that taping and/or bracing may have the same effects on dynamic stability and potentially, injury prevention, whether they are fatigued or not.

Recommendations

It is important for the certified athletic trainer to understand that a prophylactic device or tape can be worn during sports to provide support and possibly prevent injury. Though the present study may not show effectiveness, the results of this study may provide an essential direction in examining the importance of muscle re-education following an initial ankle injury. Testing various brands of prophylactic braces on diverse populations could be done to compare the results. For example, using specific athletes and sports, performing on different age groups, or use in high schools vs. college sports. Since this study created an acute fatigue condition, another recommendation is to do twenty minutes of activity or more for the fatigue portion to see if it's more effective in tape losing its motion limiting properties. This should be done to see if the tape will still produce the same results as when it has its motion limiting properties. Testing for use in sports such as soccer and ice hockey that have more long term fatigue may produce different results. The results from this study might help certified athletic trainers choose prophylactic

devices and taping methods better for injury prevention during activity.

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APPENDICES

APPENDIX A

Review of Literature

Ankle pathologies are among the most prevalent injuries treated by athletic trainers. As a result, there have been many techniques used over the years to help prevent injury and re-injury to the ankle joint. The use of prophylactic ankle braces by the athletic population to help stabilize an unstable or previously injured ankle joint has become one of the most popular methods. It is understood that after a repetitive or exhausting workout the mechanical stabilization provided by braces can decrease, potentially allowing an increase in ankle displacement. Literature shows that semi-rigid and rigid braces are the most common form of ankle orthosis used for injury prevention due to the fact that tape has been shown to lose its rigidity over time.

The purpose of this literature review is to evaluate the effects of fatigue on support while wearing two different brace types including tape and lace-up on individuals termed with chronic ankle instability. The topics that will be discussed include; 1) Chronic Ankle Instability, 2) Use of Prophylactic Support, 3) Balance Testing and 4) Summary.

Chronic Ankle Instability

Chronic ankle instability (CAI) is due to repeated disruptions to ankle integrity which causes altered mechanical joint stability.[1] CAI can result in perceived and observed deficits in neuromuscular control.[1] The majority of ankle injuries occurs on the lateral aspect of the ankle joint that can result from the motions of inversion and plantarflexion.[1-3]

Ankle Anatomy

Bones that make up the ankle are the distal end of the tibia and fibula as well as the talus, and calcaneus.[4,5] The inferior tibiofibular joint, the talocrural joint, and the subtalar joint are made up by the articulations between these bones. The amount of force that the fibula is said to transmit through the body is anywhere from 0 to 12%, a much smaller percent than the tibia.[6] The primary joint of this region which endures the most weight bearing and force absorption is the talocrural joint.[4,5] The talocrural joint is a synovial hinge joint and allows for one degree of freedom or planar movement, dorsiflexion and plantarflexion and is considered the main ankle joint. Laxity of this joint is found in 75% of subjects with a history of ankle

sprains.[25] The subtalar joint allows for the movements of eversion and inversion of the ankle as well as pronation and supination in the weight bearing position, also only one degree of movement in the transverse plane.[4,6] Due to the subtalar joint and talocrural joint working in close quarters, laxity in one leads to laxity in the other in two-thirds of those with ankle instability.[25] Following an injury to the ankle, ligaments can become more lax and ultimately lead to more ankle injuries and chronic instability.[3,5,7]

Static stabilization of the ankle joint is provided by the ligaments of the ankle, and is often a point of injury. The tibia provides an extensive site for medial ligament attachment, in particular, the deltoid ligament. The function of this ligament is to resist eversion of the ankle. The most familiar and well-known ligaments are the tibiofibular ligaments, which secure the tibia and fibula together. The tibiofibular joint has a fibrous structure known as the interosseous membrane that provides the union between these two structures.[31] Lateral attachments of ligaments for the ankle originate off the distal fibula.[26] Lateral ligaments consist of the posterior talofibular ligament (PTF), anterior talofibular (ATF), and calcaneofibular (CF) ligaments which attach the fibula to

the calcaneous.[6,26] The anterior talofibular ligament is the most anterior lateral of the three and is also the most frequently injured followed by the calcaneofibular, which sits between the three ligaments. The least often injured is the posterior talofibular ligament. The deltoid and lateral ligaments work to provide support to the talocrural and subtalar joints.

The combinations of motions that occur at the ankle complex are considered its functional anatomy. When in a weight bearing position during inversion, the ankle joint goes into further inversion due to the anatomy and the forces being applied to it, creating an explanation as to why most injuries occur to the ankle when put in this position. When there is any injury to the ankle, it can cause difficulty in performing the motions and will lead to ankle instability. Alterations in normal biomechanics can then cause injury to other areas of the body due to the relationship one part of the body has with another part of the body.[31]

Injuries to the Ankle

There are various ankle structures that can be injured while participating in athletics. Common injuries include sprains, strains, and fractures, with sprains among the

most frequent. Sprains of the ankle represent 38-50% of sports injuries.[9] Nearly 85% of the ankle sprains that do occur are inversion ankle sprains and can range in their severity.[8,9] Inversion sprains occur when the ankle is inverted and plantar flexed causing damage to the anterior talofibular ligament, the calcaneofibular ligament, or both. Another mechanism of injury to the ankle is eversion and dorsiflexion, this forceful movement causes damage to the tibiofibular joint on the medial aspect of the ankle joint. A direct blow, compression, shear forces, rotational forces, or falling are mechanisms for a fracture to the ankle joint.

Beynnons et al[27] stated that the most common risk factor for ankle sprains is a previous injury or sprain. Sprains can often lead to chronic pain or instability of the ankle in 20 to 50% of cases.[10] This will mean increased risk for re-injury of that ankle. Individuals who are termed with CAI often experience frequent sprains, and episodes of “giving way”.[7] Risk factors that can contribute to initial or re-injury of an ankle include gender, height, weight, foot type, foot size, limb dominance, range of motion, muscle strength, functional instability, and laxity.[27] All of these factors are known as intrinsic factors because they are all values that an object

maintains within itself. Extrinsic risk factors are those that act outside of the body and act upon the body as a whole. The extrinsic risk factors for ankle injury are shoe type, duration of the activity, and position of the player.[27]

Functional instability is considered an intrinsic factor. This can be defined as the feeling of instability or recurrent ankle sprains due to deficits in the individuals proprioception or due to neuromuscular deficits. Functional ankle instability can cause chronic ankle instability, which in turn causes athletes to take longer to stabilize. Clinicians feel that the use of tape, semi-rigid brace, or a lace-up brace could be an effective way to prevent injury or re-injury to the athlete's ankles.[8] A criticism of tape is that the support it provides declines by 40 to 50% after approximately five minute of exercise. Ankle braces are easily retightened during exercise to avoid any loss of support to the injured ankle.[10]

Use of Prophylactic Support

One of the most common methods for preventing lateral ankle sprains is the use of external support, such as ankle

taping or bracing. Prophylactic comes from the Greek word for “advance guard” and defined as a preventative measure; in this case, a preventative measure for ankle sprains.[12] Several studies have followed the effects of ankle braces and tape for their general purpose in ankle injury prevention.[2,9-11,13-16,20-21] There have also been studies that have evaluated the use of these devices to prevent injury by decreasing range of motion or increase proprioception.[28]

Tape

One method of bracing for stabilization that is applied to the ankle to prevent injury or re-injury is tape. The ankle is the most commonly taped part of the body with but the lateral ligament complex of the ankle still being the single most frequently injured structure during athletic activity.[29] Used in a variety of sports, tape offers mechanical support and increases proprioception.[9,10] Tape can be a costly tool because it must be re-applied daily. Unlike tape, a semi-rigid or rigid bracing technique can be reused. It is questionable whether a taping technique can withstand the stressors of fatigue and time while continuing to supply the same amount of support. According to research, tape is quite effective

in limiting ankle range of motion but loses most of these effects after about twenty min of exercise.[10-11,29]

Refshauge et al[13] studied whether taping the ankle would help improve the detection of inversion and eversion movements at the ankle, to possibly reduce the instance of injury.[13] They concluded that the use of tape to prevent, or have any effect on the movement of the ankle into plantar flexion and inversion, had little effect. The tape was shown to loosen after a period of exercise which actually hindered the ability of the individual to detect the ankle movement and correct it before injury occurred.[13]

Lohkamp[14] assessed individual's postural stability with and without tape following a stint of fatiguing on a treadmill. The stability test was performed so that the subject would have to respond quickly to sudden ankle plantar flexion and inversion (the same movements for a lateral ankle sprain) during a single leg stance. The effects of the tape after the prolonged exercise decreased. The reaction time to stabilization was significantly longer, the longer the exercise was performed. As a result, the researchers concluded that fatigue had a negative effect on the joint position sense, seeing as it took longer for stabilization to attain.[14]

The aim of another study was to compare the results of the effectiveness of a reusable ankle brace vs. athletic tape in its ability to restrict ankle inversion before and after exercise.[15] The subjects were tested before and after an exercise period as seen in the previous studies, to determine any differences in the tape or braces' ability to restrict the movement of ankle inversion.[15] Results showed that both the tape and the lace-up brace were effective in restricting movement better than no prophylaxis at all.[15] Post exercise showed little difference in the taping and bracing style that was not significantly different to the study.[15] Both were still effective in restricting inversion range of motion of the ankle pre and post exercise.[15]

The effectiveness of tape on limiting motion shows no significance and exercise times before tape loses its motion limiting properties do vary.[29] The main purpose of the taping method is to limit excessive range of motion, prevent injury, and increase mechanical support of the ankle.[29]

Semi-rigid and Lace-up Braces

Braces are another common method of ankle injury prevention. The application of these braces may vary from tie-on, straps, slide-on forms, or a combination of all applications. Semi-rigid and lace-up braces have been tested under several conditions and have continued to show more effective to ankle stability then tape alone.[12-14] This is due to the fact that braces do not loosen as the taping can after exercise. Also, the braces offer different sizes and different levels of stability so that you can adjust the tightness of the brace according to pain level or the amount of swelling that may have accrued following an injury.

Some studies have compared the effectiveness of soft braces (lace-up style) to semi-rigid braces to see which prevents injury better. Verhagen et al[30] tested the effects of brace, tape, and shoes on ankle range of motion. Ankle taping, non-rigid braces, and semi-rigid braces all showed significant ankle ROM restriction following exercise. On the other hand, only the semi-rigid bracing retained significant restriction after a certain amount of exercise, while the other two measures showed loosening over time.[30]

Cordova and Dorrough[16] performed a study using the three different bracing methods, semi-rigid, lace-up, and a

control group (no brace at all). Average angular displacement as well as the average angular velocity of the ankle using a motion analysis system was tested. Results showed that the semi-rigid brace had significantly reduced rear foot angular displacement and the angular velocity compared with the controlled conditions as well as the lace-up style which also showed less rear foot angular displacement and velocity when compared to the control condition.[16] The study also showed that both the semi-rigid and the softer lace-up brace significantly restricted inversion angular displacement by 61% and 46% when they are compared with the control condition during a sudden inversion.[16] The semi-rigid condition demonstrated a 38% reduction in inversion motion when it was compared with the lace-up brace.[16] Both studies indicate that the semi-rigid brace would be preferred to the lace-up, but that the lace-up is preferred to no brace at all in the goal of restricting rear foot motion and angular velocity.

Just as with tape, research has supported the idea that bracing reduces risk of injury by providing support, which limits excessive range of motion and enhances proprioception. This idea and use of prophylactic tape/bracing for injury prevention has become more popular over the years due to cost effectiveness. The comfort of a

brace depends on foot structure and type of brace used as the semi-rigid braces contain hard inserts while the soft braces are a canvas lace-up or strap on form.[31]

Balance Testing

Balance is the most important factor dictating strategies of movement within the closed kinetic chain.[17] Ability of balance is necessary for general life activity as well as for athletic performance. Balance is defined as the ability to maintain the body's center of gravity (COG) within the base of support provided by the feet.[17]

Types of Balance Tests

There are several ways to measure balance including the Biodex Balance System (BBS), Romberg test, Star Excursion Balance Test (SEBT), and Balance Error Scoring System (BESS).[17] Balance is commonly categorized as static and dynamic. Static balance means sustaining the center of mass over a motionless base of support, such as maintaining balance during quiet stance.[23] Dynamic balance is defined as maintaining a center of mass over the bass of support while the base of support is moving or there is an external affect to the body that causes a shift in the base of

support.[7,18,19] Functional balance is another form of balance that is analogous to dynamic balance with the addition of sport-specific tasks such as throwing and catching.[17]

Dynamic postural-control tasks require a greater degree of corresponding movement patterns using contributions from several joints.[22] This is an important aspect for the physically active population due to the fact that several of the movements relate to an athletic event or competition and maintaining equilibrium can increase function and ability of the athlete to perform at their best level. As a theory of motor learning, dynamical systems states that sensorimotor system organization involves an interaction of a variety of variables including task, environment, and organism.[7] When the dynamic is changed by these constraints, a new pattern is developed by higher brain-center inputs and peripheral inputs for the different conditions.[7]

Drop Landing

The primary mechanism of many lower extremity injuries that occurs in many sports is the task of landing from a jump. Drop landings are a common test performed to determine the dynamic balance and stability of the ankle under several conditions.[20] The jumps are good tools when

attempting to measure ability to absorb forces at the ankle joint. It is an option to allow a force platform to determine the position of the ankle and how long it takes for the ankle to maintain a state of stability after a drop jump from a certain height. This is a more functional test compared with the long-established postural control measures because it works to simulate a functional technique for assessing the effects of fatigue on neuromuscular control and dynamic stability.[2]

Wikstrom et al[32] used subjects with functional ankle instability to determine a Dynamic Postural Stability Index (DPSI) while wearing semi-rigid, rigid, and no brace after a two-legged jump to the height equivalent to 50% of their maximum vertical jump and land on a single leg. Though they expected to find these devices improve proprioception and dynamic postural stability, it was shown that dynamic postural stability was not improved during the jump protocol under either the soft or semi-rigid brace conditions over the no-brace condition. It was not known from this study that ankle bracing could improve the dynamic stability when the participant is fatigued.

An example of this drop landing procedure was performed in a study by Cordova et al (2010) utilizing 13 healthy subjects that were active in recreational

basketball.[16] The subjects were asked to perform a one legged drop landing from a standardized height under three different ankle-support conditions.[16] They were then instructed to perform five landing trials under each of the three ankle supports including a semi-rigid brace, no brace, and ankle taping.[16] The data was collected using a force platform as used in other studies. The results showed that there was significantly less ankle joint ROM under both conditions.[16] There were also no differences reported between the tape and the semi-rigid brace conditions. The study was also able to conclude that the ankle tape significantly restricted ankle-joint ROM as well as the semi-rigid ankle brace when the subjects are performing a one-legged drop landing.[16]

Star Excursion Balance Test

The star excursion balance test is a measure of dynamic postural control where the individual maintains a stable base of support while they complete a given movement, in this case, a star pattern on a grid platform.[18,21] This is a functional test of dynamic balance that challenges an individual's LOS and has high intratester and intertester reliability.[17] SEBT is used as a tool to assess or screen for musculoskeletal impairments

including chronic ankle instability which has demonstrated a decrease in anterior reaching distance when compared to uninjured control subjects.[18] It assesses maximum reach with one leg while maintaining a base of support with the other leg.[22]

In Hardys'[21] study of prophylactic ankle braces and the star excursion measures, they use an SEBT multidirectional test to study and record dynamic balance.[21] Dynamic postural control places added demands on proprioception, ROM, and strength in order to perform the tasks and maintain balance.[18] The eight directions marked on the grid included A, AM, M, PM, P, PL, L, and AL. [18,19,21] Each of the directions are placed at a 45° angle to the next direction.[2,18,19,21] Reach distances were then measured to the nearest 0.5 cm and recorded for each of the directions.[22] Leg length of each individual will correlate with the reach distance as well because understandably, a longer limb would give an advantage in a further reaching distance.[18] To eliminate this factor, leg length of each subject will be recorded and the means of SEBT will be divided by the leg length in order to normalize performance data. Hertels'[19] stated that if and when the examiner feels as though the reach foot provided too much stability to the testing limb, if equilibrium was lost, or the stance foot

was lifted from its place on the center grid then the trial must be discarded and repeated.[19]

Single-limb dynamic balance can be assessed in multiple directions using the SEBT. Participants assume a single-leg stance and reach as far as possible in eight directions, thereby challenging their dynamic balance. If plantar-flexion and dorsiflexion are limited by a lace-up style brace, reach in the anterior and posterior SEBT directions may be limited. Similarly, if inversion and eversion were restricted by a semi-rigid brace, we expect to see decreased performance in the medial and lateral SEBT directions (Hardy). By demonstrating that CAI subjects could not reach as far as the non-CAI subjects while maintaining a stable base of support, previous researchers have established the SEBT as valid in differentiating the dynamic postural control of those with and without CAI.[1]

Effects of Fatigue

Fatigue can impair the proprioceptive and kinesthetic properties of joints, including the ankle joint.[1,7] Adding fatigue can increase the threshold of muscle spindle discharge, which in turn disrupts the feedback and alters joint awareness.[1,3] There have been studies performed where the researchers used different measures of postural

stability which can account for the difference in results when testing CAI and single-leg stance.[1,7,13,23,32] Neuromuscular patterns that are necessary to complete a dynamic balance test and these patterns would appear to be altered in the presence of CAI.[1]

Shaw et al[2] compared dynamic stability using time to stabilization among Division I volleyball players wearing a lace-up brace and a semi-rigid brace prior to and after induced fatigue. After fatigue of the subjects, dynamic stability was determined better when wearing the lace-up brace. This suggests some ankle bracing may have positive influences on dynamic stability when fatigue is introduced to excite a high level of physical activity.

Summary

The majority of ankle injuries occurs on the lateral aspect of the ankle.[1-3] Ligaments of the lateral ankle originate from the distal fibula and consist of the posterior talofibular, anterior talofibular, and calcaneofibular ligaments.[6] Repeated injuries to the ankle can lead to chronic ankle instability which may be reduced by taping/bracing. Literature has indicated that tape loses its rigidity and stability over time with activity

due to loosening up or absorbing sweat, which in turn, causes it to lose its stability purposes.[13,14] Tape offers little or no support to the ankle for better correction of movement following a pattern of ankle injury after a fatigue protocol has been performed.[2,10] Semi-rigid and lace-up bracing has been tested under several conditions and has shown to be more effective to ankle stability than tape alone.[13-15] With the use of prophylactic bracing, it is proposed that dynamic balance will be enhanced after a functional fatigue protocol.

Dynamic balance is an important aspect for the physically active population due to the fact that several of the movements relate to an athletic event or competition and maintaining equilibrium can increase function and ability of the athlete to perform. There are several ways to measure balance including the Biodex Balance System (BBS), Romberg test, Star Excursion Balance Test (SEBT), and Balance Error Scoring System (BESS).[17] The SEBT is reported valid and reliable tool used to assess or screen for musculoskeletal impairments including chronic ankle instability which has demonstrated a decrease in anterior reaching distance when compared to uninjured control subjects.[18] It is a test that has demonstrated high reliability for testing functional balance.[18,19,22] Tape and

a measuring tape are the only tools needed to administer the test.

With the added support of colleague's experimental research and the increased knowledge on the effectiveness of bracing injured ankles, advances towards the use of prophylactic bracing over taping techniques for injury prevention can be established. It is important to clarify the advantages and disadvantages of prophylactic bracing and taping techniques following a functional fatigue protocol to better simulate their use in an athletic competition or recreational athletic setting.

APPENDIX B

The Problem

THE PROBLEM

Statement of the Problem

Ankle injuries are common in sports and prevention of these injuries has been well studied over the years. Clinicians have turned to the use of preventative measures such as prophylactic ankle braces to prevent the injury or re-injury of the ankle. In general, the literature suggests that bracing is suggested to be more effective than the taping method due to the fact that tape can loosen with time and fatigue of the tape causing a decrease in the limiting properties of the brace itself. The purpose of this study is to determine what affects a functional fatigue protocol would have on dynamic balance when using bracing versus taping techniques.

Definition of Terms

The following definitions of terms were defined for this study:

1) Ankle Instability Instrument (AII) – the AII determines whether a participant reports CAI (chronic ankle instability.[34] AII has been observed to be a reliable measure of self-reported CAI.[34]

2) Balance – the body’s ability to maintain its center of gravity within the base of support.[39]
3) Dynamic Balance - dynamic balance means that the subject is maintaining a center of mass over the bass of support while the base of support is moving or there is an external affect to the body that causes a shift in the base of support.[39,38,36]
4) Fatigue protocol - a test performed to fatigue the lower extremity and prophylactic brace before and following a SEBT.[31]
5) Physically active – an individual who currently performs physical activity for 20 min at least three times a week.
6) Prophylactic device - a device that is applied to the ankle to provide support and increase stability as well as help with prevention of injury or re-injury to the ankle.[12]
7) Star Excursion Balance Test (SEBT) – dynamic balance test that the subject performs with their reach leg in five directions: A, AM, M, PM, P.[38,36]

Basic Assumptions

The following were basic assumptions of this study:

1) All participants will fully understand the instructions provided and give a maximum effort during testing.
2) The subjects will be honest in completing the demographics form provided.
3) The subjects will perform to the best of their ability during the fatigue and star excursion testing periods.
4) The star excursion balance test will be a valid and reliable tool to measure the stabilization of the brace prior to and following the fatigue protocol.
5) Testing instruments are valid and reliable tools for measuring the dependent variables.
6) All subjects will volunteer with no coercion from coaches or faculty.

Limitations of the Study

Test results can be generalized for only the NCAA Division II collegiate athletes and physically active adults. Since the testing was done in the lab, the results could represent assumptive functional measures of balance.

Significance of the Study

The scope of this study was to examine the effects of a functional fatigue protocol on dynamic balance while utilizing a prophylactic ankle brace or taping technique. Dynamic balance will be determined using an SEBT. Chronic ankle instability is modified mechanical joint stability due to recurring disruptions to ankle integrity with secondary perceived and observed insufficiency in neuromuscular control.[37] In order to reduce these instances of injury it has been recommended to use a prophylactic ankle brace or taping technique.[29,26] This bracing or taping method assists in limiting ankle range of motion that results in lateral ankle sprains.[29,26] The evidence has provided that the SEBT is a sensitive test for screening musculoskeletal impairments such as chronic ankle instability.[38] Previous research has found effects of functional fatigue on drop landings or SEBT using no brace or lace up brace conditions but none have focused on the comparison of tape versus brace conditions following the same functional fatigue protocol. This information may assist athletic trainers and conditioning coaches as well as the general public which is physically active in determining what form of prophylactic bracing or taping

technique would be more beneficial to preventing injury or re-injury.

APPENDIX C

Additional Methods

APPENDIX C1

Data Collection Sheet

Data Collection Sheet

Subject #_____ Date _____

Age: _____ Gender: _____

Chronically Unstable Ankle: R / L

Maximal Vertical Jump Height _____

Leg Length _____

□ NCAA athlete

□ Physically active/recreational athlete

SEBT TEST SCORES SHEET

Subject #

Test 1 Pre-Fatigue	Tape Reach Dist (cm)	Post-Fatigue	Tape Reach Dist (cm)
A		A	
AM		AM	
M		M	
PM		PM	
P		P	
PL		PL	
L		L	
AL		AL	

Test 2 Pre-Non Fatigue	Tape Reach Dist (cm)	Post- Non Fatigue	Tape Reach Dist (cm)
A		A	
AM		AM	
M		M	
PM		PM	
P		P	
PL		PL	
L		L	
AL		AL	

Test 3 Pre-Fatigue	ASO Brace Reach Dist (cm)	Post-Fatigue	ASO Brace Reach Dist (cm)
A		A	
AM		AM	
M		M	
PM		PM	
P		P	
PL		PL	
L		L	
AL		AL	

Test 4 Pre-Non Fatigue	ASO Brace Reach Dist (cm)	Post- Non Fatigue	ASO Brace Reach Dist (cm)
A		A	
AM		AM	
M		M	
PM		PM	
P		P	
PL		PL	
L		L	
AL		AL	

APPENDIX C2
Informed Consent Form

Informed Consent Form

1. Mallory Bieringer has requested my participation in a research study at this institution. The title of the research is *The Effect of Fatigue on Balance in Ankle Tape VS Lace-up Brace Conditions Using a Star Excursion Balance Test.*

2. I have been informed that the purpose of the research is to examine the effect of fatigue on a dynamic balance test under two conditions, tape and brace, in NCAA Division II collegiate athletes and physically active volunteers 18 years of age and older, enrolled at California University of Pennsylvania.

3. My participation in this study will involve the SEBT for dynamic balance testing. I will report to the laboratory on 4 separate occasions, a minimum of three days apart. Determination of my maximum vertical jump will be done using a Vertec jump training system and I will be given three trials to do so. I will then perform a pre test of the SEBT with either a tape or brace condition. Following the pre test, I will either be asked to remain inactive or perform a functional fatigue protocol consisting of three stations. Three stations of this functional fatigue protocol include the Modified Southeast Missouri agility drill, stationary lunges, and quick jumps. After I have performed the functional fatigue protocol or remained inactive for the same time period as the functional fatigue protocol would take, I would be re-tested with the SEBT while still wearing the brace or tape condition. All of the testing will be conducted on one day in the athletic training room in Hamer Hall for approximately one hour for each subject.

4. I understand there are foreseeable risks or discomforts to me if I agree to participate in the study. The possible risk is falling during the functional balance testing using the SEBT where risks can be decreased by using the researcher as a spotter for myself. Any injuries that may occur during the balance testing can be treated at the athletic training room at Hamer Hall provided by the researcher, Mallory Bieringer. This risk is no more

than normal physical activity that normal physically active individuals would be exposed to during daily activities.

5. There are no viable alternative procedures available for this study.

6. I understand that the possible benefit of my participation in the research is contribution to existing research and may aid in understanding which condition, brace or tape, is more effective for dynamic balance using the SEBT following a functional fatigue protocol.

7. I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Mallory Bieringer will maintain all documents in a secure location in which only the student researcher and research advisor can access.

8. I have been informed that I will not be compensated for my participation.

9. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by

Student Researcher:	Graduate Faculty Thesis Advisor:
Mallory Bieringer PO BOX 204 Roscoe, PA 15477 734-347-1993 Bie0029@calu.edu	Rebecca Hess, Ph.D. B6 Hamer Hall California University of Pennsylvania California PA, 15419 724-938-4359 Hess_ra@calu.edu

10. I understand that written response may be used in quotations for publication but my identity will remain anonymous.

11. I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my

consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me upon request.

Subject's
Signature_____Date_____

12. I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in theis research study, have answered any questions that have been raised, and have witnessed the above signature.

13. I have provided the subject/participant a copy of this signed consent document if requested.

Investigator's
Signature_____Date_____

Approved by the California University of Pennsylvania IRB:

Start date _02_/_04_/__2011__, End Date: _02_/_03_/_2012__

Appendix C3

Fatigue Protocol

Three stations were used in the fatigue protocol including a Modified Southeast Missouri agility drill (SEMO), stationary lunges, and quick jumps with the use of data collected from the subjects' vertical jump height.

The SEMO was composed of a series of forward sprints, side shuffles, and back peddling.[4] The SEMO was completed in a rectangle of 12 X 19 ft (3.6 X 5.7 m) as performed in Shaw and Gribble's study due to testing space. Following this station the subjects immediately began the stationary lunges that were timed with a metronome. The distance of lunge was determined by the measures of the subject's true leg length from the anterior superior iliac spine to the distal portion of the medial malleolus prior to the protocol. Each lunge was performed five times equaling ten lunges total with alternating lunge legs.[4] One lunge was performed every two seconds using a metronome.[4] Starting with their feet together they would step forward with their lunging leg and place their leading foot firmly on the ground. Subjects had to avoid any sideways tilting or swaying in the upper body and bring the lower body to a position where the front thigh became parallel with the floor during hip and knee flexion, while maintaining an upright torso. They would then return to standing position

while their hands remained on their hips. Proper technique was critical to fatigue the individual.

Finally, as the last step of the fatigue protocol, the subjects performed 10 quick jumps. To set up this station, the individuals maximal vertical jump height was recorded using the Vertec™ vertical jump tester. This system measures from 6 to 12 feet with color-coded vanes that offer half-inch measurements for immediate feedback. First, the subjects' standing height was measured by standing under the Vertec™ vertical jump tester and reaching up to touch the highest point possible while maintaining both feet flat on the ground. Second, participants performed a two-footed maximal vertical jump reaching to the highest point possible on the Vertec™. From Shaws'[4] study each participant was given three jump trials to determine their greatest jump height, that height was then recorded.[4] The standing reach height was then subtracted from the individuals maximal vertical jump height in order to get their $Vert_{max}$.[4] The quick jumps were performed double legged with both arms above the head reaching for a distance that was 50% of their $Vert_{max}$ previously recorded. This was done ten times reaching for a tape placement on the wall for the subject to hit each time with both hands.[4] Again, correct form was critical for

fatigue to be reached and if the form was not correct, the jump was not counted. If the tape was not touched with both hands, the jump was not counted. Each subject was able to establish a baseline time with the first testing session to determine fatigue in the subsequent testing trials. Participants continued to complete each station until the time to finish the stations increased by 50% when compared to their baseline times.[4]

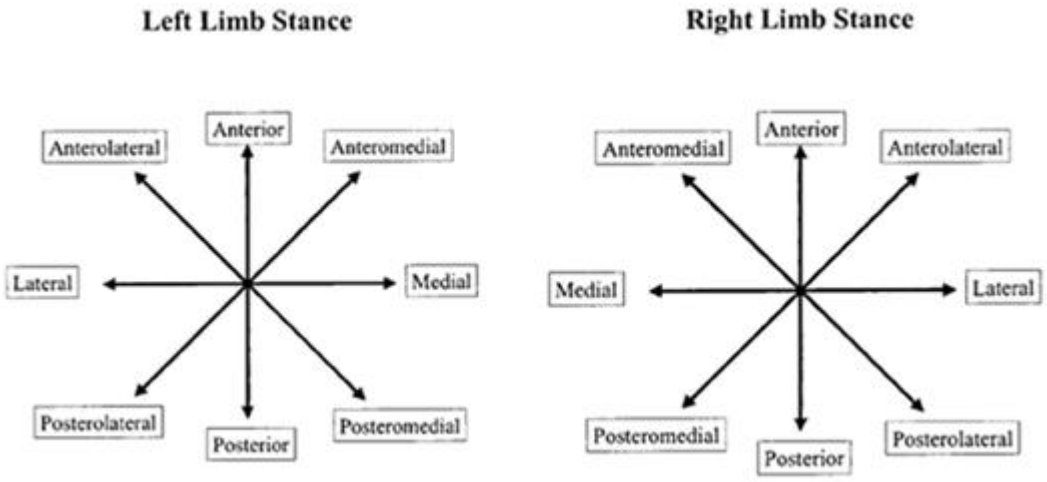
Stationary Lunges

Quick Jumps

Appendix C4

Pictures of SEBT

Star Excursion Balance Test (SEBT)



(http://www.efdeportes.com/efd135/upper-body-exercise-on-dynamic-postural-control.htm)

APPENDIX C5

Institutional Review Board

California University of Pennsylvania

Proposal Number

Date Received

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title ***The Effect of Fatigue on Balance in Ankle Tape VS Lace Up Brace Conditions Using a Star Excursion Balance Test on Chronically Unstable Ankles***

Researcher/Project Director ***Mallory Bieringer***

Phone # ***734-347-1993*** ***E-mail Address*** ***bie0029@calu.edu***

Faculty Sponsor (if required) ***Dr. Rebecca Hess***

Department ***Health Science***

Project Dates ***January 2011*** ***to*** ***May 2011***

Sponsoring Agent (if applicable) _____

Project to be Conducted at *Athletic Training Room and B5 laboratory room in Hamer Hall at California University of Pennsylvania*

Project Purpose: ☒ ***Thesis*** ☐ ***Research*** ☐ ***Class Project*** ☐ ***Other***

Keep a copy of this form for your records.

Approved, September 12, 2005 / (updated 02-09-09)

Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(ses)or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.*

The purpose of this study will be to examine the effects of fatigue on dynamic balance using the star excursion balance test (SEBT) with 2 different prophylactic ankle bracing techniques. National Collegiate Athletic Association (NCAA) Division II collegiate athletes and physically active students attending California University of Pennsylvania with chronic ankle instability are expected to participate in this study (N~15). Subjects that have completed the ankle instability instrument and are termed physically active may volunteer for this study. Each subject who will sign the informed consent form (attached) will have to complete a functional fatigue protocol and functional balance test using the SEBT. Each subject who met the criteria will begin in either a brace or taped condition and perform the SEBT followed by a functional fatigue protocol or a resting period equal to that of the fatigue protocol. The subjects will be tested once more following the resting period or functional fatigue protocol to compare the results of the SEBT. The order of testing will not be randomized due to non-fatigue time having to equal fatigue time of each separate individual. Each subject will perform practice trials for all aspects of the study as recommended in the literature. This will allow for each subject to become familiar with the test as well as to minimize any learning effects. Pictures of the SEBT are attached.

Before the SEBT, each subject's leg length will be measured bilaterally in centimeters as the distance between the anterior superior iliac crests and the medial malleolus to normalize the SEBT score. The subject will report the chronically unstable ankle being tested after filling out the ankle instability instrument. The SEBT uses a star on the floor with eight lines extending at 45 degree increments from the center of the grid. The subject will stand on the unstable ankle while placing the heel of the foot on the center of the star and hold the hands on their hips. Then the subject will reach with the opposite leg to touch as far as possible along the chosen line. The subject will touch the farthest point possible on the line with the most distal part of their reach foot. The subject then returns to a bilateral stance while maintaining equilibrium. The subject will perform three bouts of practice trials for a warm up followed by one test trial in each of five directions depending on the testing limb. If a subject loses their balance during a trial, they will be asked to repeat the trial and the miss trial will be discarded.

Following the initial SEBT with the tape or brace technique on the chronically unstable ankle each subject will perform a funcitonal fatigue protocol or rest for the time it would take to perform the fatigue protocol. This fatigue protocol is made up of three separate stations including a Modified Southeast Missouri agility drill, stationary lunges, and quick jumps. Prior to performing the functional fatigue protocol each subjects maximum vertical jump will be recorded using a Vertec jump training system. The subjects will perform a two footed maximal vertical jump reaching for the highest bar they can, their vertical reach height will then be determined by subracting their vertical reach height from their jumping height. This height will be used for the quick jump portion of the fatigue protocol. Lunging distance will be determined by leg length measurements from the ASIS to the medial malleolus. The Modified Southeast Missouri Agility Drill is composed of a series of forward sprints, side shuffle, and back peddling. Following this station the subjects will go right into the stationary lunges that will be timed with a metronome. The distance of lunge will be determined by the measures recorded and each lunge will be performed five times equaling ten lunges total. With the metronome, the lunges will be one lunge per every two seconds. Proper technique is key for the fatigue of the individual. For the final station of quick jumps the subject will reach for a distance equal to 50% of their maximal jump height ten times reaching for a tape placement on the wall. The subjects will each perform three warm up trials of the SEBT, and for the test trial, the distance from the center of the grid to the reach points will be measured and recorded on the data sheet . The average reach for the five directions will be recorded and will offer a score of each excursion performed.

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*

   a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

      The potential risks and/or discomforts are minimal include falling during the SEBT and the functional fatigue protocol as well as increased heart rate and breathing patterns. Any injury or discomforts that could occur during the fatigue protocol are the same risks the individuals make being physically active in their regular exercise routines. In the SEBT the researcher will additionally minimize the risk of falling by acting as a spotter to the subjects being tested. The researcher will monitor any changes in appearance or physical signs during the fatigue protocol as well. If an injury was to occur, the researcher will take care of the subjects as a certified athletic trainer in the Athletic Training Room in Hamer Hall.

   b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

      All subjects for this study will be volunteers who are eighteen years or older and are NCAA Division II collegiate athletes or physically active students at California University of Pennsylvania and who experience chronic ankle instability. Prior to the study, an informational meeting will be held with the potential subjects to explain the idea of the study in the absence of the coach or teaching staff. Any individual who suffers from any visual, vestibular, balance disorder, serious lower extremity injury and/or a concussion six months prior to the test, and/or currently suffering from lower extremity injury not be included in this study as these conditions may hinder an accurate balance assessment. This exclusion due to these medical conditions will be performed by the supervising Certified Athletic Trainer while maintaining patient confidentiality.

   c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

      An informed consent form (attached) will be competed and signed by all voluntary subjects before partaking in this study o n the day of testing. Each signed form will be held in reserve by the researcher.

   d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

      Data will be collected during the spring semester of 2011. All of the subjects will come in for four separate testing times, at least three days apart from one another, to perform a pre and post SEBT to the fatigue protocol or resting period. All collected data will be identified by subject number and will be maintained by the researcher in a secure location in which only the researcher and research advisor may gain access.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

☐ *Adult volunteers*	☐ *Mentally Disabled People*
☒ *CAL University Students*	☐ *Economically Disadvantaged People*
☐ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☐ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

4. *Is remuneration involved in your project?* ☐ *Yes or* ☒ *No. If yes, Explain here.*

5. *Is this project part of a grant?* ☐ *Yes or* ☒ *No If yes, provide the following information:*

   Title of the Grant Proposal _____

   Name of the Funding Agency _____

   Dates of the Project Period _____

6. *Does your project involve the debriefing of those who participated?* ☐ *Yes or* ☒ *No*

   If Yes, explain the debriefing process here.

7. *If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix___in the Policies and Procedures Manual.*

California University of Pennsylvania Institutional Review Board
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview or questionnaire?
☐ **YES**—Complete this form
☐ **NO**—You MUST complete the "Informed Consent Checklist"—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:

☐ (1) Statement about the general nature of the survey and how the data will be used?

☐ (2) Statement as to who the primary researcher is, including name, phone, and email address?

☐ (3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

☐ (4) Statement that participation is voluntary?

☐ (5) Statement that participation may be discontinued at any time without penalty and all data discarded?

☐ (6) Statement that the results are confidential?

☐ (7) Statement that results are anonymous?

☐ (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)

☐ (9) Statement that returning the survey is an indication of consent to use the data?

☐ (10) Who to contact regarding the project and how to contact this person?

☐ (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)

☐ (12) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)?

☐ (13) FOR ELECTRONIC/WEBSITE SURVEYS: Does the text of the cover letter or explanatory statement appear before any data is requested from the participant?

☐ (14) FOR ELECTONIC/WEBSITE SURVEYS: Can the participant discontinue participation at any point in the process and all data is immediately discarded?

California University of Pennsylvania Institutional Review Board
Informed Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview, or questionnaire?
☐ **YES**—DO NOT complete this form. You MUST complete the "Survey/Interview/Questionnaire Consent Checklist" instead.
☒ **NO**—Complete the remainder of this form.

1. **Introduction** (check each)
   ☒ (1.1) Is there a statement that the study involves research?
   ☒ (1.2) Is there an explanation of the purpose of the research?

2. **Is the participant.** (check each)
   ☒ (2.1) Given an invitation to participate?
   ☒ (2.2) Told why he/she was selected.
   ☒ (2.3) Told the expected duration of the participation.
   ☒ (2.4) Informed that participation is voluntary?
   ☒ (2.5) Informed that all records are confidential?
   ☒ (2.6) Told that he/she may withdraw from the research at any time without penalty or loss of benefits?
   ☒ (2.7) 18 years of age or older? (if not, see Section #9, Special Considerations below)

3. **Procedures** (check each).
   ☒ (3.1) Are the procedures identified and explained?
   ☒ (3.2) Are the procedures that are being investigated clearly identified?
   ☒ (3.3) Are treatment conditions identified?

4. **Risks and discomforts**. (check each)
   ☒ (4.1) Are foreseeable risks or discomforts identified?
   ☒ (4.2) Is the likelihood of any risks or discomforts identified?
   ☒ (4.3) Is there a description of the steps that will be taken to minimize any risks or discomforts?
   ☒ (4.4) Is there an acknowledgement of potentially unforeseeable risks?
   ☒ (4.5) Is the participant informed about what treatment or follow up courses of action are available should there be some physical, emotional, or psychological harm?
   ☒ (4.6) Is there a description of the benefits, if any, to the participant or to others that may be reasonably expected from the research and an estimate of the likelihood of these benefits?
   ☒ (4.7) Is there a disclosure of any appropriate alternative procedures or courses of treatment that might be advantageous to the participant?

5. **Records and documentation**. (check each)
   ☒ (5.1) Is there a statement describing how records will be kept confidential?
   ☒ (5.2) Is there a statement as to where the records will be kept and that this is a secure location?
   ☒ (5.3) Is there a statement as to who will have access to the records?

6. For research involving more than minimal risk (check each),

☒ (6.1) Is there an explanation and description of any compensation and other medical or counseling treatments that are available if the participants are injured through participation?

☒ (6.2) Is there a statement where further information can be obtained regarding the treatments?

☒ (6.3) Is there information regarding who to contact in the event of research-related injury?

7. Contacts.(check each)

☒ (7.1) Is the participant given a list of contacts for answers to questions about the research and the participant's rights?

☒ (7.2) Is the principal researcher identified with name and phone number and email address?

☒ (7.3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

8. General Considerations (check each)

☒ (8.1) Is there a statement indicating that the participant is making a decision whether or not to participate, and that his/her signature indicates that he/she has decided to participate having read and discussed the information in the informed consent?

☒ (8.2) Are all technical terms fully explained to the participant?

☒ (8.3) Is the informed consent written at a level that the participant can understand?

☒ (8.4) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)

9. Specific Considerations (check as appropriate)

☐ (9.1) If the participant is or may become pregnant is there a statement that the particular treatment or procedure may involve risks, foreseeable or currently unforeseeable, to the participant or to the embryo or fetus?

☐ (9.2) Is there a statement specifying the circumstances in which the participation may be terminated by the investigator without the participant's consent?

☐ (9.3) Are any costs to the participant clearly spelled out?

☒ (9.4) If the participant desires to withdraw from the research, are procedures for orderly termination spelled out?

☐ (9.5) Is there a statement that the Principal Investigator will inform the participant or any significant new findings developed during the research that may affect them and influence their willingness to continue participation?

☐ (9.6) Is the participant is less than 18 years of age? If so, a parent or guardian must sign the consent form and assent must be obtained from the child

- ☐ Is the consent form written in such a manner that it is clear that the parent/guardian is giving permission for their child to participate?
- ☐ Is a child assent form being used?
- ☐ Does the assent form (if used) clearly indicate that the child can freely refuse to participate or discontinue participation at any time without penalty or coercion?

☒ (9.7) Are all consent and assent forms written at a level that the intended participant can understand? (generally, 8th grade level for adults, age-appropriate for children)

California University of Pennsylvania Institutional Review Board
Review Request Checklist (v021209)

This form MUST accompany all IRB review requests.
Unless otherwise specified, ALL items must be present in your review request.

Have you:

☐ (1.0) FOR ALL STUDIES: Completed ALL items on the Review Request Form?
Pay particular attention to:

- ☐ (1.1) Names and email addresses of all investigators
  - ☐ (1.1.1) FOR ALL STUDENTS: use only your CalU email address)
  - ☐ (1.1.2) FOR ALL STUDENTS: Name and email address of your faculty research advisor
- ☐ (1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—NO EXCEPTIONS)
- ☐ (1.3) Answered completely and in detail, the questions in items 2a through 2d?
  - ☐2a: NOTE: No studies can have zero risk, the lowest risk is "minimal risk". If more than minimal risk is involved you MUST:
    - ☐ i. Delineate all anticipated risks in detail;
    - ☐ ii. Explain in detail how these risks will be minimized;
    - ☐ iii. Detail the procedures for dealing with adverse outcomes due to these risks.
    - ☐ iv. Cite peer reviewed references in support of your explanation.
  - ☐ 2b. Complete all items.
  - ☐ 2c. Describe informed consent procedures in detail.
  - ☐ 2d. NOTE: to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location ON UNIVERSITY PREMISES. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.
- ☐ (1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you MUST:
  - ☐ (1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.
  - ☐ (1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate ("assent").
- ☐ (1.5) Included all grant information in section 5?
- ☐ (1.6) Included ALL signatures?

☐ (2.0) FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

- ☐ (2.1) Attached a copy of all consent form(s)?
- ☐ (2.2) FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE: attached a copy of all assent forms (if such a form is used)?
- ☐ (2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)

☐ (3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

- ☐ (3.1) Attached a copy of the cover letter/information sheet?
- ☐ (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)
- ☐ (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

☐ (4.0) FOR ALL STUDENTS: Has your faculty research advisor:

- ☐ (4.1) Thoroughly reviewed and approved your study?
- ☐ (4.2) Thoroughly reviewed and approved your IRB paperwork? including:
  - ☐ (4.2.1) Review request form,
  - ☐ (4.2.2) All consent forms, (if used)
  - ☐ (4.2.3) All assent forms (if used)
  - ☐ (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)
  - ☐ (4.2.5) All checklists
- ☐ (4.3) IMPORTANT NOTE: Your advisor's signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.

☐ (5.0) Have you retained a copy of all submitted documentation for your records?

10

Project Director's Certification
Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature

Department Chairperson's Signature

Student or Class Research

Student Researcher's Signature

Supervising Faculty Member's Signature if required

Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

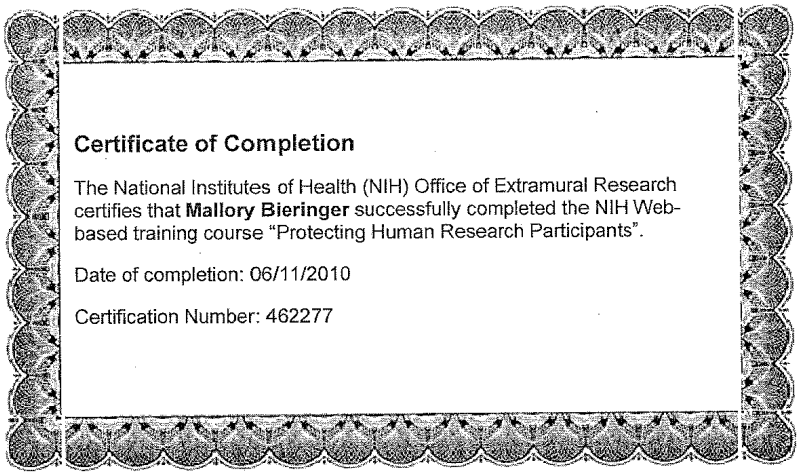
1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved[_____] ☐ Disapproved

Chairperson, Institutional Review Board

Date

Approved, September 12, 2005 / (updated 02-09-09)



Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Mallory Bieringer** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/11/2010

Certification Number: 462277

Institutional Review Board
California University of Pennsylvania
Psychology Department LRC, Room 310
250 University Avenue
California, PA 15419
instreviewboard@cup.edu
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP,Chair

Ms. Bieringer,

Please consider this email as official notification that your proposal titled " The Effect of Fatigue on Balance in Ankle Tape vs Lace Up Brace Conditions Using a Star Excursion Balance Test on Chronically Unstable Ankles" (Proposal #10-024) has been approved by the California University of Pennsylvania Institutional Review Board as submitted, with the following stipulation:

(1) The consent form must include a statement that participants must be over 18 years of age.

Once you have made this revision, you may immediately begin data collection. You do not need to wait for further IRB approval. [At your earliest convenience, you must forward a copy of the revised consent form for the Board's records].

The effective date of the approval is 02-04-2011 and the expiration date is 02-03-2012. These dates must appear on the consent form .
Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)
(2) Any events that affect the safety or well-being of subjects
(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).
(4) To continue your research beyond the approval expiration date of 02-03-2012 you must file additional information to be considered for continuing review. Please contact instreviewboard@cup.edu

Please notify the Board when data collection is complete.
Regards,
Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

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ABSTRACT

Title: THE EFFECT OF FATIGUE ON BALANCE IN ANKLE TAPE VS LACE UP BRACE CONDITIONS USING A STAR EXCURSION BALANCE TEST ON CHRONICALLY UNSTABLE ANKLES

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Date: May 2011

Research Type: Master's Thesis

Context: With the added support of colleague's experimental research and the increased knowledge on the effectiveness of bracing injured ankles, advances towards the use of prophylactic bracing over taping techniques for injury prevention can be established. Previous studies have not examined the effects of fatigue and bracing on individuals with chronic ankle instability while utilizing a prophylactic ankle brace or taping method.

Objective: The primary purpose of this study was to determine the effects of a functional fatigue protocol on dynamic balance while utilizing a prophylactic bracing technique and tape.

Design: This research was a quasi-experimental, within subjects, repeated measures design. Independent variables in this study were condition (tape and semi-rigid bracing technique) and fatigue (fatigue and non-fatigue). The dependent variable was the measure of functional balance using SEBT following a fatigue protocol during the application of both conditions.

Setting: The testing was performed in a controlled laboratory setting by the researcher.

Participants: Fifteen physically active individuals with chronic ankle instability volunteered for this study (7 males, 8 females).

Interventions: Each subject was assigned to four testing sessions under both conditions (brace condition, fatigue condition) and a SEBT was

used to measure dynamic balance and functional balance, respectively.

Main Outcome Measures: SEBT scores were computed from all test trials and differences in reach were examined among all variables.

Results: The within-subjects repeated measures ANOVA was calculated comparing the two levels of prophylactic bracing conditions (lace-up brace and tape). No significant effect was found ($F(1,14) = 1.309$, $P \geq .05$).

Conclusion: There appears to be no significant difference between the use of tape or lace-up brace following a fatigue protocol on individuals with chronic ankle instability when testing functional balance.

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