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The Effect of the Brian Mulligan Mobilization with Taping Procedure for Inverison Ankle Sprains on Functional Range of Motion

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THE EFFECT OF THE BRIAN MULLIGAN MOBILIZATION WITH TAPING PROCEDURE FOR INVERISON ANKLE SPRAINS ON FUNCTIONAL RANGE OF MOTION

BY

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Abstract

Inversion ankle sprains are a common occurrence in today's sports and society. Many preventative strategies, common rehabilitation programs, and modalities are used to avoid this occurrence or re-occurrence of an ankle sprain. Although satisfactory results can be achieved with the use of conventional therapeutic avenues, problems or complications may still occur. This study sets out to determine the significance of the Brian Mulligan mobilization with taping procedure for inversion ankle sprains on functional range of motion.

Seven subjects volunteered for the study. They consisted of 4 females and 3 males ranging in age from 19-32 years. Functional range of motion was measured by using two different functional therapeutic exercises: BAPS Board and Asterisk Program. The BAPS Board was used to test the achievement of the range of motions of dorsiflexion, eversion, plantarflexion and inversion. The Asterisk Program tested functional range of motions in the vectors of 0, 30, and 90 degrees.

A multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test of both the BAPS Board and Asterisk Program. Significant statistical differences (P=.005) existed in ankle functional range of motion between groups when the Asterisk Program was performed at 90 degrees. No other significant statistical differences were found between groups in any other measurement of the Asterisk Program or in the BAPS Board. Although limited statistical significance was found within this study, results may have helped to show that clinical importance may exist with the use of the Brian Mulligan mobilization with taping procedure for inversion ankle sprains on functional range of motion.

CHAPTER 1

INTRODUCTION

Ankle sprains are the most commonly evaluated and treated injury by sports medicine professionals (Crites, 2005). Physiotherapists, athletic trainers and physical therapists are all aware of the frequency of ankle sprains. With this awareness, medical professionals are continually trying to help prevent ankle sprains, improve rehabilitation, and decrease the amount of time that the patient is out of activity, work, or their sport.

The current and most widely excepted theory today is that with a lateral inversion sprain, the lateral ligament complex is damaged (Hetherington, 1996). Along with this excepted theory many preventative strategies, common rehabilitation programs, and modalities are used to avoid the occurrence or re-occurrence of an ankle sprain. Prevention can be successfully accomplished with basketweave taping, ankle bracing and restrictive footwear. If an incidence of an ankle sprain does occur, many traditional rehabilitation programs can be implemented. These rehabilitation programs typically begin with RICE (rest, ice, compression, elevation) and then follow a continuum of gait training, low level therapeutic exercises, proprioceptive training, and then possibly sport specific drills for athletes. Once this level is achieved, patients are usually able to function well enough to return to their daily activities. Along with the rehabilitation process, modalities such as ice, ultrasound and electrical stimulation are used to help with pain modulation and to put the anatomical structures in the correct environment for healing (Starkey, 1993).

Statement of Problem

Although satisfactory results can be achieved with the use of conventional therapeutic avenues, problems or complications can occur. Patients may experience chronic functional instabilities and be prone to re-injury (Hertel, 2002). For patients who are athletes, their return to participation maybe delayed or postponed. With these common recurrent negative side effects, new approaches and improvements must be sought out to improve outcomes.

One approach that has been developed is based on the Mulligan concept of joint positional faults (Hetherington, 1996). This alternate theory states that when an inversion sprain occurs, the lateral ligament complex remains intact and the forces are transmitted though the fibula (Kavanagh, 1999). The fibula is therefore subluxed forward and caudally on the tibia at the inferior tibiofibular joint. This results in a minor positional fault with decreased functional ability and pain.

Treatment for this positional fault would consist of MWM (Mobilizations With Movement) and application of the Mulligan taping for inversion ankle sprains. By performing a mobilization on the distal fibula in an anteroposterior (AP) direction, and providing the Mulligan taping procedure, great improvements could be made in the painfree range of inversion (Kavanagh, 1999). Mulligan (2004) emphasizes that the AP mobilization is specifically in a dorso cranial direction. This taping procedure is used to hold the fibula in place and maintain the correct anatomical positioning (Mulligan, 2004). The importance of the Mulligan taping with dorso cranial mobilization and its relation to rehabilitation has not been clinically proven. By performing a dorso cranial mobilization with the Mulligan taping method, and incorporating it into the rehabilitation process, a new approach to post injury ankle rehabilitation may be achieved.

Hypotheses

The hypotheses tested in this research investigation included:

Research Hypothesis: The application of the Mulligan taping procedure with the dorso cranial mobilization will help aid in the rehabilitation process by allowing increases in functional range of motion and functional rehabilitation outcome.

Null Hypothesis: There will be no significant interaction between the control and experimental groups during pre and post tests of ankle BAPS Board ROM testing and the Asterisk program with the application of the Mulligan taping procedure with the dorso cranial mobilization.

Definition of Terms

The following terms were defined for clarification purposes of this study:

Asterisk Program: A functional rehabilitation program that involves placing strips of tape on the floor in an asterisk pattern. These strips of tape form different planes of motion and vectors. Asterisk program exercises can be used as both a rehabilitation tool and a testing tool (Blair, 1999).

BAPS Board: (**B**iomechanical **A**nkle **P**latform **S**ystem) – A circular platform that is elevated by a single pivot point in the center (Petrofsky & Lohman, 2004). Different size balls can be placed on the bottom of the board to increase the height and increase the amount of ankle movement. The patient can stand while using this board to improve balance or sit while using this board to improve ankle range of motion.

Caudal: Inferior or nearer to the feet (Moore & Agur, 2002)

Dorso-Cranial glide: Mobilization were the fibula is glided in a posterior and superior direction (Mulligan, 2004).

Functional Rehabilitation: Rehabilitation that mirrors the activities of the athletes sport through the use of multi-plane movement, closed kinetic chain activities, and proprioceptive re-education, while activating specific body areas (Blair, 1999).

Grade one inversion ankle sprain: One of the most frequent injuries in sports and occurs with the foot in inversion, plantar flexion and adduction (Arnheim & Prentice, 1997).

Grade three inversion ankle sprain: Caused by a severe force to the ankle while the foot is in inversion, plantar flexion and adduction. Grade three inversion ankle sprains are usually uncommon in sports but when they do occur they result in major loss of function and inability to weight bear (Arnheim & Prentice, 1997).

Grade two inversion ankle sprain: Caused by a moderate force while the foot is in inversion, plantar flexion and adduction. Grade two inversion ankle sprains have a high incidence in sports and may cause a persistent unstable ankle that also recurrently becomes sprained (Arnheim & Prentice, 1997).

Positional Fault: Occurs when the foot is forcibly inverted beyond its natural range and the fibula becomes wrenched forward on the tibia (Mulligan, 2004).

Thenar Eminance: Lateral surface of the palm of the hand that contains the abductor pollicis brevis, flexor pollicis brevis and opponens pollicis (Moore & Agur, 2002).

Assumptions

The following assumptions were made about the study:

1. All subjects were healthy and did not have any other ankle pathologies that were unknown and that would affect the results of this study.
2. The BAPS Board and Asterisk Program are valid and reliable for challenging functional outcomes of ankle rehabilitation.
3. The certified and licensed athletic trainer applied the Mulligan taping procedure and dorso cranial mobilization in the correct application process as described by Brian Mulligan (Mulligan, 2004).
4. All subjects were taped with the same consistency.
5. All subjects put forth maximal efforts to achieve the best results in each trial.

Delimitations

1. Only subjects determined by the orthopaedic physician or doctor of podiatric medicine (DPM) to have an inversion ankle sprain of less than a third degree were qualified for the study.
2. Subjects were volunteers from the Barry University athletic training facility, Footcare Express and The Barry University Foot and Ankle Center of South Miami.

Limitations

1. The accuracy of the BAPS Board and the Asterisk Program to challenge functional abilities in rehabilitation.
2. The effort at which the subjects performed the functional rehabilitation exercises.
3. Subjects inability to report to rehabilitation due to illnesses, travel conflicts, or any other unforeseen circumstances.
4. The subjects fear of pain or belief that further injury may occur from participation in this study.
5. The ability of the certified and licensed athletic trainer to properly perform the dorso cranial mobilization of the fibula and correctly perform the application of the Mulligan taping procedure.

Significance of the Study

This study is very important to the functional aspect of ankle rehabilitation and to the need to decrease the negative lasting effects that often occur after a lateral ankle sprain. Alternate ankle rehabilitation programs and theories on the mechanisms of injury and rehabilitations are always of great value. The approach of Brian Mulligans' theory of a positional fault occurring at the distal tibiofibular joint is a topic that needs to be studied and researched more. Along with this theory, the application of the Mulligan mobilization with taping procedure to inversion ankle sprains also needs to be practiced and studied as well. This will help to determine if a positional fault does occur and if the taping procedure is productive in assisting with the rehabilitation process. This study will help to ensure that the true clinical value is found and shared with sports medicine professionals.

CHAPTER 2

REVIEW OF LITERATURE

Lateral ankle sprains are a common occurrence within sports and daily activity. Theories of mechanism, prevention, and rehabilitation of lateral ankle sprains have remained consistent. Trauma to the lateral ligament complex is a well understood and excepted mechanism of injury for a lateral ankle sprain. Prevention has followed the basic applications of taping and bracing while rehabilitation has consisted of rest, ice, compression, elevation (RICE), therapeutic exercises, and return to sport or daily living activities.

Within recent years, a new approach on the mechanism, rehabilitation and treatment of lateral ankle sprains has been introduced. This approach strays greatly from the accepted theories and practices that have been used for lateral inversion ankle sprains. This study will attempt to apply this approach and theory to ankle treatment and post injury rehabilitation.

The review of literature will include explanation of the concept of a positional fault and how this fault can occur at the distal tibiofibular joint. Common bracing and taping for inversion sprains will be discussed along with mobilizations, taping and functional rehabilitation for a positional fault.

Distal Tibiofibular Positional Fault

Brian R. Mulligan, a qualified physiotherapist, developed a concept about the mechanism of injury for inversion (supination) sprain of the ankle. This concept is based on the idea that the problem from an inversion sprain lies within the distal tibio/fibular joints (Mulligan, 2004). Mulligan (2004), states that when the foot is forcefully inverted beyond its normal anatomical limits, a positional fault occurs. This fault results in forces being transmitted through to the fibula and shifting the fibula's location anterior and caudally to the tibia (Hetherington, 1996). This positional fault is not readily palpable or visible on X-ray (Kavanagh, 1999). Hetherington (1996) states that patients may describe a "clunk" sound when they experience an injury that results in a positional fault. This "clunk" may represent the sound of the fibula subluxing forward in relation to the tibia (Hetherington, 1996). This proposal strays greatly away from the commonly accepted belief that an inversion sprain results in damage of the lateral ligament complex of the ankle. Mulligan (2004), states that he is confident that the lateral ligament complex is rarely damaged during an inversion sprain. Effusion that may be present after this type of injury is believed to be caused by soft tissue damage. This effusion is responsible for maintaining the anterior and caudal displacement of the fibula (Hetherington, 1996). Kavanagh (1999) performed a study that set out to test the hypothesis that a positional fault occurs at the distal tibiofibular joint in lateral ankle sprains. Seventeen normal subjects, two subjects with a chronic tendency to "go over" on one or both ankles, and six patients with acutely sprained ankles were tested. Anterior-posterior (AP) mobilizations of the lateral malleolus were performed on the right and left ankles of all subjects.

Patients were positioned lying supine with the foot tested in the subtalar neutral position. The patients' ankle was placed with the heel resting on a wooden bar with a potentiometer under each malleolus (Kavanagh, 1999). Three recordings were taken of each ankle. The tester began to push gently and gradually increased the force until the end of range was reached or the subject asked them to stop (Kavanagh, 1999). Each mobilization took place over approximately five seconds. Kavanagh (1999) found that a significantly greater amount of movement per unit force occurred in one third of the patients with acutely sprained ankles. This meaning that there was more movement available at the distal tibiofibula joint in respect to the amount of force that was placed on the joint. Subjects with acute or chronic ankle sprains reached a higher amount of movement at the distal tibiofibula with a lesser amount of force. These results support the hypothesis that a positional fault does occur at the inferior tibiofibular joint in patients with ankle sprains.

Mobilization Treatment for Positional Fault

Successful treatment for this positional fault has been found by following the principles and application of 'Mobilizations with Movement (MWM) as described by Brian Mulligan (Hetherington, 1996). Mulligan (2004) describes this MWM as being used as either a test or a treatment. This MWM should be performed in a dorso cranial direction (a posterior and superior direction) by using your thenar eminence, while the thenar eminence of your opposite hand stabilizes and lies underneath the medial malleolus (mulligan, 2004). Mulligan (2004) describes the benefit of this treatment by sharing a patient's case that occurred in 1992. The patient was a middle aged man who "went over" on his ankle six weeks prior to his initial visit. The initial evaluation found there to be swelling present in the ankle and zero degrees of inversion (Mulligan, 2004). Mulligan's assessment found that as he glided the fibula obliquely dorsally and in a cranial direction on the tibia, the patient was able to fully invert his foot without any pain (Mulligan, 2004). Mulligan (2004) stated that he performed repetitions of "MWM" and taped the patients' fibula dorsally on his tibia to complete the treatment. The patient stated that he felt 90 % better following the treatment of "MWM". According to Mulligan (2004) this case study supports the theory of a positional fault in a number of ways. First of all, if the lateral ligament complex was the primary fault, the degree of inversion would have increased over a six week period (Mulligan, 2004). Secondly, when the foot is inverted during a repetition of "MWM" the lateral ligament complex is being put on stretch. This therefore should cause pain to a damaged lateral ligament complex. In this case study, no pain was felt and inversion was full and pain-free. Mulligan concludes that the fibula was returned to its correct anatomical position (Mulligan, 2004).

A second supporting case occurred in England in 1994 during one of Brian Mulligan's courses. During this course a therapist was present who was unable to invert her foot for 13 years. This therapist's fibula was glided dorsally and maintained in that position. While in this position, she was able to actively achieve full inversion (Mulligan, 2004).

Hetherington (1996) describes her approach to the management of inversion/ plantarflexion ankle injuries with the use of patients that have been referred to her clinic. This approach is based on Mulligans' concept of joint positional faults. Patients who were referred to the clinic were examined to detect if a positional fault had occurred and they were treated with “MWM” and taping (Hetherington, 1996). Initial evaluation of the case studies found painful and limited inversion and plantarflexion (Hetherington, 1996). Deficiencies in balance were also noted when the patients were tested in one leg standing with eyes closed (Hetherington, 1996). Electrophysical agents were not used with these case studies unless there was significant swelling (Hetherington, 1996). Many of the patients were treated with immobilization by an airsplint for 5-10 days prior to “MWM” treatment. During the initial treatment, the most restricted movement was treated first. In these instances, inversion was likely the most restricted movement. The patient was in a long sitting position with a sandbag under the lower leg (Hetherington, 1996). The therapist glided the lateral malleolus posterior with their thenar eminence. While this glide was maintained, the patient performed active inversion (Hetherington, 1996). Passive overpressure should be added to the patients’ active movement (Hetherington, 1996). This overpressure can be applied by the therapist or by the patient using a manual therapy belt. Three sets of ten pain-free repetitions were performed during the initial treatment. The patients’ active movement must be pain-free and there is an evaluation after each set of ten repetitions (Hetherington, 1996). Post treatment evaluation found increased range of pain-free inversion, and improvement in balance deficiencies when the patients were retested with eyes-closed one leg standing test. Hetherington (1996) believes that the balance deficiencies may have been due to the malposition of the fibula and not as a result of damage to the mechano-receptors.

Anteroposterior Glide on the Talus for Acute Ankle Inversion Sprains

Along with the anteroposterior (AP) mobilization of the fibula to increase inversion, therapist will also use additional MWM to restore dorsifexion and plantarflexion (Hetherington, 1996). Green, Refshauge, Crosbie, and Adams (2001) performed a study to determine whether an (AP) mobilization on the talus could improve the therapeutic outcome on an acute ankle sprain. Green et al. (2001) looked at the outcomes on range of motion of dorsiflexion, degree of pain during dorsiflexion, and the variables of speed, step length, and single support time when analyzing gait. Forty-one subjects with acute ankle inversion sprains were assigned to either a control group or an experimental group. The control group was to follow a RICE protocol (rest, ice, compression and elevation) only. The experimental group followed the RICE protocol and was also treated with AP mobilizations (Green et al.). Treatment occurred over a two week period with treatment sessions occurring on every second day with the exception of weekends. Results showed that patients that were treated with AP mobilizations achieve greater improvement in dorsiflexion range of motion within fewer treatments and increased stride speed (Green et al.).

Collins, Teys and Vincenzino (2004) performed a study on whether the application of Mulligan’s MWM technique improves talocrural dorsiflexion and if this technique relieves pain in subacute populations. Fourteen subjects with a grade II lateral ankle sprain that had occurred on an average of 40 days prior to testing made up the participants. Three treatment conditions were developed. These three treatment conditions were MWM for dorsiflexion, placebo and a no-treatment control. In the MWM for dorsiflexion treatment group, the therapist applied a posteroanterior force to the distal leg using a treatment belt while stabilizing the foot and talus (Collins et al. 2004). Keep in mind that the movement technique is a posteroanterior force because the belt is attached to the posterior aspect of the leg and is traveling in an anterior direction.

Three sets of ten repetitions were performed. If pain was experienced, the treatment was stopped and the subject was excluded from the study (Collins et al.). The placebo condition mimicked the MWM for dorsiflexion condition with the exception of a few alterations in the performance of the technique and instructions. Patients in the control group were asked to produce the same stance as the patients in the two previous groups and asked to hold that position for five minutes (Collins et al.). The therapist did not perform any mobilizations on the patient during these treatment sessions (Collins et al.). Collins et al found that MWM treatment group had significant improvements in dorsiflexion but no significant changes in pain. This techniques success is believed to be due to a mechanical effect and not as an influence on the pain system (Collins et al.).

Exalby (1996) also discusses the importance of the use of MWM for the post-acute stage of ankle sprains. Exalby (1996) states that MWMs can be performed by applying a PA glide on the tibial and fibula with a counter AP glide on the talus. Along with these two glides, MWMs can be performed on the inferior tibiofibular joint in an AP or PA direction (Exalby, 1996). Exalby (1996) emphasizes the idea that the direction of the MWM on the tibia and Fibula produces a pain-free movement for the patient.

Common Bracing and Taping For Lateral Inversion Sprains

The restriction of ankle inversion has been fairly successful by using the application of taping, bracing and spatting. Sports Medicine professionals have used these methods of application to help prevent lateral inversion sprains, to prevent the re-occurrence of a lateral inversion sprain and to enhance post injury rehabilitation.

Researchers have set out to determine the effectiveness of taping and bracing and which types of support are the most beneficial. Manfroy, Ashton-Miller, and Wojtys (1997) studied the effects of exercise, pre-wrap and athletic tape on the resistance to ankle inversion. Twenty – five subjects took two single-foot balance tests that measured resistance to inversion. During the first single-foot balance test tape was applied to the ankle directly and during the second single-foot balance test, tape was applied with pre-wrap. Resistance to inversion was measured before taping, after taping, immediately after 40 minutes of exercise and after the removal of the tape. Compared to the baseline of the untaped condition, resistance with direct taping increased 8.7% before exercise and 0.4% after exercise. With taping and pre-wrap, resistance increased 11.5% before exercise and 3.5% after exercise. From this study, it can be assumed that taping with pre-wrap can increase maximal resistance to inversion when compared to taping without pre-wrap.

Ricard, Sherwood, Schulthies and Knight (2000) conducted a similar study on the effects of tape and exercise on dynamic ankle inversion. This study set out to compare the effects of tape, with and without the pre-wrap on dynamic ankle inversion before and after exercise. Thirty college-age male and female students balanced on their right leg on an inversion platform that was tilted to produce 15 degrees of plantar flexion. Ankle inversion was suddenly created by pulling the trap door on the inversion platform support. Ten trials were performed before and after an exercise session. Ricard et al. (2000) concluded by stating that there was no difference in the amount of inversion restriction when taping with pre-wrap compared with taping to the skin.

Sharpe, Knapik and Jones (1997) performed a study on the effectiveness of ankle braces in the reduction of the reoccurrence of ankle sprains in female soccer players. For this study, medical records over a five year period for thirty-eight players were examined. A total of 1717 practices and 650 games were exposed. Data on history of ankle sprains, types of intervention, type of bracing and incidence of occurrence was examined. Four intervention groups were established. These four groups were braced, taped, combination, and no treatment. Results from this study showed that the group with ankle bracing had no ankle sprain reoccurrences, and the ankle sprain recurrence frequency did not differ among the taped, combination, and no treatment groups.

Lyle and Corbin (1992) compared the effectiveness of ankle braces to athletic tape in the restriction of ankle inversion before and after exercise. An Elgin machine was used to test ankle inversion ROM. Subjects reported for three days for testing. The subject was assigned to a treatment condition and tested for ankle inversion prior to exercise and then tested again after exercise. All subjects were tested in each of the three conditions. Lyle and Corbin (1992) simply concluded that both tape and bracing are more effective in restricting inversion ROM than when neither tape nor bracing is used. Along with this conclusion it was stated that a lace-up brace can be as effective as tape in reducing the risk of ankle injury.

Pederson, Ricard, Merrill, Schulthies and Allsen (1997) studied the effects of spatting and ankle taping on inversion before and after exercise. Four conditions were tested. Subjects were randomly assigned to an untaped, taped, taped and spatted, or a spatted condition. Subjects were videotaped on an inversion platform before and after a 30 minute period of rugby drills. Results from this study found that the 30 minute exercise bout resulted in an increase in the amount and rate of inversion. After exercise, taping restricted motion 6.5 degrees, spatting and taping combined restricted motion 15.5

degrees, and spatting alone restricted motion 11.2 degrees when compared to the untaped treatment. Spatting combined with taping was found to be the most effective in reducing inversion before and after exercise. All taping treatments were found to be effective in reducing the rate and amount of inversion compared to the untaped treatment group.

Taping for a Positional Fault Occurring at the Inferior Tibiofibular Joint

Along with the numerous MWM techniques that have been used to treat a positional fault occurring at the inferior tibiofibular joint, a taping procedure has also been used and described in the literature. This taping procedure is far from the conventional taping, bracing and spatting that has been discussed previously in this chapter. Conventional methods of ankle taping are primarily concerned with the restriction of ankle inversion. The taping procedure for the tibiofibular joint attempts to reduce and correct a positional fault that may be occurring. Mulligan (2004) states that a repositioning of the fibula should be performed as soon as possible, and this position should be held "in place" by the taping procedure. Using 5cm wide tape, Mulligan (2004) tapes the fibula in place by laying the tape across the lower leg obliquely, pulling the fibula dorsally on the tibia and allowing the tape to travel around and upward. Hetherington (1996), tapes all of her patients following their treatments. Hetherington (1996) uses two strips of 25mm tape and applies the first strip at an angle over the lateral malleolus. During this first step, a posterior glide is applied to reposition the distal fibula. This first strip of tape is approximately 15cm in length so that it may be wrapped around the lower leg (Hetherington, 1996). Once this first piece of tape is secured, Hetherington (1996) applies a second piece on the top of the first to reinforce and strengthen the taping.

This taping should be replaced every 24 hours and continued for two weeks (Hetherington). Hetherington (1996) believes that gait patterns and balance performance are significantly improved with this taping procedure. Exelby (1996) also supports the idea that this taping procedure is beneficial to the treatment outcome when applied to the fibula while an AP glide is held.

Functional Rehabilitation

After the occurrence of an ankle sprain, rehabilitation must take place to restore the ankle joint to its normal functional state. Normal functional state refers to the degree of functional performance that was achievable before the onset of an injury. The effectiveness of this rehabilitation will determine the quality of the final outcome. Many ankle rehabilitation programs are very similar and are considered "cookbook." Cookbook rehabilitation programs offer the same exercises to each individual with the same degree of injury (Blair, 1999). These programs can lack creativity and efficiency. Athletic trainers and therapists now understand that ankle rehabilitation programs must be original and designed specifically for each patient. Programs need to be geared toward the patients' lifestyle, profession or sport. In order to create these types of programs and achieve maximal results, functional activities should be incorporated into the rehabilitation program.

Osborne and Rizzo (2003) describe functional ankle rehabilitation as an extremely important component of acute ankle sprain treatment. Mattacola and Dwyer (2002) divide functional rehabilitation into four basic categories. These four categories are ROM, strengthening, proprioception and activity-specific training. Functional rehabilitation should continue until pain-free gait and activities are achieved. Incorporating functional rehabilitation stresses healing tissues and activates the specific adaptation to imposed demand (SAID) principle (Mattacola and Dwyer, 2002). Mattacola and Dwyer (2002) state that the functional activities that are chosen must be specific to the demands that are placed on the ankle joint. Bernier, Sieracki, and Levy (2000) state that functional exercises fall along a continuum. At the beginning phases of this continuum such activities as walking, static balance, tilt boards and mini-tramp can be found. As this continuum progresses, more challenging exercises are introduced. Clock drill, functional hop, and return to sport activities are located further down and towards the end of the continuum. Bernier et al (2000) state that pain and range of motion are the two determining criteria for patient placement along the continuum.

Mattacola and Dyer (2002) affirm that functional rehabilitation can begin on the day of injury as long as ankle stability is present. Grade I and II ankle sprains are classified as stable injuries so functional rehabilitation should begin without delay.

Bernier et al. (2000) have an eight stage progression for functional progression of ankle rehabilitation. Stages one and two focus on building a stable core and performing functional activities in a gravity reduced environment. Stage three is permitted when weight bearing in pain-free. During this stage neuromuscular control activities are introduced. Stage four moves to static balance which progresses to stage five where functional weight-bearing is begun. Stage six prepares the patient for the return to running. Functional control activities like cariocas and box drills are located in stage seven. Stage eight concludes the progression with sport specific activities.

When reviewing functional exercise programs, there are a few "stand-by" exercises that are used very frequently. The first of these well known exercises is the tilt, or wobble board. The tilt board is a device that allows the ankle to be rehabilitated in uniplanar motions. This functional tool is a rectangular square that has a fulcrum underneath it that extends the width of the board (Madras and Barr, 2003). The ankle is allowed to move in a plantarflexion/ dorsiflexion pattern and also in an inversion/eversion pattern. One of the primary ideas behind this apparatus is for the patient to move the board back and forth touching the floor with its edges. Another use is to single or double-limb balance on the board without touching the floor (Madras and Barr, 2003). Lynch and Renstrom (1999) implement the tilt board into their rehabilitation program as soon as possible. Waddington, Roger and Adams (2004) performed a five week wobble-board exercise intervention program with a healthy elderly population. One of their main objectives was to determine if wobble board training would help in the ability to discriminate between different degrees of ankle inversion. From this study, Waddington et al. (2004) found that ankle movement discrimination improved greatly. Subjects were better able to differentiate between the five predetermined extents of inversion after wobble-board training. This finding allows for the assumption that wobble-board training also improves ankle performance.

Another very commonly used rehabilitation tool is the ankle disk, or also known as a balance board. Unlike the tilt, or wobble board, an ankle disk allows for mutliplanar movement. An ankle disk is usually a circular platform that has a semi-circular ball underneath it (Madras and Barr, 2003). With this device, a patient may be asked to perform exercises where they are to control circumferential movements of the ankle.

Along with this, the patient may be asked to balance on the board without allowing the edges of the circular platform to touch the ground (Madras and Barr, 2003). A well know ankle disk is the Biomechanical Ankle Platform System (BAPS). Hoffman and Payne used the BAPS board in their research on the effects of proprioceptive ankle disk training. Hoffman and Payne (1995) set out to determine if BAPS ankle training would reduce proprioceptive deficits and increase postural control in healthy subjects. Postural sway is the subjects' ability to be able to use their sensory input and proper muscle responses to control an upright stance. Subjects were asked to train their dominant leg three times a week for ten weeks with the BAPS board. The experimental group showed significant decreases in postural sway in medial-lateral and anterior-posterior parameters.

Tropp, Askling, and Gillquist (1985) studied two different methods for the prevention of ankle sprains. One of these methods was coordination training on an ankle disk. Males from the Swedish national soccer league who had a history of previous ankle problems were given a coordination ankle training program using the ankle disk. The program consisted of training for ten minutes, five times weekly for the first ten weeks and then five minutes three times weekly thereafter. From their study, Tropp et al (1985) found that ankle disk training reduces the incidence of ankle sprains among players with a history of ankle injuries to the same level as men who do not have any history of ankle sprains. Tropp et al, stated that ankle disc training improves functional stability, postural control, and should be implemented in the rehabilitation of ankle injuries. Tropp et al also believe that ankle disk training should be done by players with previous ankle problems to hinder the reoccurrence.

Osbourne, Chou, Laskowski, Smith, and Kaufman (2001) set out to investigate whether ankle disk training alters the onset latency of selected distal lower limb muscle groups of previously sprained ankles. Onset latency refers to the activation time of the stimulated muscle groups. Each subject went through an ankle inversion testing procedure and then was given an ankle disk program. Subjects were instructed to train only the experimental leg with the ankle disk for fifteen minutes daily for eight weeks. After eight weeks, subjects again went through the ankle inversion testing procedure. Osbourne et al. (2001) found that anterior tibialis muscle onset latency significantly decreased after eight weeks of ankle disk training in subjects who have a history of lateral ankle sprains.

Matsusaka, Yokoyama, Tsuruaki, Inokuchi and Okita (2001) studied the effects of ankle disk training on functionally instable ankles. Two experimental groups were organized. Subjects in both groups were trained to stand on an ankle disk with their affected limb. Group one performed the training sessions with the application of adhesive tape while members of group two performed the training sessions without tape application. Ankle disk training was performed for ten minutes a day, five times per week, for ten weeks. Before and after this training period, postural sway was tested using a stabilometry technique. Matsusaka et al. (2001) found that in group one, postural sway measurements decreased significantly after four weeks and were within normal range at six weeks. In group two, values improved significantly after six weeks of training, and were within normal range after eight weeks. Matsusaka et al. concluded by stating that ankle disk training improves postural sway in patients with functionally unstable ankles. Along with this statement, Matsusaka et al. also suggest that the superior results in group one are a result of the increased afferent input from skin receptors that were stimulated by the adhesive tape.

Soderman, Werner, Pietila, Engstrom, and Alfredson (2000) conducted a study on the use of balance board training on the prevention of traumatic injuries in the lower extremities of female soccer players. During the season the players in the intervention group performed ten to fifteen minutes of balance board training. Exercises were performed for three sets of fifteen seconds on each leg. This program was to be done initially each day for thirty days, and then three times per week after this for the rest of the season. Prior to and after the season, flexibility and postural sway measurements were taken. Results from this study show that balance board training had no effect on the number, incidence or type of traumatic injury. Although not a primary purpose of this study, Soderman et al. (2000) also mention that the intervention group had significantly improved their balance index in their non-dominant leg with their knee extended.

An exercise that leaves much creativity to the athletic trainer or therapist is the Asterisk Program. Bernier, Sieracki and Levy (2000) believe that this exercise program is excellent for strengthening the muscles of the ankle, hip and knee. To begin this exercise, strips of tape must be placed on the floor in an asterisk pattern. The areas between these strips of tape embody different vectors that represent different planes of motion (Blair, 1999). These vectors should be numbered or lettered for identification. Many different functional activities can be performed with this program depending on where the patient is in the functional continuum. Reaches, hops, lunges and balance testing can be performed. These activities can be measured by recording distances reached or hopped, repetitions to fatigue, and time of balance in a certain vector (Blair, 1999).

A variation of the Asterisk Program is the Clock Drill. For this drill, Bernier et al configure a box using four markers that are located at 2:00, 4:00, 8:00, and 10:00 (Bernier et al). Just as with the Asterisk Program, the patient stands inside of this pattern and stands on the involved leg. The main purpose of the clock drill is for the patient to reach out and touch each marker with the uninvolved foot. Bernier et al. start the exercise out in the frontal plane, and then moves to the anterior, lateral and then posterior planes. For an involved left leg, the patient would reach out and touch the ten O'clock position and then touch the rest of the markers in a clockwise direction. For an involved right leg, the patient would start at the two o'clock position and move in a counterclockwise direction.

Gribble, Hertel, Denegar, and Buckley (2004) investigated the effects of fatigue and chronic ankle instability on dynamic postural control. To test postural control, Gribble et al used the Star Excursion Balance Test (SEBT). The SEBT is very similar and set-up closely to the way the Asterisk program and Clock Drill. The SEBT was formed with eight lines of athletic tape at 45 degrees from each other. The patient was asked to reach in anterior, medial and posterior directions while maintaining a single-leg stance with the other leg in the middle of the grid. Reaching distances were recorded and calculated to represent a reach distance as a percentage of leg length (MAXD). By using the SEBT, Gribble et al. (2004) found that chronic ankle instability and fatigue affect dynamic postural control. Gribble et al. found that in all three reaching directions, the involved limbs of the chronic ankle instability group recorded less MAXD.

CHAPTER 3

METHODS

Subjects

Volunteer subjects from The Barry University athletic training room, Footcare Express, and The Barry University Foot and Ankle Center of South Miami participated in the study. Flyers were posted at these locations advertising for volunteers to participate in this study on the Brian Mulligan taping procedure with dorso cranial mobilization for ankle inversion sprains. See Appendix B for flyer used for subject recruitment.

In order to qualify for participation, volunteers must meet the following criteria: (a) all subjects presented with an acute ankle inversion sprain that was less than a third degree sprain, (b) an orthopaedic physician or doctor of podiatric medicine (DPM) determined whether the ankle sprain was less than a third degree sprain and also verified that the ankle sprain was a result of an inversion mechanism, and (c) the subject was able to perform an open-eyed single-leg stance for a least 15 seconds on their involved extremity.

All subjects that qualified for this study signed an informed consent form before any participation, testing, or functional exercises were performed. The informed consent stated the significance of the study, the possible side effects of the study, risks and precautions, time requirements, voluntary participation, and the confidentiality of subjects' data and results. Subjects were informed of the possibility of discomfort being present during this study but that no further degree of injury could result from participation. See Appendix C for a copy of the written informed consent form used for this study.

The sample group for this study consisted of 30 subjects. Subjects were randomly assigned to two groups: Control and Experimental. Fifteen subjects were in the control group and 15 were in the experimental group. The control group performed the two functional rehabilitation exercises without the Brian Mulligan taping with dorso cranial mobilization for an inversion ankle sprain. The experimental group performed the two functional rehabilitation exercises using the Brian Mulligan taping with the dorso cranial mobilization for inversion ankle sprain.

INSTRUMENTS

Baps Board

The BAPS Board or **B**iomechanical **A**nkle **P**latform **S**ystem (CAMP- Jackson, Michigan 49201) is a functional rehabilitation tool that is used in the ankle rehabilitation process. The BAPS Board is a circular platform on which the foot is placed. Underneath this platform, different diameter hemispheres can be placed to increase the excursion of the board and to increase or decrease the levels of difficulty (See Figure 1). There are five different size hemispheres, each representing another degree of difficulty. Four ranges of motions can be achieved during the use of this functional tool: dorsiflexion, plantarflexion, eversion and inversion. Subjects were in a seated position with their knee in a 90 degree angle. Subjects were assessed on the level of difficulty that could be reached by the level of hemisphere used and the ability to touch down on each of the four ranges of motion.

Figure 1. BAPS Board and Hemispheres

Asterisk Program

The Asterisk Program is a functional rehabilitation tool that involves placing strips of tape on the floor to produce a pattern similar to an asterisk (Blair, 1999) (See Figure 2). By applying strips of athletic tape to the floor, vectors are produced. These vectors can serve as different planes of motion (Blair, 1999). The Asterisk Program can be used as a functional rehabilitation tool or a functional assessment/testing tool. For this study, subjects were visually assessed on the ability to balance on the involved ankle and reach as far as possible with the uninvolved ankle. This assessment was performed in a 0 degree, 30 degree, and a 90 degree vector. This test reflected the functional capabilities of the involved ankle.

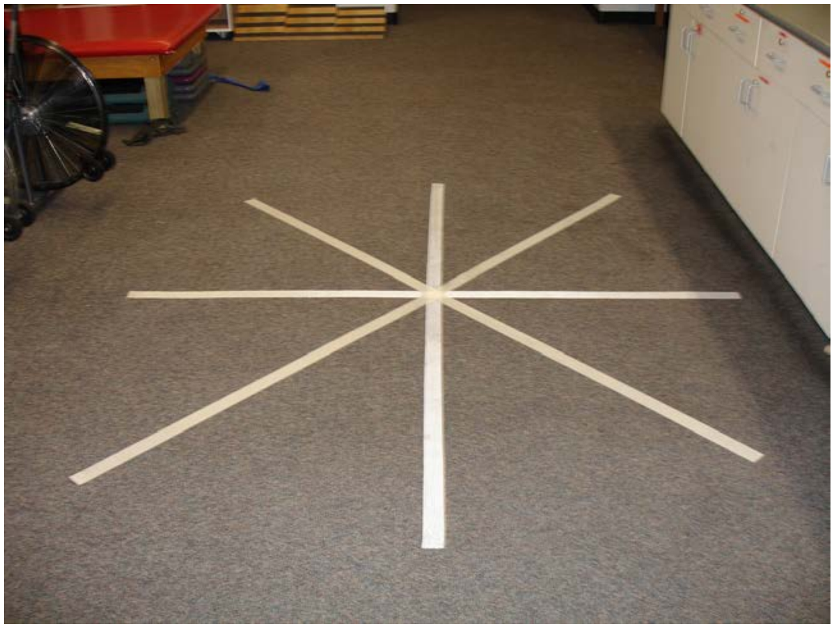

Figure 2. Asterisk program set-up

Mulligan taping procedure with dorso cranial mobilization

The Brian Mulligan taping procedure begins with a dorso cranial mobilization of the fibula performed along with the application of 5cm wide tape to the anterior surface of the fibula. This tape is positioned obliquely across the lower leg and pulls the fibula dorsally and travels around and upward on the lower leg (Mulligan, 2004) (See Figure 3).

Figure 3. Mulligan tape application

Athletic Tape

Athletic tape to be used in this study is 2inch (5cm) Zonas tape manufactured by Johnson & Johnson (New Brunswick, NJ).

PROCEDURES

After obtaining approval from the Institutional Review Board (IRB) at Barry University, volunteers came forth after flyers were posted around the Barry University Athletic training room, Footcare Express, and The Barry University Foot and Ankle Center of South Florida. See Appendix D for IRB approval Letter. Volunteer subjects gained clearance from an orthopaedic physician or doctor of podiatric medicine (DPM) who determined that their ankle sprain was less than a third degree sprain caused by an inversion mechanism.

Coordinators from each site contacted the certified athletic trainer when volunteer subjects came forward with interest to participate in this study. At this time the certified athletic trainer would schedule a time with the coordinators to meet with the volunteer subjects to perform the study. Subjects were instructed to dress appropriately like they would for a rehabilitation session and they were also notified not to apply any lotions or oils to the skin of their lower extremities. The certified athletic trainer would travel to each site that had volunteers and bring the needed instrumentation for the study. During this scheduled time, a consent form was given to the volunteer subjects and they agreed to participate.

All of the data collection for each subject was collected in a one day trial. See Appendix E for a copy of the results page. Subjects were randomly placed in either the control or experimental group. Subjects had to pass an initial pre-test of an eyes-open one-legged balance session of at least fifteen seconds to be considered functionally capable to participate in this study. Procedures for control group and experiment group were as followed:

Instructions and guidelines were explained to both groups prior to tested trials. The certified athletic trainer demonstrated the functional rehabilitation exercises to the subjects and allowed the subjects to perform each functional rehabilitation exercise as many times as needed on the uninvolved ankle. This was done so that the subject fully understood and experienced the functional requirements that the functional rehabilitation exercise demanded. Once the subject was confident in their understanding of what the test required, they were allowed to begin the tested trial.

The order of the functional exercises was randomized throughout the subject pool. One of the functional exercises was the BAPS Board. The subject was instructed to sit on a stool with their knee in a 90 degree angle and place their foot at a 90 degree angle on the BAPS Board. The height of the stool would be adjusted for comfort and to allow for the correct alignment of the lower extremity (See Figure 4). The subject performed this functional exercise without footwear. The certified athletic trainer informed the subjects to stabilize their knee with their hands to prevent any unwanted motion to occur at the knee or hip joint. The certified athletic trainer was positioned in a way so that proper alignment of the subjects' lower extremity could be evaluated and corrected if needed. Also from this positioning, the certified athletic trainer was able to see and confirm all touch downs during the testing procedure. All trials for each subject began on level one of the BAPS Board. The subject was instructed to touch the sides of the board to the ground during each attempt to produce the four basic ranges of motions of dorsiflexion, eversion, plantarflexion and inversion. Subjects were asked to attempt these ranges of motion in this specific order also. After each touch down, the subject was instructed to return their ankle to the 90 degree starting position. If the subject was able to touch down on all four of these ranges of motion, the next level hemisphere was added and the process continued. When the athlete was unable to touch down on one of these ranges of motion at a certain level, that score was recorded. Once a score was recorded, the subject was asked to try and achieve any remaining ranges of motion on that specific level. If a subject was able to accomplish any of the remaining range of motions, the certified athletic trainer would document this achievement.

Figure 4. BAPS board exercise set up

The second functional exercise that was to be performed was the Asterisk program. The certified athletic trainer would perform the functional exercise for the subject to allow them to see the correct form and procedure. The subject was then allowed to practice the functional exercise as many times as needed with their uninjured ankle to allow themselves to become comfortable and confidence in the procedure of the functional exercise. The subject was to perform this functional exercise without footwear. The subject was then asked to place their non-injured ankle in the center of the asterisk. The center of the asterisk was marked with a dot to maintain accuracy of foot placement and measurements of distances reached. The certified athletic trainer would make sure that the ankle joint was properly placed and centered in the asterisk. Three vectors of 0, 30, and 90 degrees were tested. A goniometer was used to accurately produce each vector of the asterisk (See Figure 5).

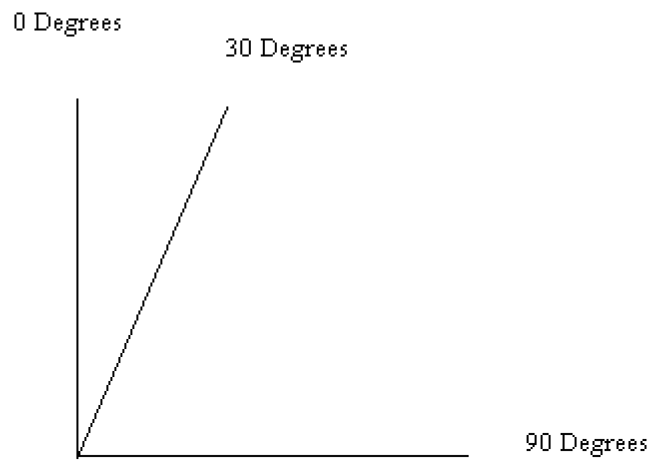

Figure 5. Asterisk program vectors for a left involved ankle

With their hand on their hips, the subject would stand on the involved ankle and start by reaching as far as possible in the 0 degree direction and touch down with the heel of the uninvolved foot. The certified athletic trainer was positioned on the subjects injured side to provide stability in a case of lose of balance and to assess for proper form. At the point of touch down, the certified athletic trainers assistant would mark this point of contact with a marker. The subject would continue on to the 30 and 90 degree vector (See figure 6). Order of vectors would be randomized. Between each attempt in a vector, the subject was allowed to return to the center and stand on both feet to regain balance and rest. Emphasis was placed on making sure that the subject was using the motion needed for the asterisk program from their ankle, knee, and hip. Improper forward flexion, extension, or lateral bending from the torso or lumbar region was considered improper form. If a trial contained improper form, the certified athletic trainer would stop the test and once again explain and demonstrate the correct procedure before allowing the subject to continue. After all attempts were completed, distances were measured in centimeters by using a tape measure.

Figure 6. Asterisk program procedure for left involved ankle

After the completion of the first set of functional testing, the certified athletic trainer would perform a dorso cranial (angled upward and posterior) mobilization and apply the Brian Mulligan taping technique to the experimental group. While holding the dorso cranial mobilization, tape was applied on the anterior surface of the fibula and positioned obliquely across the lower leg. The tape pulls the fibula dorsally and travels around and upward on the lower leg. This taping procedure would take approximately 2-3 minutes to perform. With this taping procedure in place, the subjects in the experimental group again performed the functional rehabilitation exercises a second time. During the performance of the Asterisk program, previous marked distances were covered up with 2 inch (5cm) wide tape. This was done so that subjects were not aware of their previous achievements. After completion of the trials, results were recorded by the certified athletic trainer.

The control group did not have the dorso cranial mobilization and Brian Mulligan taping technique applied to them after the completion of the first set of functional testing. The control group was simply allowed a 2-3 minute break before performing the functional exercises a second time. Once again during the Asterisk program the previous marked distances were covered up with 2 inch wide tape so that subjects were not aware of their previous achievements.

DESIGN AND ANALYSIS

The independent variables in this study were the groups (treatment vs. control) and time of testing (pre and post). The dependant variable measurement of the BAPS Board was recorded in accordance to levels achieved and number of touch downs performed. Scale of achievement began at a level one plus .25 for each direction achieved, and continued on to level one plus .50 and continued in that manner until a possible perfect achievement of a level 5 plus 1.0. The other four dependant variables of this study were the distance reached in each of the three vectors of 0 degrees, 30 degrees, 90 degrees and the total combined distance reached by the subject in the Asterisk Program. Distance achieved in each vector was measured separately and calculated along with a total distance achieved in all of the vectors. Statistical significance was tested using a 2x2 Multiple ANOVA with an alpha level set at .05. If multivariate significance is found, 2x2 ANOVAs for each dependant variable were used to determine specifically where significance had occurred.

CHAPTER 4

RESULTS

The purpose of this study was to analyze the effect of the application of the Brian Mulligan taping procedure with the dorso cranial mobilization on the functional range of motion and functional rehabilitation outcome of inversion ankle sprains.

Four females and three males (N=7), aged 19-32 years, with the average age being 24.3 years, qualified and agreed to participate in the study. All volunteers met the criteria of: (a) an acute ankle inversion sprain that was less than a third degree sprain, (b) an orthopaedic physician or doctor of podiatric medicine (DPM) determined whether the ankle sprain was less than a third degree sprain and also verified that the ankle sprain was a result of an inversion mechanism, and (c) the subject was able to perform an open-eyed single-leg stance for at least 15 seconds on their involved extremity.

Subjects were randomly assigned to two groups: Control and Experimental. Four subjects were in the experimental group and three were in the control group. Subjects in each group were tested within one week of initial injury. The control group performed the two functional rehabilitation exercises without the Brian Mulligan taping with dorso cranial mobilization for an inversion ankle sprain. The experimental group performed the two functional rehabilitation exercises using the Brian Mulligan taping with the dorso cranial mobilization for inversion ankle sprain. The demographics of each group participating in the study are summarized in Table 1.

Table 1

Subject Demographics

	GENDER	AGE (M)	HEIGHT (inches)
EXPERIMENTAL n= 4	Females (3),Male(1)	25.8	67.75
CONTRL n=3	Males (2), Female (1)	22.3	68.6

Volunteer subjects were asked to fill out a subject questionnaire before participation in this study. See Appendix F for subject questionnaire. Variables such as grade of inversion ankle sprain, daily discomfort rating, previous occurrences of inversion ankle sprains, lower leg injuries, lower leg surgeries, and if they considered themselves as athletic or as non-athletic were recorded. Daily discomfort rating was on a scale of 0-10, with 0 representing no discomfort and 10 representing the maximal discomfort experienced. Four of the subjects had Grade 2 inversion ankle sprains and three subjects had Grade 1 inversion ankle sprains. The mean daily discomfort rating was a 4.4 out of a possible 10. Five of the seven subjects had had previous inversion ankle sprains to the same ankle being studied. All of the subjects in this study were from an athletic population that had no history of other lower leg injuries or a history of lower leg surgeries. Individual subject data can be seen summarized in Table 2.

Table 2

Individual Subject Data

Subject	Gender	Grade of ankle sprain	Daily discomfort (1-10)	Athletic/Non	Previous ankle sprains	Hx.of lower leg injury	Hx.of lower leg surgery	Control/Experimental
1	M	2	6	Athletic	0	No	No	Exp.
2	F	1	5	Athletic	1	No	No	Exp.
3	F	2	4	Athletic	0	No	No	Control
4	M	I	5	Athletic	3	No	No	Control
5	M	I	4	Athletic	2	No	No	Control
6	F	2	4	Athletic	2	No	No	Exp.
7	F	2	3	Athletic	1	No	No	Exp.

Functional range of motion of the ankle joint was measured using the BAPS Board and the Asterisk program. BAPS Board functional range of motion was determined by calculating the amount of levels (1-5) and number of touch – downs achieved during pre and post – tests. Subjects were asked to touch-down on the range of motions in the specific order of dorsiflexion, eversion, plantarflexion, and then inversion. Subjects were scored on by increments of .25. By touching-down on dorsiflexion, the subject would receive .25, eversion received .50, plantarflexion receive .75 and inversion allowed the subject to be elevated to the next level hemisphere. Example: If a subject was on level one of the BAPS Board and achieved dorsiflexion, eversion, plantarflexion and then could not achieve inversion, a score of 1.75 was recorded. On the second attempt, if the subject achieved all touch downs on the first hemisphere, they were elevated to the second hemisphere. If no touch downs were produced on the second hemisphere, a score of 2.0 was received. Once one touchdown was not achieved, scoring was stopped. Patients were encouraged to try and complete the remaining touchdowns left on that specific BAPS Board level. Any additional touchdowns that were achieved were recorded as supplementary data. BAPS Board level of achievement and functional range of motion completion can be seen in Table 3.

Table 3

BAPS Board level of achievement and range of motion completion

	BAPS Board Levels of achievement	BAPS Board ROM Achieved				Control/Exp.
Subject		Dorsiflexion	Eversion	Plantarflexion	Inversion	
1 Pre-Intervention	3.5	Y	Y	N	Y	Exp.
1 Post-Intervention	5.5	Y	Y	N	Y	
2 Pre-Intervention	6	Y	Y	Y	Y	Exp.
2 Post-Intervention	6	Y	Y	Y	Y	
3 Pre-Intervention	3	N	N	Y	Y	Control
3 Post-Intervention	3.25	Y	N	N	N	
4 Pre-Intervention	6	Y	Y	Y	Y	Control
4 Post-Intervention	6	Y	Y	Y	Y	
5 Pre-Intervention	5.5	Y	Y	N	Y	Control
5 Post-Intervention	5.5	Y	Y	N	Y	
6 Pre-Intervention	4.75	Y	Y	Y	N	Exp.
6 Post-Intervention	4.75	Y	Y	Y	Y	
7 Pre-Intervention	5.75	Y	Y	N	Y	Exp.
7 Post-Intervention	6	Y	Y	Y	Y	

Asterisk program functional range of motion was calculated and recorded in four separate measurements: Distances achieved at 0 degrees, 30 degrees, 90 degrees and total distance achieved. The distances achieved by the subjects were measured in centimeters. Combined mean distances achieved in each separate measurement can be seen in Table 4.

Table 4

Summary of Asterisk Program performed at 0 degrees, 30 degrees, 90 degrees and combined Total Sum of Distance Achieved

	Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	N
Asterisk @ 0deg.	Experimental	41.875 (4.87)	47.25 (7.63)	4
	Control	47.83 (6.25)	46.33 (11.25)	3
Asterisk @ 30deg.	Experimental	47.875 (6.49)	50.5 (6.12)	4
	Control	48 (7.36)	48 (14.10)	3
Asterisk @ 90deg	Experimental	55 (6.78)	61.625 (6.86)	4
	Control	52.67 (14.35)	49.33 (13.57)	3
Total sum of Asterisk	Experimental	144.74 (17.42)	159.375 (19.49)	4
	Control	148.5 (26.86)	143.67 (38.26)	3

For the BAPS Board, a multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test. In the experimental BAPS Board group, a pre-test mean was recorded at 5, and a post- test mean was recorded at a 5.875, which resulted in an increase of a mean of .875. This increase is equivalent to acquiring more than an additional three range of motion touch-downs after the intervention of the Brian Mulligan mobilization and taping procedure.

The control BAPS Board group recorded a pre-test mean of 4.83 and a post-test mean of 4.916. This resulted in an increase of only .086, or an equivalent increase of less than one more touch down range of motion acquired. No significant difference existed in ankle functional range of motion between groups, resulting in the null hypothesis being accepted. Table 5 summaries ANOVA values for ankle functional range of motion.

Table 5

Summary of BAPS Board Pre and Post – Test of Ankle Functional Range of Motion

	n	Pre-Test Mean	Post-Test Mean	Significance	Power
Experimental	4	5	5.875	0.21	0.217
Control	3	4.83	4.916	0.21	0.217

$F\ (1, 5) = 2.063; p > .05$

For the Asterisk Program performed at 0 degrees, a multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test. In the experimental pre-0 degrees asterisk program, a mean distance achieved of 41.875 cm was calculated. In the experimental post-0 degrees asterisk program, a mean distance of 47.25 cm was calculated. Therefore in the experimental group, an increase of 5.375 cm was acquired. In the Control pre- 0 degrees asterisk program, a mean distance of 47.83 cm was calculated. In the Control post- 0 degrees asterisk program, a mean distance of 46.33 cm was calculated. This resulted in a decrease of 1.5 cm. No significant difference existed in ankle functional range of motion between groups, resulting in the null hypothesis being accepted. Table 6 summaries ANOVA values for ankle functional range of motion.

Table 6

Summary of Asterisk Program performed at 0 degrees, Pre and Post – Test of Ankle Functional Range of Motion

	n	Pre-0deg.Asterisk Program Mean	Post-0deg. Asterisk Program Mean	Significance	Power
Experimental	4	41.875	47.25	0.099	0.376
Control	3	47.83	46.33	0.099	0.376

$F (1, 5) = 4.105; p>.05$

For the Asterisk Program performed at 30 degrees, a multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test. In the Experimental pre- 30 degrees Asterisk program, a mean of 47.875cm was calculated. In the Experimental post- 30 degrees Asterisk program, a mean of 50.5cm was calculated. This resulted in a 2.265 cm increase. In the Control pre- 30 degrees Asterisk program, a mean of 48cm was calculated. In the Control post-30 degrees Asterisk program, a mean of 48cm was recorded. This resulted in neither an increase or in a decrease in the functional ankle range of motion achieved. No significant difference existed in ankle functional range of motion between groups, resulting in the null hypothesis being accepted. Table 7 summaries ANOVA values for ankle functional range of motion.

Table 7

Summary of Asterisk Program performed at 30 degrees, Pre and Post – Test of Ankle Functional Range of Motion

	n	Pre-30deg.Asterisk	Post-30deg. Asterisk	Significance	Power

		Program Mean	Program Mean		
Experimental	4	47.875	50.5	0.618	0.072
Control	3	48	48	0.618	0.072

F (1, 5) = .282; P> .05

For the Asterisk Program performed at 90 degrees, a multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test. In the Experimental pre- 90 degrees Asterisk program, a mean of 55cm was calculated. In the Experimental post- 90 degrees Asterisk program, a mean of 61.625cm was calculated. This resulted in a 6.625cm increase. In the Control pre- 90 degrees Asterisk program, a mean of 52.67cm was calculated. In the Control post-90 degrees Asterisk program, a mean of 49.33cm was recorded. This resulted in a decrease of 3.34cm. Significant differences existed in ankle functional range of motion at 90 degrees between groups, resulting in the null hypothesis being rejected. Table 8 summaries ANOVA values for ankle functional range of motion.

Table 8

Summary of Asterisk Program performed at 90 degrees, Pre and Post – Test of Ankle Functional Range of Motion

	n	Pre-90deg.Asterisk Program Mean	Post-90deg. Asterisk Program Mean	Significance	Power
Experimental	4	55	61.625	0.005	0.963
Control	3	52.67	49.33	0.005	0.963

F (1, 5) = 22.756; P = .005

For the Total Sum of Distance achieved during the Asterisk Program, a multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test. In the Experimental Pre-Total Sum of Distances achieved during the Asterisk program, a mean of 144.75cm was calculated. In the Experimental post- Total Sum of Distances achieved during the Asterisk program, a mean of 159.375cm was calculated. This resulted in a mean increase of 14.625cm increase. In the Control pre- Total Sum of Distances achieved during the Asterisk program, a mean of 148.5cm was calculated. In the Control post- Total Sum of Distances achieved during the Asterisk program, a mean of 143.67cm was recorded. This resulted in a decrease of 4.83cm. No significant differences were found in total ankle functional range of motion between groups, resulting in the null hypothesis being accepted. Table 9 summaries ANOVA values for ankle functional range of motion.

Table 8

Summary of Total Sum of Distance achieved during Asterisk Program, Pre and Post – Test of Ankle Functional Range of Motion

	n	Pre-Total deg. Asterisk Program Mean	Post-Total deg. Asterisk Program Mean	Significance	Power
Experimental	4	144.75	159.375	0.082	0.421
Control	3	148.5	143.67	0.082	0.421

$F(1, 5) = 4.732$; $P > .05$

Summary

From this study, five separate measures of functional ankle range of motion were calculated. Measurements were calculated using the BAPS Board, Asterisk Program at 0 degrees, 30 degrees, 90 degrees, and total sum of Asterisk Program functional ankle range of motion. Results from the BAPS Board, Asterisk Program at 0 degrees, 30 degrees and the total sum of Asterisk Program functional ankle range of motion were found to be statistically non-significant ($P>.05$). Results from the Asterisk Program at 90 degrees were found to be statistically significant ($p=.005$).

Although results from the BAPS Board, Asterisk Program at 0 degrees, 30 degrees, and total sum of Asterisk Program functional ankle range of motion were found to be statistically non-significant, increases in mean functional ankle range of motion were found in each of the experimental groups. This finding may not have proven to be statistically significant, but these results of positive increases of ankle mean range of motion may prove to be of clinical significance.

Summary of the results from the control groups in these five separate measurements found that in the Asterisk Program at 0 degrees, 90 degrees, and in the total sum of Asterisk Program functional ankle range of motion group, all had mean decreases in ankle range of motion. The control group in the Asterisk Program performed at 30 degrees had no difference in mean functional ankle range of motion. BAPS Board functional ankle range of motion results in the control group producing only a minimal insignificant increase.

CHAPTER 5

Discussion

Lateral ankle sprains are commonly seen in all ages of our population and are the most commonly evaluated and treated injury by sports medicine professional (Crites, 2005). With this common occurrence, many theories and approaches of treatment have been established to decrease this incidence and to help individuals return to their activities of daily living without pain and with full function as soon as possible. One of these theories has been Brian Mulligans (2004) concept of a joint positional fault occurring at the distal tibiofibular joint. Correction of this anatomical positional fault consists of proper and precise mobilizations and the use of the Brain Mulligan taping procedure for lateral inversion sprains (Mulligan, 2004). Very little research has been performed on this theory and no research has been performed on this theory and its relation to functional range of motion of an inversion ankle sprain. The purpose of this study was to determine if the Brain Mulligan mobilization with taping procedure significantly increased the functional range of motion of an inversion ankle sprain. The BAPS Board and the Asterisk program were used to determine the functional range of motion of inversion ankle sprains. Range of motion measurements were recorded after the completion of pre-test and post-test trials in the control and experimental groups. BAPS Board range of motions of dorsiflexion, plantarflexion, eversion and inversion were tested. Asterisk program range of motion was tested at degrees of 0, 30, and 90.

Four females and three males (N=7), aged 19-32 years, with the average age being 24.3 years, qualified and agreed to participate in the study. Subjects were randomly assigned to two groups: Control and Experimental. Four subjects were in the experimental group and three were in the control group.

Using a multivariate repeated measures ANOVA, statistical comparisons were determined between groups at pre-test and post-test for the BAPS Board and the Asterisk program. A small sample size of $n = 7$, most likely hindered the statistical results of this study and also the statistical power.

BAPS Board Summary

In the experimental BAPS Board group, a pre-test mean was recorded at 5, and a post- test mean was recorded at a 5.875, which resulted in an increase of a mean of .875. This average mean increase of .875 is equivalent to a subject acquiring more than three additional range of motions after the intervention of the Brian Mulligan mobilization with taping procedure. The control BAPS Board group recorded a pre-test mean of 4.83 and a post-test mean of 4.916. This resulted in an increase of only .086, or an equivalent increase of less than one more range of motion acquired. When statistical analysis of group comparisons was performed, no statistical differences ($p>.05$) in ankle functional range of motion were found. Although not statistically significant, increases were found and recorded in the experimental group that had the intervention of the Brian Mulligan mobilization with ankle taping. This may support the idea that the application of the Brian Mulligan mobilization with ankle taping can be clinically significant in the rehabilitation process. By applying the Brian Mulligan mobilization with taping procedure, the possible positional fault that the subjects may have acquired within these inversion ankle sprains may have been anatomically corrected. This taping procedure may have realigned the fibula which then allowed for a more complete and pain-free range of motion in inversion and plantarflexion.

A number of studies have been performed that support the idea that the BAPS Board is advantageous to the rehabilitation process. Matsusaka, Yokoyama, Tsuruaki, Inokuchi, and Okita (2001) found in their study on the effects of ankle disk training on functionally instable ankles that postural sway measurements decreased significantly after four weeks and were within normal range at six weeks. Hoffman and Payne (1995), set out to determine if BAPS Board ankle training would reduce proprioceptive deficits and increase postural control in healthy subjects. The experimental group in this study showed significant decreases in postural sway in medial – lateral and anterior – posterior parameters. These two studies show great support for the use of the BAPS Board in the rehabilitation setting. Our present study does not negate this support, but the use of the BAPS Board to test increases in functional range of motion of an ankle joint in a numerical measured form may not be the best application of the BAPS Board.

Summary of Asterisk Program Performed at 0 Degrees

In the experimental pre-0 degrees asterisk program, a mean distance achieved of 41.875 cm was calculated. In the experimental post-0 degrees asterisk program, a mean distance of 47.25 cm was calculated. Therefore in the experimental group, a mean increase of 5.375 cm was acquired. In the Control pre- 0 degrees asterisk program, a mean distance of 47.83 cm was calculated. In the Control post- 0 degrees asterisk program, a mean distance of 46.33 cm was calculated. This resulted in a decrease of 1.5 cm. Statistical analysis was performed between groups and there was found to be no statistical significance ($p>.05$). Although non-significant statistically, increases in functional ankle range of motion were found in the experimental group that could be thought of as clinically significant, whereas a decrease in functional ankle range of motion was found in the control group.

Asterisk Program performed at 0 degrees was a chosen functional exercise because of its ability to test the ankle talocrural joint in a sagittal plane of motion. As known, dorsiflexion can be one of the main ranges of motions that can be impaired following an inversion ankle sprain (Collins, 2004). By performing the Asterisk Program at 0 degrees with the application of the Brian Mulligan mobilization with taping procedure it can be determined to what extent this procedure could benefit the functional rehabilitation. As discussed previously, the experimental group increased mean functional range of motion as compared to decreased functional range of motion in the control group. These gains in functional range of motion could be the credit of the Brian Mulligan mobilization with taping procedure correcting a positional fault of anterior displacement of the fibula that prevented a motion of dorsiflexion. Subjects may have felt more support and a decrease in discomfort, allowing them to achieve greater functional range of motions. The control group was recorded as having a mean loss of 1.5cm in functional range of motion. This may have been caused by a restriction of functional range of motion by a positional fault of the fibula. Discomfort may have been experienced on the first attempt of the Asterisk Program at 0 degrees which may have brought on a guarding during the second attempt which contributed to a mean loss in functional range of motion.

Summary of Asterisk Program Performed at 30 Degrees

In the experimental pre- 30 degrees Asterisk program, a mean of 47.875cm was calculated. In the Experimental post- 30 degrees Asterisk program, a mean of 50.5cm was calculated. This resulted in a 2.265 cm increase. In the Control pre- 30 degrees Asterisk program, a mean of 48cm was calculated. In the Control post-30 degrees Asterisk program, a mean of 48cm was recorded. This resulted in neither an increase or in a decrease in the functional ankle range of motion achieved. No statistical significant difference was found in ankle functional range of motion between groups ($p>.05$).

In the Asterisk Program performed at 30 degrees, only a minimal mean increase was achieved in the experimental group and neither an increase nor decrease was seen in the control group. In comparison to the other variations of functional range of motions that were tested in the Asterisk Program, performance at 30 degrees resulted in the least amount of positive mean gains of functional range of motion. Functional range of motion tested at 30 degrees activates motions in a transverse plane instead of a motion performed in a sagittal plane as seen at 0 degrees, or a frontal plane as seen at 90 degrees. Functional range of motion tested at 30 degrees may promote more of a dorsiflexion and eversion route to achieve functional degrees of range of motion. Due to this possibility, the application of the Brian Mulligan mobilization with taping procedure would be of little help. The Brian Mulligan mobilization with taping procedure is intended to increase inversion and dorsiflexion ranges of motion. During an Asterisk Program trial at 30 degrees this would not be beneficial due to the motion of eversion. Therefore it can be seen to as why only a minimal achievement was acquired during the experimental group and why no achievement was acquired during the control group. The minimal mean achievement acquired in the experimental group may have been a result of the possible increase of dorsiflexion gained from the application of the Brian Mulligan mobilization with taping procedure. The use of the Asterisk Program at 30 degrees can be questionable for functional rehabilitation of inversion ankle sprains.

Summary of Asterisk Program Performed at 90 Degrees

In the Experimental pre- 90 degrees Asterisk program, a mean of 55cm was calculated. In the Experimental post- 90 degrees Asterisk program, a mean of 61.625cm was calculated. This resulted in a 6.625cm increase. In the Control pre- 90 degrees Asterisk program, a mean of 52.67cm was calculated. In the Control post-90 degrees Asterisk program, a mean of 49.33cm was recorded. This resulted in a decrease of 3.34cm. Significant differences existed in ankle functional range of motion between groups ($p=.005$).

The Asterisk program performed at 90 degrees was the only measurement of functional range of motion that produced results that were statistically significant. Performance of the Asterisk program at 90 degrees requires the involved ankle to perform motion in the frontal plane that produces inversion. This is important because the ankle is performing the main motion of inversion that is limited in lateral ankle sprains. The improvement found in the experimental group is not only statistically significant, but is also clinically significant because it shows that the Brian Mulligan mobilization with taping procedure was beneficial in improving inversion. These results provide support for cases that have been presented by Brian Mulligan (2004). One such case was a man who presented with zero degrees of inversion. After application of dorso cranial mobilization by Brian Mulligan, the patient was able to fully invert his ankle without any pain. A second case that is supported by these results is a case that occurred in England during one of Brian Mulligans' courses. During this course a therapist was present who was unable to invert her foot for 13 years. This therapists' fibula was glided dorsally and maintained in that position. While in this position, she was able to actively achieve full inversion. These results provide great support for the use of the Brian Mulligan mobilization with taping procedure for the increase of inversion in that lateral ankle sprain.

Summary of Total Sum of Distance Achieved During Performance of Asterisk Program

In the Experimental Pre-Total Sum of Distances achieved during the Asterisk program, a mean of 144.75cm was calculated. In the Experimental post- Total Sum of Distances achieved during the Asterisk program, a mean of 159.375cm was calculated. This resulted in a mean increase of 14.625cm increase. In the Control pre- Total Sum of Distances achieved during the Asterisk program, a mean of 148.5cm was calculated. In the Control post- Total Sum of Distances achieved during the Asterisk program, a mean of 143.67cm was recorded. This resulted in a decrease of 4.83cm. Statistical significance was not found between the experimental and control group ($p>.005$).

When looking at the combined results of all of the Asterisk program measurements of functional range of motion, it can be seen that the results in the experimental groups combined for an increase in functional range of motion. When looking at the combined results of functional range of motion in the control groups, it can be seen that a loss in functional range of motion was achieved. Although these results were found to be statistically non-significant, it is worthy to note that these results can be described as possibly clinically important.

Conclusion

Results from this study can be viewed as being very supportive to the theory of a positional fault occurring at the distal tibiofibular joint in subjects who have sustained acute lateral inversion ankle sprains. Also from this study, health care providers can be very optimistic that the application of the Brian Mulligan mobilization with taping procedure can be clinically benefited to subjects that have sustained inversion lateral ankle sprains. Results from this study may give reason to believe that forces are transmitted though the fibula during an inversion lateral sprain causes it to be drawn anteriorly and caudally (Hetherington, 1996). During this study the performance of the Brian Mulligan mobilization may have helped relocate the fibula in a position closely related to the correct anatomical position. This may have then allowed a greater functional range of motion. This position was seemingly held in place by the application of the Brian Mulligan taping procedure for the correction of a positional fault. These two applications in conjunction with each other proved to be beneficial, even though only minimal and in most cases statistically insignificant.

The application of the Brian Mulligan mobilization with taping procedure not only could have relocated the fibula, but also could have supplied a sense of a "supportive" feeling and comfort to the experimental group. Two out of the four experimental subjects were quoted as saying satisfactory remarks towards the Brian Mulligan mobilization with taping procedure. Unsolicited comments were recorded as followed: Subject # 6 was quoted as saying, "I feel much more stable and comfortable with this taping." Subject # 7 was quoted as saying, "This tape job feels very supportive, and do you think that I could have this tape job when I go to my practices and games?" Subject #7 did continue to use the application of the Brian Mulligan mobilization with taping procedure for the remainder of her sport participation during the spring season.

The small decreases in functional range of motion seen in the control groups could be due to a number of reasons. Two of the main reasons for the decrease in functional range of motion could be muscle guarding and pain. With the fibula in a positional fault, pain may be experienced when a subject tries to perform complete ranges of motion. Once a subject performed their first trial and experienced pain, muscle guarding and tension may have been activated during their second attempt to prevent them from reaching the same degree of functional range of motion that produced pain in their first attempt.

Applicability

Health care providers can implement the Brain Mulligan mobilization with taping procedure into the rehabilitation and therapy of lateral inversion ankle sprains. This application can be very helpful in aiding and improving the traditional "cook book" methods of rehabilitation for lateral inversion ankle sprains. This procedure can be performed immediately following a lateral inversion sprain granted that no fractures have taken place. In theory, the early application will reposition the fibula in its correct position and prevent the possibility of the maintenance of the fibula in the anterior and caudal displacement by the arrival of effusion (Hetherington, 1996). From this early application, this taping can be left on throughout the night until the next day when treatment with a health care provider resumes. This application can be used throughout all phases of the rehabilitation process. This application can be utilized when the subject is weight bearing as well as non-weight bearing. Application of the Brian Mulligan mobilization with taping can be used with such initial functional exercises as open – chain range of motion theraband exercises and proprioceptive exercises such as Dynadisk, minitramp, and tilt board. The use of this application can be used throughout the functional phases all the way to more challenging therapeutic exercises such as running, cutting and sport specific activities. When full sport participation has resumed, it does not mean that the application of the Brian Mulligan mobilization with taping procedure must stop. This application can be used in conjunction with the basic basket weave taping procedure for the prevention of ankle sprains. This procedure can be implemented as an addition step in the taping procedure for the prevention of a lateral inversion ankle sprain. The Brian Mulligan mobilization with taping procedure can be implemented in just about every aspect of the treatment and prevention of lateral inversion ankle sprains. This intervention leaves the rehabilitation possibilities endless for the healthcare provider.

Recommendations for Future Research

The following recommendations for future research are made:

1. Perform a study with the same hypothesis over a more longitudinal time that will allow a greater amount of subjects to be present. This will enhance the statistical significance and statistical power of the study.

2. Research needs to be provided on the affect of the Brian Mulligan mobilization with taping procedure throughout a complete rehabilitation program. This will help

determine the possible deceases in the amount of time lost from sport participation, work, leisure activities, or activities of daily living.

3. More research needs to be provided in the aspect of the effect of the Brian Mulligan mobilization with taping procedure in the prevention of lateral inversion ankle sprains. This may help provide answers to how the occurrence of lateral inversion ankle sprains may be limited

4. Research the affect of the Brain Mulligan mobilization with taping procedure on chronic cases of lateral inversion ankle sprains. This will help give a comparison between acute and chronic cases, and determine the significance between each.

5. Perform a study that compares the effects of the Brian Mulligan mobilization with taping procedure between Grade 1 lateral inversion ankle sprains and Grade 2 lateral inversion ankle sprains. This will help determine the significance of this procedure within each lateral inversion ankle sprain classification.

6. Perform studies that expand on the other functional range of motion exercises such as Dynadisk, wobble board and tilt board. This may help determine which functional activities are best suited for lateral inversion ankle sprain rehabilitation.

7. Acquire more subjective information from subjects after the application of the Brian Mulligan mobilization with taping procedure. This may provide significant information as to the satisfaction of the subject.

8. Perform a study that questions health care providers' knowledge, thoughts, and degree of use of the Brian Mulligan mobilization with taping procedure. This will help to determine if the theory is reaching out to health care providers, if there is a clear

understanding of the theory, and if many health care providers are putting this theory to practice.

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The Effect of the Brian Mulligan Mobilization with Taping Procedure for Inversion Ankle Sprains on Functional Range of Motion

Michael Cappella

Introduction: Inversion ankle sprains are a common occurrence in today's sports and society. Many preventative strategies, common rehabilitation programs, and modalities are used to avoid this occurrence or re-occurrence of an ankle sprain. Although satisfactory results can be achieved with the use of conventional therapeutic avenues, problems or complications may still occur. This study sets out to determine the significance of the Brian Mulligan mobilization with taping procedure for inversion ankle sprains on functional range of motion.
Subjects: Seven subjects volunteered for the study. They consisted of 4 females and 3 males ranging in age from 19-32 years.
Measurements: Functional range of motion was measured by using two different functional therapeutic exercises: BAPS Board and Asterisk Program. The BAPS Board was used to test the achievement of the range of motions of dorsiflexion, eversion, plantarflexion and inversion. The Asterisk Program tested functional range of motions in the vectors of 0, 30, and 90 degrees.
Statistical Analysis: A multivariate repeated measures ANOVA was used to determine whether significance existed between groups at pre-test and post-test of both the BAPS Board and Asterisk Program.
Results: Significant statistical differences (P=.005) existed in ankle functional range of motion between groups when the Asterisk Program was performed at 90 degrees. No other significant statistical differences were found between groups in any other measurement of the Asterisk Program or in the BAPS Board. Although Limited statistical significance was found within this study, results proved to show that clinical significance may exist with the use of the Brian Mulligan Mobilization with Taping Procedure.

Introduction

Ankle sprains are the most commonly evaluated and treated injury by sports medicine professionals (Crites, 2005). Physiotherapists, athletic trainers and physical therapists are all aware of the frequency of ankle sprains. With this awareness, medical professionals are continually trying to help prevent ankle sprains, improve rehabilitation, and decrease the amount of time that the patient is out of activity, work, or their sport.

The current and most widely excepted theory today is that with a lateral inversion sprain, the lateral ligament complex is damaged (Hetherington, 1996). Along with this excepted theory many preventative strategies, common rehabilitation programs, and modalities are used to avoid the occurrence or re-occurrence of an ankle sprain.

Prevention can be successfully accomplished with basketweave taping, ankle bracing and restrictive footwear. If an incidence of an ankle sprain does occur, many traditional rehabilitation programs can be implemented. These rehabilitation programs typically begin with RICE (rest, ice, compression, elevation) and then follow a continuum of gait training, low level therapeutic exercises, proprioceptive training, and then possibly sport specific drills for athletes. Once this level is achieved, patients are usually able to function well enough to return to their daily activities. Along with the rehabilitation process, modalities such as ice, ultrasound and electrical stimulation are used to help with pain modulation and to put the anatomical structures in the correct environment for healing (Starkey, 1993).

Although satisfactory results can be achieved with the use of conventional therapeutic avenues, problems or complications can occur. Patients may experience chronic functional instabilities and be prone to re-injury (Hertel, 2002). For patients who are athletes, their return to participation maybe delayed or postponed. With these common recurrent negative side effects, new approaches and improvements must be sought out to improve outcomes.

One approach that has been developed is based on the Mulligans' concept of joint positional faults (Hetherington, 1996). This alternate theory states that when an inversion sprain occurs, the lateral ligament complex remains intact and the forces are transmitted though the fibula (Kavanagh, 1999). The fibula is therefore subluxed forward and caudally on the tibia at the inferior tibiofibular joint. This results in a minor positional fault with decreased functional ability and pain.

Treatment for this positional fault would consist of MWM (Mobilizations With Movement) and application of the Mulligan taping for inversion ankle sprains. By performing a mobilization on the distal fibula in an anteroposterior (AP) direction, and providing the Mulligan taping procedure, great improvements could be made in the painfree range of inversion (Kavanagh, 1999). Mulligan (2004) emphasizes that the AP mobilization is specifically in a dorso cranial direction. This taping procedure (see Figure 1) is used to hold the fibula in place and maintain the correct anatomical positioning (Mulligan, 2004). The importance of Mulligan taping and dorso cranial mobilization and its relation to rehabilitation has not been clinically proven. By performing a dorso cranial mobilization with the Mulligan taping method, and incorporating it into the rehabilitation process, a new approach to post injury ankle rehabilitation may be achieved.

Figure 1. Brian Mulligan taping procedure for inversion ankle Sprains.

Subjects

Four females and three males (N=7), aged 19-32 years, with the average age being 25.8 years, qualified and agreed to participate in the study. All volunteers met the criteria of: (a) an acute ankle inversion sprain that was less than a third degree sprain, (b) an orthopaedic physician or doctor of podiatric medicine (DPM) determined whether the ankle sprain was less than a third degree sprain and also verified that the ankle sprain was a result of an inversion mechanism, and (c) the subject was able to perform an open-eyed single-leg stance for at least 15 seconds on their involved extremity.

Subjects were randomly assigned to two groups: Control and Experimental. Four subjects were in the experimental group and three were in the control group. Subjects in each group were tested within one week of initial injury. The control group performed the two functional rehabilitation exercises without the Brian Mulligan taping with dorso cranial mobilization for an inversion ankle sprain. The experimental group performed the two functional rehabilitation exercises using the Brian Mulligan taping with the dorso cranial mobilization for inversion ankle sprain.

Volunteer subjects were asked to fill out a subject questionnaire before participation in this study. Variables such as grade of inversion ankle sprain, daily discomfort rating, previous occurrences of inversion ankle sprains, lower leg injuries, lower leg surgeries, and if they considered themselves as athletic or as non-athletic were recorded. Daily discomfort rating was on a scale of 0-10, with 0 representing no discomfort and 10 representing the maximal discomfort experienced. Four of the subjects had Grade 2 inversion ankle sprains and three subjects had Grade 1 inversion ankle sprains. The average daily discomfort rating was a 4.4 out of a possible 10. Five of the seven subjects had had previous inversion ankle sprains to the same ankle being studied. All of the subjects in this study were from an athletic population that had no history of other lower leg injuries or a history of lower leg surgeries.

Measurements

One of the functional exercises was the BAPS Board. The subject was instructed to sit on a stool with their knee in a 90 degree angle and place their foot at a 90 degree angle on the BAPS Board. The height of the stool would be adjusted for comfort and to allow for the correct alignment of the lower extremity. The subject performed this functional exercise without footwear. The certified athletic trainer informed the subjects to stabilize their knee with their hands to prevent any unwanted motion to occur at the knee or hip joint. The certified athletic trainer was positioned in a way so that proper alignment of the subjects' lower extremity could be evaluated and corrected if needed. Also from this positioning, the certified athletic trainer was able to see and confirm all touch downs during the testing procedure. All trials for each subject began on level one of the BAPS Board. The subject was instructed to touch the sides of the board to the ground during each attempt to produce the four basic ranges of motions of dorsiflexion, eversion, plantarflexion and inversion. Subjects were asked to attempt these ranges of motion in this specific order also. After each touch down, the subjects were instructed to return their ankle to the 90 degree starting position. If the subject was able to touch down on all four of these ranges of motion, the next level hemisphere was added and the process continued. When the athlete was unable to touch down on one of these ranges of motion at a certain level, that score was recorded. Once a score was recorded, the subject was asked to try and achieve any remaining ranges of motion on that specific level. If a subject was able to accomplish any of the remaining range of motions, the certified athletic trainer would document this achievement.

The second functional exercise performed was the Asterisk program. The certified athletic trainer would perform the functional exercise for the subject to allow them to see the correct form and procedure. The subject was then allowed to practice the functional exercise as many times as needed with their uninjured ankle to allow themselves to become comfortable and confidence in the procedure of the functional exercise. The subject performed this functional exercise without footwear. The subject was then asked to place their non-injured ankle in the center of the asterisk. The center of the asterisk was marked with a dot to maintain accuracy of foot placement and measurements of distances reached. The certified athletic trainer would make sure that the ankle joint was properly placed and centered in the asterisk. Three vectors of 0, 30, and 90 degrees were tested. A goniometer was used to accurately produce each vector of the asterisk.

With their hand on their hips, the subject would stand on the involved ankle and start by reaching as far as possible in the 0 degree direction and touch down with the heel of the uninvolved foot. The certified athletic trainer was positioned on the subjects injured side to provide stability in a case of lose of balance and to assess for proper form. At the point of touch down, the certified athletic trainers assistant would mark this point of contact with a marker. The subject would continue on to the 30 and 90 degree vector. Order of vectors would be randomized. Between each attempt in a vector, the subject was allowed to return to the center and stand on both feet to regain balance and rest. Emphasis was placed on making sure that the subject was using the motion needed for the asterisk program from their ankle, knee, and hip. Improper forward flexion, extension, or lateral bending from the torso or lumbar region was considered improper form. If a trial contained improper form, the certified athletic trainer would stop the test and once again explain and demonstrate the correct procedure before allowing the subject to continue. After all attempts were completed, distances were measured in centimeters by using a tape measure.

Statistical Analysis

The independent variables in this study were the groups (treatment vs. control) and time of testing (pre and post). The dependant variable measurement of the BAPS Board was recorded in accordance to levels achieved and number of touch downs performed. Scale of achievement began at a level one plus .25 for each direction achieved, and continued on to level one plus .50 and continued in that manner until a possible perfect achievement of a level 5 plus 1.0. The other four dependant variables of this study were the distance reached in each of the three vectors of 0 degrees, 30 degrees, 90 degrees and the total combined distance reached by the subject in the Asterisk Program. Distance achieved in each vector was measured separately and calculated along with a total distance achieved in all of the vectors. Statistical significance was tested using a 2x2 Multiple ANOVA with an alpha level set at .05. If multivariate significance is found, 2x2 ANOVAs for each dependant variable were used to determine specifically where significance had occurred.

Results

From this study, five separate measures of functional ankle range of motion were calculated. Measurements were calculated using the BAPS Board, Asterisk Program at 0 degrees, 30 degrees, 90 degrees, and total sum of Asterisk Program functional ankle range of motion. Results from the BAPS Board, Asterisk Program at 0 degrees, 30 degrees and the total sum of Asterisk Program functional ankle range of motion were found to be statistically non-significant (P>.05). Results from the Asterisk Program performed at 90 degrees (see Table 1) were found to be statistically significant (p=.005).

Table 1. *Summary of Asterisk Program performed at 90 degrees, Pre and Post – Test of Ankle Functional Range of Motion*

	n	Pre-90deg.Asterisk Program Mean	Post-90deg. Asterisk Program Mean	Significance	Power
Experimental	4	55	61.625	0.005	0.963
Control	3	52.67	49.33	0.005	0.963

$F(1, 5) = 22.756$; $P = .005$

Discussion

Results from this study can be viewed as being very supportive to the theory of a positional fault occurring at the distal tibiofibular joint in subjects who have sustained acute lateral inversion ankle sprains. Also from this study, health care providers can be very optimistic that the application of the Brian Mulligan mobilization and taping procedure can be clinically benefited to subjects that have sustained inversion lateral ankle sprains. Results from this study may help give reason to believe that forces are transmitted though the fibula during an inversion lateral sprain causes it to be drawn anteriorly and caudally (Hetherington, 1996). During this study the performance of the Brian Mulligan mobilization may have helped relocate the fibula in a position closely related to the correct anatomical position. This may have then allowed a greater functional range of motion. This position was seemingly held in place by the application of the Brian Mulligan taping procedure for the correction of a positional fault. These two applications in conjunction with each other proved to be beneficial, even though only minimal and in most cases statistically insignificant.

The small decreases in functional range of motion seen in the control groups could be due to a number of reasons. Two of the main reasons for the decrease in functional range of motion could be muscle guarding and pain. With the fibula in a positional fault, pain may be experienced when a subject tries to perform complete ranges of motion. Once a subject performed their first trial and experienced pain, muscle guarding and tension may have been activated during their second attempt to prevent them from reaching the same degree of functional range of motion that produced pain in their first attempt.

Health care providers can implement the Brain Mulligan mobilization and taping procedure into the rehabilitation and therapy of lateral inversion ankle sprains. This application can be very helpful in aiding and improving the traditional “cook book” methods of rehabilitation for lateral inversion ankle sprains. This procedure can be performed immediately following a lateral inversion sprain granted that no fractures have taken place. In theory, the early application will reposition the fibula in its correct position and prevent the possibility of the maintenance of the fibula in the anterior and caudal displacement by the arrival of effusion (Hetherington, 1996). From this early application, this taping can be left on throughout the night until the next day when treatment with a health care provider resumes. This application can be used throughout all phases of the rehabilitation process. This application can be utilized when the subject is weight bearing as well as non-weight bearing. Application of the Brian Mulligan mobilization with taping can be used with such initial functional exercises as open – chain range of motion theraband exercises and proprioceptive exercises such as Dynadisk, minitramp, and tilt board. The use of this application can be used throughout the functional phases all the way to more challenging therapeutic exercises such as running, cutting and sport specific activities. When full sport participation has resumed, it does not mean that the application of the Brian Mulligan mobilization with taping procedure must stop. This application can be used in conjunction with the basic basket weave taping procedure for the prevention of ankle sprains. This procedure can be implemented as an addition step in the taping procedure for the prevention of a lateral inversion ankle sprain. The Brian Mulligan mobilization with taping procedure can be implemented in just about every aspect of the treatment and prevention of lateral inversion ankle sprains. This intervention leaves the rehabilitation possibilities endless for the healthcare provider.

VOLUNTEERS NEEDED!

Do you have an ankle sprain?
Are you interested in trying a new rehabilitation technique?
If your answers are yes, then this study is for you!

"THE EFFECT OF THE BRIAN MULLIGAN MOBILIZATION WITH TAPING PROCEDURE FOR INVERSION ANKLE SPRAINS ON FUNCTIONAL RANGE OF MOTION"

Please see your physician or receptionist for participation in this study or Call 716-812-1698

Time requirement is approximately 30 minutes
Volunteers will be asked to perform two functional exercises

Barry University
Informed Consent Form

Your participation in a research project is requested. The title of the study is “The Effect of the Brian Mulligan Mobilization with Taping Procedure for Inversion Ankle Sprains on Functional Range of Motion.” The research is being conducted by Michael J. Cappella, a student in the Sport and Exercise Science department at Barry University, and is seeking information that will be useful in the field of Athletic Training. The aims of the research are to help determine the importance and value of the Brian Mulligan taping procedure and its contributions to the functional rehabilitation of lateral ankle sprains. In accordance with these aims, the following procedures will be used: Volunteers with an acute ankle sprain will be randomly assigned to either a control group or an experimental group. Volunteer subjects will be asked to perform two functional exercises. These two functional exercises are the BAPS Board (Biomechanical Ankle Platform System) and the Asterisk Program. The control group will perform in this study without the application of the Brian Mulligan taping procedure, while the experimental group will have the Brian Mulligans’ taping procedure incorporated into their functional exercise regimen. We anticipate the number of participants to be 30.

If you decide to participate in this research, you will be asked to participate during your regular rehabilitation schedule. This study will require approximately 30 minutes of your time and will only be a one time trial.

Your consent to be a research participant is strictly voluntary and should you decline to participate or should you choose to drop out at any time during the study, there will be no adverse effects on your health care delivery or the status of your sprained ankle. Participation in this study will not delay the rehabilitation process or delay your time to return to your sport, employment, or your activities of daily living. No further degree of ankle injury can result from the participation in this study.

The risks of involvement in this study are minimal but minor discomfort to the ankle joint is possible during the performance of the functional exercises. Minor discomfort may also occur during the removal of tape from the ankle joint. The following procedures will be used to minimize these risks: The volunteers will practice the functional exercises with their non-injured ankle to gain a complete understanding of the exercise. Along with this the certified athletic trainer will provide the volunteers with any needed support during the performance of the Asterisk Program. Tape remover solution will be provided to aid in the removal of tape.

The benefits to you for participating in this study may include the possibility of gaining a new approach to your rehabilitation that could be advantageous to your recovery. There is no direct benefit to the participants.

As a research participant, information you provide will be held in confidence to the extent permitted by law. Any published results of the research will refer to group averages only and no names will be used in the study. A participant number will be assigned and used for data collection. Data will be kept in a locked file in the researcher's office. Your signed consent form will be kept separate from the data. All data will be retained indefinitely.

If you have any questions or concerns regarding the study or your participation in the study, you may contact me, Michael J. Cappella, at (305) 899-3555, my supervisor, Dr. Sue Shapiro, at (305) 899-3574, or the Institutional Review Board point of contact, Mrs. Nildy Polanco, at (305)899-3020. If you are satisfied with the information provided and are willing to participate in this research, please signify your consent by signing this consent form.

Voluntary Consent

I acknowledge that I have been informed of the nature and purposes of this experiment by Michael J. Cappella and that I have read and understand the information presented above, and that I have received a copy of this form for my records. I give my voluntary consent to participate in this experiment.

______________________ __________
Signature of Participant *Date*

______________________ __________
Researcher *Date*

Experimental/ control **RESULTS** Subject #

BAPS BOARD

Pre-intervention level of achievement and range of motion completion:

		Achieved	
Level 1 + .25, .50, .75, 1.0			
Level 2 + .25, .50, .75, 1.0	Dorsiflexion	Y	N
Level 3 + .25, .50, .75, 1.0	Eversion	Y	N
Level 4 + .25, .50, .75, 1.0	Plantarflexion	Y	N
Level 5 + .25, .50, .75, 1.0	Inversion	Y	N

Post-intervention level of achievement and range of motion completion:

		Achieved	
Level 1 + .25, .50, .75, 1.0			
Level 2 + .25, .50, .75, 1.0	Dorsiflexion	Y	N
Level 3 + .25, .50, .75, 1.0	Eversion	Y	N
Level 4 + .25, .50, .75, 1.0	Plantarflexion	Y	N
Level 5 + .25, .50, .75, 1.0	Inversion	Y	N

ASTERISK PROGRAM

Pre-intervention distance achieved:

0 degrees: Total Distance Achieved:

30 degrees:

90 degrees:

Post-intervention distance achieved:

0 degrees: Total Distance Achieved:

30 degrees:

90 degrees:

"THE EFFECT OF THE BRIAN MULLIGAN MOBILIZATION WITH TAPING PROCEDURE FOR INVERSION ANKLE SPRAINS ON FUNCTIONAL RANGE OF MOTION"

SUBJECT QUESTIONAIRE

Subject # __

Date: _______ Grade of Ankle Sprain: _______

Age: ______ Profession/Occupation: _______

Height:____ Athletic/Non-Athletic: _______

1. What is your daily discomfort rating? 0 1 2 3 4 5 6 7 8 9 10
   Minimal Moderate Maximal

2. Have you ever sprained your injured ankle before? ___________________

3. If yes, approximately how many times?_____________________________

4. Have you ever sprained your non-injured ankle before? _______________

5. If yes, approximately how many times?_____________________________

6. Have you had any other previous ankle or lower leg injuries? ___________

7. If yes, Please explain:____

8. Have you had any previous ankle or lower leg surgeries?_______________

9. If yes, Please explain:____