A COMPARISON OF ATHLETIC TAPE AND THE CLOTH WRAP IN RESTRICTING ANKLE SUPINATION DURING A MAXIMAL VERTICAL JUMP

By

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Abstract

A COMPARISON OF ATHLETIC TAPE AND THE CLOTH WRAP IN RESTRICTING ANKLE SUPINATION DURING A MAXIMAL VERTICAL JUMP

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This study examined the ability of the closed gibney with heel locks and figure-of-eights, and the cotton ankle wrap applied using the Louisiana technique followed with an overlay of athletic tape in the same manner in their ability to limit ankle supination during a maximal vertical jump. For this study, 12 athletes from the 2001-2002 Humboldt State University intercollegiate men’s basketball participated. Data was collected using 2D motion analysis software. A repeated measures ANOVA adjusted for multiple comparisons with a Post Hoc Bonferroni was utilized to analyze the differences between the baseline (no ankle support applied), pretest (with the application of support), and posttest (after 15 minutes of exercise) measurements for each of the two testing conditions.

The data showed the closed gibney significantly reduced ankle supination from the baseline to the pretest measurements ($p = .001$). While no significance existed between the baseline to the posttest ($p = .098$), there was significance between the baseline and posttest ($p = .003$). The cotton ankle wrap showed significance between the baseline and pretest ($p = .002$), the pretest and posttest ($p = .024$), and the pretest to posttest ($p = .009$) measurements. Comparing the two testing conditions showed no significance between baseline ($p = 1.00$), pretest ($p = 1.00$), and posttest ($p = 1.00$).
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Chapter One

Introduction

Athletic taping as a means of injury prevention is widely practiced, although its effectiveness is widely disputed. It is well accepted that the ankle has one of the highest rates of injury among all other joints of the human body (Garrick & Requa, 1988; Gross, Bradshaw, Ventry, and Weller, 1987; Mack, 1982). This injury rate coupled with the varying views on its efficacy has led to numerous studies on the ability of athletic tape to support the ankle. Proponents of ankle taping agree that tape decreases in its support with exercise, but they state that the residual restrictions in motion are still adequate in decreasing extreme ranges of motion (Libera, 1967; Karlsson, Sward, and Andreasson 1993; Gross, Batten, Lamm, Lorren, Stevens, Davis, & Wilkerson, 1994). Opponents of ankle taping argue that the effectiveness of athletic tape decreases with exercise beyond what is necessary to protect the ankle (Ferguson, 1978; McIntyre, Smith, & Denniston, 1983). Emerick (1979) believes that ankle taping is costly in resources as well as in the time commitment of athletic trainers. Fumich, Ellison, Guerin, & Grace, (1981) questioned whether or not the residual restriction provided by the athletic tape post exercise would be adequate in reducing ligamentuous injuries about the ankle. With all of the varying results and ideas on the effectiveness of using athletic tape to prevent injury to the ankle, there is an overwhelming call for further research on this controversial topic. It may be important to think outside the box so to speak, and try looking at different ways to measure whether or not athletic tape is a useful tool in protecting the vulnerable ankle. The use of newer biomechanical video analysis may allow us to offer further insight into this dispute.
Statement of the Problem

The use of athletic tape to prevent injury to the ankle is a common practice. There is an abundance of time and resources being spent on this practice, a practice that is widely disputed among sports health care professionals. There is research available that accepts athletic tape as an efficient means of supporting the ankle for prevention and injury rehabilitation. While at the same time research exists that denounces its use as being ineffective, time consuming, and costly. If athletic tape is to be used to provide support as a preventative measure as well as a treatment for existing ankle sprains, it is important that there be more conclusive studies conducted on its use. These studies should further help to define the mechanism by which athletic tape prevents ankle sprains.

Review of Literature

Prevalence of ankle injuries. There is an abundance of literature on injuries of the ankle. This is probably due to the high incidence of injuries not only in the competitive athlete, but also for those participating in recreational athletics (Gross et. al., 1987). Garrick and Requa (1973) and Robbins, Waked, and Rappel (1995) reported that ankle sprains are the most common sports injury. Obrascous (1985) conducted a study on the Canadian Men’s National Basketball Team and demonstrated that the ankle is the most commonly injured body part for the basketball player. Wilkerson (1992) reported that ankle injuries are the most common joint injury seen in sports medicine, general orthopedics, family practice, or general medicine. Between 20 to 25% of time lost to injuries in running and jumping sports involve the ankle (Mack, 1982). In 1997, Beachy, Akau, Martinson, and Olderr conducted a longitudinal among high school athletes, and
demonstrated the knee to be the most injured body part consisting of 1712 injuries with 610 injuries resulting in at least one day-lost. The ankle was second having 1584 recorded injuries, but 708 of these injuries resulted in at least one day-lost. The authors concluded that although the knee had a higher prevalence of injuries, the injured ankle was responsible for the most days lost.

Epidemiology of ankle injuries. According to Robbins et al., (1995), “90 to 95% of ankle sprains are inversions that cause partial or complete rupture of the anterior talofibular ligament and occasionally the calcaneofibular ligament”. The most common mechanism of injury to the ankle is that of the foot being forced into plantarflexion and inversion. A common scenario is that of a basketball player coming down from a jump and landing on the foot of another player. The ankle in this case, which has a natural pattern of plantarflexion and inversion during a vertical jump, is forced further into inversion, thus causing the athlete to sustain a lateral, or inversion ankle sprain. The natural pattern of the foot during a vertical jump is to fall into a plantarflexed and inverted position (Obrascous, 1985). This ankle positioning has led Obrascous to theorize that the use of an external ankle prophylactic to restrict ankle inversion/plantarflexion during a vertical jump, may help to maintain a neutral ankle position while airborne thus reducing the chance of landing in a compromised position.

Anatomy and biomechanics. The anatomy and biomechanics of the ankle leave the lateral side vulnerable to ligament sprains. The true ankle joint is comprised of three bones, the tibia, the fibula, and the talus. The tibia and fibula come together to form the ankle mortise in which the talus sits. Together, these three bones form the talocrural joint. The talocrural joint is a true hinge joint that provides the ankle with only two
motions, plantarflexion (foot pointing down) and dorsiflexion (foot pointing up) (Hertel, Denegar, Monroe, & Stokes, 1999). Directly inferior to the talocrural joint is the subtalar joint, which is comprised of the talus and the calcaneus. The subtalar joint may be divided into anterior and posterior joints that have separate joint capsules but have the same axis of rotation (Rockar, 1995). Together these two joints allow inversion and eversion of the ankle (Hertel et al., 1999). The talus is a wedged shaped bone that is narrower posteriorly than anteriorly (Rockar, 1995; Loudon, & Bell, 1996). As the ankle is plantarflexed the narrow portion of the talus rotates into the ankle mortise. The anatomical design of the talus explains the slight looseness or increased amount of motion of the ankle joint in plantarflexion. The medial ankle is protected from sprains by the lateral malleolus, which projects farther downward than the medial malleolus. The lateral malleolus serves as an actual physical block to medial or eversion ankle sprains. In contrast to the lateral malleolus, the medial malleolus is shorter and can act as a fulcrum, which can increase the chance of lateral or inversion ankle sprains (Booher & Thibodeau, 1994).

The ligaments of the ankle are lateral, medial, and anterior. The medial deltoid ligament is triangular, thick, and very strong, which stabilizes the joint during eversion and prevents subluxation (Wilkerson, 1992). There are three main lateral ligaments of the ankle, the anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament. The anterior ligament of the ankle is the anterior inferior tibiofibular ligament. This ligament holds the tibia and fibula together at the ankle, and is commonly referred to as the syndesmosis of the ankle.
Advocates of ankle taping. The practice of taping to support ligaments of the ankle has been demonstrated in the literature to date back as far as the 1880's when it was used by the U.S. Army (Libera, 1967). Excesses in ranges of motion are commonly recognized as the main mechanism of ligamentous injuries. Therefore it is logical to assume that by limiting these excesses in joint motions one might reduce the incidence of ankle sprains (Reisberg & Verstraete, 1992). “A given ligament can be protected to some extent from damaging overstretch if the movement that produces the stretch is limited by the proper application of tape” (Wickstrom, 1980). Evidence exists that ankle taping restricts the motion associated with inversion sprains (Metcalf & Denegar, 1983). Fumich, Ellison, Guerin, and Grace (1981) measured ankle range of motion immediately before taping, immediately after taping and after a three-hour football practice, and demonstrated that after exercise, there was an average residual restriction of 50% or greater when compared to the initial restriction prior to exercise. They concluded that taping effectively limits the extreme ranges of ankle motion initially, and provides residual restriction during and after exercise. Frankeny, Jewett, Hanks, and Sebastianelli (1993) in a review article concluded that “epidemiological studies have shown ankle taping to be an effective prophylaxis against ankle sprains”. Garrick and Requa (1973) studied the use of athletic tape applied using a stirrup with horseshoe and figure of eight technique on 2,563 collegiate intramural basketball players. In this study it was observed that the use of the athletic tape in conjunction with a high support basketball shoe gave an injury incidence of 6.5/1000 games, while the players with the same style shoe without the use of the athletic tape had and injury incidence of 30.4/1000 games.
Gross et al. (1987) conducted an experimental study to determine if the use of athletic tape applied using a basket weave technique with stirrups and horseshoes, could limit ankle motion before and after a brief bout of exercise. Prior to exercise and immediately after the application of the athletic tape, inversion was decreased by 18.17 degrees. After 10 minutes of non-linear running and 20 toe raises, there was a residual restriction in inversion of 12.97 degrees. The authors concluded that athletic tape significantly reduces ankle inversion before and after a brief period of exercise.

Obrascous (1985) concluded that taping an ankle holds the athletes’ foot in a neutral position while airborne, which offsets the natural pattern of the foot to fall into a plantarflexed/inverted position when the athlete jumps. In addition to the restriction of range of motion, it has been suggested that ankle taping may decrease the chances of sustaining an ankle sprain by improving the user’s judgement of position and orientation of their foot and ankle, otherwise known as proprioception (Robbins et al., 1995). Proprioception refers to the conscious and unconscious appreciation of joint position. Conscious awareness of joint motion and position is essential for proper joint function, whereas unconscious proprioception modulates muscle function and initiates reflex stabilization (Prentice, 1999). Robbins and Waked (1998) believe the support provided by athletic tape is negligible, but that athletic tape may prove beneficial in reducing ankle sprains by improving the judgment of position and orientation of the plantar aspect of the foot in relation to the leg. Wright, Stefanyshyn, and Nigg supported this concept in a 1998 correspondence letter in response to Robins and Waked’s 1998 article in which they write "although the support provided by tape may be small, it may be sufficient to return the ankle to a more stable neutral position while the foot is unloaded, and prior to ground
contact, thereby reducing the occurrence of landing with and inappropriate foot position." Karlsson et al. (1993) brought attention to the effectiveness of ankle taping by giving three possible reasons: 1) reduction of mechanical ankle instability, 2) limitation of extreme ankle motions; and 3) shortening of the reaction time of the peroneal muscles by affecting the proprioceptive function of the ankle joint and the lower leg muscles. Karlsson et al. (1993) further concluded that “ankle taping is highly effective and functional. It increases the mechanical stability of the ankle and decreases the range of motion. It is easy to apply and remove and there are few complications after the use of tape”.

Despite the differences in opinion on the mechanism by which athletic tape may help to prevent ankle injuries, the supporters of its use seem to be content in their own personal philosophy on the matter and continue to practice its use.

Opponents of ankle taping. Preventative ankle taping has met with opposition from physicians and athletic trainers who question its value, and from athletes who complain about the discomfort that taping may cause (Emerick, 1979). Ferguson (1973) denounces preventative ankle taping for the following reasons: 1) the strapping invariably becomes loose during the early stages of activity, 2) the mobile nature of the skin sliding over the subcutaneous structures prevents rigid support, 3) the ability of the lower leg muscles to become stronger is diminished by the tape; and, 4) tape prohibits the subtalar joint from acting as a safety valve in preventing injuries to the ankles and knees. McCluskey, Lewis, and Blackburn (1976) have refuted portions of Ferguson’s work, by stating that the loosening of the tape would permit subtalar joint motion thus allowing it to act as a safety valve while still preventing extreme ranges of motion associated with ankle
sprains. Further concern has been noted that the movements that require extreme
dorsiflexion and plantarflexion and/or movements in which intrinsic shock absorption is
deemed important may be compromised by the restrictions provided by athletic tape
(McIntyre, Smith, and Denniston, 1983). Mayhew (1992) denounced the closed basket
weave because it may impair such activities as vertical jumping, long jumping, or any
performance that requires plantarflexion of the ankle. Taping for preventative measures
has also been noted to be relatively expensive and time-consuming (Alves, Alday,
Ketcham, and Lentell, 1992). The use of athletic tape to support the ankle has been
estimated to cost approximately $1.80 per application (Metcalf, Schlabach, Looney, &
Renehan, 1997).

Ankle taping is generally accepted to restrict initial range of motion, and that the
restricted range of motion decreases after brief periods of exercise (Gross, Lapp, and
Davis, 1991; Emerick, 1979). The question becomes, does the residual restriction
provided by athletic tape post exercise still provide adequate protection against ankle
sprains. There is a disparity in findings of post exercise range of motion among different
studies. Fumich et al. (1981) measured the effects of taping on foot and ankle motion
before and after exercise, and demonstrated that after a three hour football practice, the
taped ankle retained 50% of the original restriction in plantarflexion and inversion
provided by the tape prior to exercise. Rarick, Bigley, Karst, and Malina (1962) also
demonstrated a 50% decrease in the ability of the tape to restrict motion after 10 minutes
of exercise. Fumich et al. (1981) theorized that it is possible for the loosening in the first
10 minutes to be maximal, and further loosening after a long exercise period is not
significant. Malina, Plagenz, and Rarick (1963) reported on the effects of exercise upon
the supporting strength of athletic tape. The study measured range of motion and force restricted by the tape before and after five minutes of exercise. The results demonstrated that exercise of no more than five minutes duration significantly reduced the supporting strength of athletic tape. Myburgh, Vaughan, and Isaacs (1984) reported that no restriction in range of motion may be provided by conventional ankle taping following one hour of vigorous exercise. Glick, Gordon, and Nishimoto (1976) demonstrated that athletic tape held the talus in place for no more than 20 minutes of exercise. After this time, the subtalar motion of taped subjects matched that of the untaped subjects. However the authors of this article failed to mention the method of tape application.

As research grows on the efficacy of athletic tape to support the ankle, the lines of dissention only seem to widen. The proponents of using athletic tape debate the theory’s on how or why it works, while the opponents seem to be comfortable just agreeing that the use of athletic tape is not an effective tool in the battle over ankle sprains.

Tape on skin vs. underwrap. In addition to the overall debate on the use of athletic tape to support the vulnerable ankle, there exists a secondary debate within the community of health care professionals who are advocates of its use. To use underwrap, or not to use underwrap, that is the question. Studies have been conducted which support the tape on skin philosophy while at the same time other studies have concluded that there is no difference between tape on skin and the use of underwrap. There are also studies that have found that tape with underwrap provides more support than taping directly on the skin.

Malina et al. (1963) demonstrated that the tape on skin conditions had a higher supporting strength before and after exercise when compared to the tape over stockinette.
Ricard, Sherwood, Schulthies, and Knight (2000) studied the effects of tape and exercise on ankle inversion. In their study dynamic inversion was measured on 30 subjects with three different testing conditions (no tape, tape on skin, tape with underwrap) before and after exercise. This study concluded that applying tape over underwrap was just as effective as applying tape directly on skin. The tape on skin and the underwrap groups demonstrated about a 10 degree motion restriction compared to no tape prior to exercise. Post exercise the tape on skin condition allowed an increase range of motion of 2.1 degrees and the tape over underwrap allowed a increase range of motion of 1.7 degrees. Manfroy, Ashton-Miller, and Wojtys (1997) evaluated the effects of exercise on tape on skin and underwrap conditions, and measured the ability to restrict weight bearing resistance to ankle inversion in Newton-meters. Results demonstrated that after exercise the tape with underwrap resisted an average of 1.44 N-m more than with the ankle untaped, and the tape applied to the skin resisted an average of 0.21 N-m more than with the ankle untaped. The authors of this study concluded that their data shows a trend suggesting that taping over underwrap may provide greater protection against inversion ankle injuries than taping directly onto the skin. The results of this study are consistent with those of Delacerda (1978). Delacerda demonstrated that the use of underwrap with tape was more effective than tape on skin when limiting inversion. He reported that inversion increased 7.67 degrees after exercise for the underwrap, and 7.88 degrees for the tape on skin.

The differences in motion restriction between ankles taped with underwrap and ankles that are taped directly to the skin are evident. However, the differences are small in comparison to the overall motion that is restricted by the use of athletic tape.
Closed Gibney (basket weave) ankle tape. A closed Gibney or basket weave ankle tape with a double heel lock and figure eight’s has been demonstrated in the literature as an effective method of taping an ankle to prevent excessive ranges of motion, particularly inversion (Gross et al., 1987, Rarick et al., 1962, Malina et al., 1963, Ricard et al., 2000). As far back as 1940, the closed Gibney or basket weave ankle strapping technique without the heel locks was considered the most secure method for reducing ankle sprains (Allen, 1940). The heel locks have since been added and increase the effectiveness of the closed Gibney (Libera, 1967). The heel lock prevents the calcaneous from rolling either inward or outward around the long axis of the foot (Wickstrom, 1980). Rarick et al. (1962) concluded that the closed basket weave combined with heel locks was the most effective means of providing mechanical support to the ankle. Felder and Mcneeley (1978) stated that the basket weave provides compression support for the soft tissues, while the heel locks and figure eight limits plantarflexion and inversion of the ankle.

Cotton ankle wrap. The cotton ankle wrap has been said to be clinically effective in preventing ankle injuries by health care professionals and certified athletic trainers (Davies, 1977). The cotton ankle wrap has its roots as far back as 1930 where it was used by Harvard University as a regular preventative procedure (Quigley, Cox, and Murphy, 1946). This method of ankle stabilization is not quite as plentiful in more recent literature as is the closed Gibney. Malina et al. (1963) concluded that although the cotton ankle wrap does give some protection prior to exercise, the wrap is quickly loosened by exercise and after five minutes of vigorous physical activity it does not add materially to the support of the unwrapped ankle. Libera (1962) studied ten football players over the course of a 110-minute practice on separate days with different methods of taping and the
cotton ankle wrap, and similar to Malina et al. (1963), measured both extreme ranges of plantarflexion and inversion as well as force restricted by the supports. He concluded that the taping methods provided significantly greater support (34%) than ankle wraps in the pre and post-measurements. Simon (1969) reported on the effectiveness of ankle taping and cotton wrapping in the prevention of ankle injuries, and concluded that there was no difference between the taped and wrapped groups in the numbers of injuries occurred.

The cotton ankle wrap has not been in a published experimental research study since Simon’s 1969 article. Despite the lack of current research the cotton wrap has continued to be used in the clinical setting. Although the majority of studies conducted have found that the cotton ankle wrap provides less support than athletic tape after exercise, the question still exists whether or not the residual restriction afforded by the cotton ankle wrap is sufficient to decrease traumatic ankle sprains.
Purpose

The purpose of this study was to determine if the closed gibney ankle tape with figure of 8's and heel locks, and the cotton ankle wrap could effectively limit ankle supination during a maximal vertical jump before and after exercise. Reduction of supination in the airborne athlete may help to allow the ankle to land in a neutral position thereby decreasing the chance of sustaining a lateral ankle sprain.

Operational Definitions

*Plantar flexion:* Lowering the foot so that the bottom surface moves away from the front of the leg.

*Inversion:* The motion which elevates the inside border of the foot and depresses the outside border of the foot.

*Adduction:* Movement of the ankle complex (talocural and subtalar joints) and foot so that the forefoot turns in.

*Supination:* Any movement of the ankle complex towards the midline of the body from the zero degrees set with the goniometer by the researcher prior to each jump.

Assumptions

In this study, certain assumptions are noted to be implicit in the design and implementation:

1. The subjects contributed their full effort in the execution of the maximal vertical jumps.

2. The instrument chosen to measure supination during the maximal vertical jumps was sensitive enough to measure fine movements of ankle supination.
3. Supination during a maximal vertical jump predisposes an athlete to sustaining an ankle sprain (Obrascous, 1985; Hopper, 1986).

Research Questions

1. Will the application of the closed gibney with figure of 8's and heel locks restrict inversion during the maximal vertical jump before and after exercise?

2. Will the application of the cotton ankle wrap restrict inversion during the maximal vertical jump before and after exercise?

3. Will there be any difference of inversion during the maximal vertical jump between the support provided by the closed gibney with figure of 8's and heel locks and the cotton ankle wrap before or after exercise?

Limitations

The following limitations are noted as they may have affected the outcome of this study.

1. The Peak Motus software used to digitize video into the computer for evaluation could only operate at 30 frames per second. This may have affected the sensitivity of the instrument.

2. The Peak Motus software owned by Humboldt State University only captures two dimensional images. Rotation or movement out of the frontal plane during the vertical jump will not measure supination as defined by the researcher.
Delimitations

The following delimitations are noted as they may have affected the outcome of this study.

1. This study was limited to Division II athletes from the Humboldt State University men's basketball team. By using collegiate level basketball players it was thought that they would be more experienced in performing maximal vertical jumps. This sample has also had previous experience using the "Vertec" vertical jumping system.

2. Exercise designed to stress the ankle tape and cotton wrap was set at 15 minutes which is consistent with current literature which generally ranges from 10-20 minutes of sub maximal exercise.

3. The instrument chosen to measure ankle inversion in this study has not been utilized in previous literature as a method of measuring ankle supination.

Significance of Study

An enormous amount of time and money is being spent on the practice of ankle taping regardless of the varying opinions that exists within the athletic training and allied health care community on its effectiveness. Is taping effective for the prevention of ankle sprains? That is the question that many are striving to answer if an answer is to be elucidated. This debate may never be settled completely, but there needs to be continuing research to either support or refute its use. There is an abundance of literature available on the use of athletic tape and its ability or inability to support the vulnerable ankle. The problem is that most current literature is concerned with obtaining the same measurements but differ by employing different devices to achieve those measurements. This study was designed to examine the role of athletic tape and the cotton ankle wrap in
supporting the ankle in a manner different from the norm. This study incorporated measuring the effect of external ankle support has on ankle motion in a real life setting specific to an athletic population.

The cotton ankle wrap may be archaic in the minds of many. This method of ankle stabilization has been studied in the past but no current literature is available on its effectiveness. Despite this lack of scientific research, there are still the few that have clung on to the cotton ankle wrap and support its use only with anecdotal evidence.

The significance of this study is that it will present a different perspective on the effectiveness of or the ineffectiveness of athletic tape to provide preventative support to the ankle in a real life setting. This study will also pull the cotton ankle wrap out of the archives and provide current literature on its ability or inability to function as a preventative external ankle support.
Chapter Two

Methodology

Subjects. Subjects (n = 12) in this study were Division-II intercollegiate athletes from the men's basketball team at Humboldt State University. All subjects participated voluntarily in this study. All subjects met the inclusion criteria of having not sustained any ankle injury for the two months prior to their participation in this study. Human subjects approval (02-98) was obtained on January 22, 2002.

Instrumentation. To measure the maximal vertical jumps the "Vertec" vertical jump measuring system (Sports Imports, Columbus, OH) was utilized. This system consists of a tall pole with moveable blades at increments of 1/2 inch. Each jump was recorded in the frontal plane with a Cannon digital camera model XL1 3CCD (Cannon Inc, Tokyo, Japan). The iris was set at 1.8 and the shutter speed was at 1/500. The lens of the camera was 30 feet from the toes of each subject. The video captured by the camera was digitally imputed into a computer at 30Hz using Peak Motus two-dimensional motion analyzer software (Peak Performance Technologies Inc., Englewood, CO).

Study Design. On two non-consecutive days each subject was asked to follow identical procedures with the exception of the method of stabilization applied to their ankles. As the subjects for this study all are a part of a very competitive intercollegiate basketball program, each subject was given their own days and times of participation so that only one subject was being tested at a time. It was thought that competition among subjects might skew the results of this study or increase the risk of injury to the subjects.

As appointed, each subject came to the biomechanics laboratory on campus at Humboldt State University. Upon arrival each subject read and signed an informed
consent form. Subjects were then randomly assigned to one of the two testing conditions, either the closed gibney with four heel locks (two on the medial side, and two on the lateral side) and two figure-of-eight’s, or the cotton ankle wrap.

To prepare the subjects for the maximal vertical jumps, subjects performed a warm up consisting of a five minute warm up on a stationary cycle followed by ten consecutive vertical jumps. Prior to performing the maximal vertical jumps, 1/2-inch reflective markers (Peak Performance Technologies Inc.) were placed on three anatomic positions of the lower leg. Subjects were positioned with their feet shoulder width apart facing forward towards the camera. The first reflector was placed on the tibial tubercle. A standard goniometer was placed on the anterior ankle with the axis of rotation directly over the talocrural joint. This spot was marked and a reflector was placed. The goniometer was again placed with its axis over the talocrual joint with the fixed arm pointing directly at the marked tibia tubercle, the movement arm was set at exactly 180 degrees and the third spot was marked on the dorsum of the forefoot with a reflective marker. For the purpose of this research this alignment will be referred to as 0 degrees of inversion. The goniometer was used to make sure the reflectors were set at 180 degrees prior to each jump. After the aforementioned warm up and the reflectors were placed, subjects performed the first of the three jumps. All three jumps were performed without shoes. The height of each jump was measured and recorded with the “Vertec” Vertical Jumping System. All jumps were performed bare footed. The first of these three jumps were performed with no external ankle stabilization applied. A single jump was performed and recorded. This jump was to serve as a baseline for the following two jumps.
The second jump was performed with the testing condition that was randomly selected by the subject, either wrap or tape. Both ankles were supported with either the closed gibney with heel locks and figure-of-eight’s (Appendix A), or the cotton ankle wrap (Appendix B). A single experienced athletic trainer certified by the National Athletic Trainers Association, applied all taping and wrapping in a standardized method. Again subjects performed a single jump which was then digitized into the computer for evaluation.

It is an undisputed fact that athletic tape decreases in its support during activity. With this in mind, a 15-minute bout of exercise preceded and followed by 10 consecutive vertical jumps were performed for the purpose of stressing the tape prior to the third and final jump. The duration of the exercise bout was designed to cause the subjects to perspire, which would cause the tape to lose some of its adherence to the skin. The pattern of the exercise was designed to apply lateral stresses to the wrap/tape supports. This pattern was adapted from the Illinois Agility Run, which was originally designed to be a timed test to evaluate speed and agility. The pattern was modified by the researcher to be a continuos loop with figure-of-eight’s which were to be jogged at a sub-maximal level (Appendix C). Subjects jogged for seven and a half minutes clockwise and then seven and a half minutes counter clockwise to ensure that the supports were evenly stressed. To apply stresses to the plantar flexion aspect of the supports, subjects performed 10 consecutive vertical jumps prior to the 15 minutes of jogging, and 10 more consecutive vertical jumps after the exercise. All exercise was supervised by the primary researcher to ensure that no more or no less was being done to stress the ankle supports beyond what was designed. Subjects then returned to the biomechanics laboratory and
performed one last jump that was recorded and digitized. This last jump was performed in the same manner as the previous jumps.

*Statistical Analysis*

The data collected was evaluated using a repeated measures ANOVA and adjusted for multiple comparisons with a Post Hoc Bonferroni. Significance was looked for within subjects under the same testing condition between the baseline, pre test and post test measurement, and within subjects between the two testing conditions. Means were then calculated for the baseline, pre tests, and posttest measurements for each of the two testing conditions. The repeated measures ANOVA was then applied to the data to check for significance within each of the two testing conditions and between the two testing conditions.
Chapter Three

Results

In this study, two different methods of ankle stabilization were assessed in their ability to reduce ankle supination during a maximal vertical jump. The methods of ankle stabilization used were the closed gibney with heel locks and figure-of-eight's, and the cotton ankle wrap. All data was analyzed using SPSS for Windows Standard Version 10.0 (SPSS, Inc. 1999) to determine if either of the two ankle stabilization methods was effective at reducing ankle supination. The criterion for statistical significance was set at the .05 alpha level.

Twelve subjects from the NCAA Division II men's basketball team at Humboldt State University participated in this study. Each subject performed two trials. Each trial consisted of three separate maximal vertical jumps. The first trial was performed with one of the two testing conditions, which was randomly assigned to each subject on their first visit. The second trial was then performed with the remaining testing condition. For each trial a baseline (no support), a pretest (immediately after application of ankle support), and a posttest measurement (with support after exercise) was recorded. All measurements were obtained by video recording each jump and digitally imputing the video into Peak Motus motion analysis software (Peak Performance, Inc.). Raw data and means are presented in Table 1 and Figure 1.

All data was analyzed using a repeated measures ANOVA and adjusted for multiple comparisons with a Post Hoc Bonferroni. Results for the trials utilizing the closed gibney with heel locks and figure-of-eight's showed that this method of stabilization was significant at reducing ankle supination from the baseline measurement.
Table 1

Raw Data and Mean Scores in Degrees

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<th></th>
<th>Cotton Ankle Wrap</th>
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</table>

Mean Scores 12.96 6.01 8.18 11.74 5.73 7.66

(M = 12.96, SD = 3.91) to the pretest measurement (M = 6.01, SD = 3.90) (p = .001). No significance exists between the pretest and the posttest measurements (M = 8.18, SD = 2.46) (p = .098). However there is significance between the baseline and the posttest scores (p = .003).
Results for the trials utilizing the cotton ankle wrap proved to be significant at reducing ankle supination from the baseline measurement ($M = 11.74, SD = 3.78$) to the pretest measurement ($M = 5.73, SD = 3.31$) ($p = .002$). Significance also exists between the pretest and posttest measurements ($M = 7.66, SD = 3.20$) ($p = .024$).

The baseline and posttest measurements also demonstrate a significant difference ($p = .009$).

Comparing the baseline measurements between the tape and wrap trials showed no significance ($p = 1.00$). These results were the same for the pretests ($p = 1.00$) as well as the posttests ($p = 1.00$) when comparing the two testing conditions.

Figure 1. Mean scores of ankle supination during a maximal vertical jump before and after exercise with two separate methods of external ankle stabilization.
## Table 2

Maximal Vertical Jumps in Inches

<table>
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<th>Closed Gibney Posttest</th>
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Chapter Four

Discussion

One of the most debated topics in the profession of athletic training is the use of athletic tape in the prevention of injuries to the vulnerable ankle. This has been a topic of discussion and research for the past 40 years and will no doubt be an area of contention for years to come. Most research has focused on the ability of athletic tape to reduce extreme ranges of motion when an external force is applied to the ankle. Others have measured the ability of the taped ankle to withstand higher amounts of force.

This study examined the effectiveness of athletic tape as an appropriate measure for the prevention of inversion ankle injuries in a way that is unique from previous studies. The uniqueness of this study further lies in the instrument chosen to obtain the necessary measurement. Digitally analyzing anatomical motions has existed for some time now, but to the knowledge of the researcher, it has not been used to measure the airborne kinematics of the ankle with and without the aid of an external ankle support. This study also includes a method of ankle stabilization that has fallen away from the mainstream practices of athletic training, the cotton ankle wrap. With the emergence of new innovations in ankle braces, the cotton ankle wrap seems to have been replaced in the literature as well as on the ankles of the athletes. The most recent studies available on this technique are provided by a Daniel Libera in 1967, and a 1963 study by Malina et al.. Libera concluded that athletic tape provided 34% more support than the cotton ankle wrap after 110 minutes of football practice. Malina et al. focused on the ability of the wrap to restrict excessive ranges of motion and forces before and after five minutes of exercise. It was concluded that the cotton ankle wrap could not be recommended.
Further studies on the ability of the cotton ankle wrap to prevent ankle injuries are not available.

The purpose of this study was to determine if two separate methods of external ankle support were effective in reducing ankle supination during a maximal vertical jump. The methods of stabilization used in this study were the closed gibney with heel locks and figure-of-eight's, and the cotton ankle wrap.

This study presented three questions to be answered: 1. Will the closed gibney with heel locks and figure-of-eight's restrict ankle supination during a maximal vertical jump before and after exercise? 2. Will the cotton ankle wrap restrict ankle supination during a maximal vertical jump before and after exercise? 3. Will there be any significant difference of ankle supination during the maximal vertical jumps between the support provided by the closed gibney with heel locks and figure-of-eight's, and the cotton ankle wrap?

The closed gibney was shown to be significant in reducing ankle supination during the maximal vertical jump before and after exercise. This finding supports the theory presented by Obrascous (1985). By limiting the ability of the foot to fall into a supinated position during the airborne phase of a jump, there is a better chance that landing will occur with the ankle in a neutral position thereby decreasing the likelihood of sustaining a lateral ankle sprain.

The results of the cotton ankle wrap refute the findings of Malina et al., (1963), and Libera (1967). As this study did not measure extreme ranges of motion or the force restricted by the cotton wrap with the application of an external load as the aforementioned studies did, their findings are not refuted, only their conclusions. In the
present study, the cotton ankle wrap proved to be significant at reducing ankle supination in the airborne phase of a maximal vertical jump before and after exercise. This would support the theory that the use of external ankle supports including the cotton ankle wrap, may help to keep the ankle in a neutral position during a vertical jump. Maintaining this neutral position throughout the jump and into the landing phase of the jump may decrease the incidence of sustaining a lateral ankle sprain. These findings would support the use of the cotton ankle wrap as a viable alternative in the use of external ankle supports in the prevention of lateral ankle sprains.

While both methods of external ankle support presented in this study were shown to be significant at reducing ankle supination during the maximal vertical jump, there was no significant difference between the two. The closed gibney with heel locks and figure-of-eight’s did not perform significantly better than the cotton ankle wrap at the pretest or posttest measurements, and visa versa.

With this information it is feasible to use either method for the prevention of ankle sprains. It is largely dependent on the sport, the athlete, and the philosophy of the health care professional applying the support. The cotton ankle wrap is a little bulkier so it may not work as well with sports such as soccer where the cleats are by design tight fitting. In sports such as football, volleyball, and basketball the cotton ankle wrap may be the better choice than the closed gibney if for no better reason than it is easier, faster, and cheaper to apply. Athletes may subjectively prefer one method to the other from personal experience, or just the shear feeling of the applied support. As the cotton ankle wrap is an “old school” method so to speak, it may be harder for those that are new to the field of
athletic training or other related professions to accept as an effective and appropriate method of ankle support.

Another area of contention pertaining to the use of external ankle supports is the possible detriments they may pose to athletic performance. Mayhew (1972) concluded that the closed gibney ankle taping significantly reduced vertical jumping performance. The results of this study do not support these findings. The maximal vertical jump results for the closed gibney trials showed that 10 out of twelve, or 83% of the subjects vertical jump was equal to or higher than their baseline score after exercise. The maximal vertical jump results for the cotton ankle wrap trials showed that 11 out of twelve, or 92% of the subjects vertical jump was equal to or higher than their baseline score after exercise.

When considering the potential benefits of this study it is important to consider any limitations that may have affected the results. The limitations of this study lie within the instrument used to evaluate ankle supination. The Peak Motus motion analysis software owned by Humboldt State University is the base software offered by Peak Performance Technologies Inc. Being as such, there are limitations to its ability to be completely accurate. First, this system is only capable of operating in a two dimensional plane. Any rotation of the subjects body or hip will skew the data obtained. This was explained to the subjects and closely monitored by the researcher. Second, the sampling rate of the software only captures video in 30 hertz. This means that for 60 frames captured by the digital video recorder, the software only recognizes 30 of those frames. Third, the digitizing process of the video into the computer was all performed manually and human error must be taking into consideration.
Conclusions

Hundreds of Thousands of dollars are being spent every year on the use of ankle tape to support the vulnerable ankle despite the ongoing controversy surrounding its use. Alternative methods of supporting the ankle such as the cotton ankle wrap are not being used due to the lack of research to supports its use, and the people who do use it, do so with only anecdotal evidence of its effectiveness. This study has validated the use of the closed gibney with heel locks and figure-of-eight’s as well as the cotton ankle wrap in their ability to prevent ankle sprains by helping the ankle to remain in a neutral position while in the airborne phase of a maximal vertical jump. Maintaining this position may decrease the chance of landing with the ankle supinated thereby decrease the chance of sustaining a lateral ankle sprain.

Peak Performance Technologies Inc. currently has available a 60 hertz, three dimensional, self-digitizing software package. Further research on this topic should be conducted with the upgraded software to decrease the limitations recognized in this study.
References


Appendix A

Closed Gibney Ankle Tape with Heel Locks and Figure-of-Eights
Closed Gibney Ankle Tape with Heel Locks and Figure-of-Eights

1. Both ankles of each subject were prepped by eliminating any existing moisture and the application of Quick Drying Adhesive (Mueller).

2. Heel and lace pads (Cramer) were used over the posterior heel and achilles, and over the anterior ankle to decrease the chance of the ankle support causing blisters or sores.

3. Three-inch underwrap (Mueller) was applied in a uniform manner starting from the mid-distal foot and spiraling up with about a quarter overlap, to just below the belly of the gastrocnemius muscle.

4. Using one and a half inch white zinc oxide athletic tape (Alert Services, Tx.), an anchor strip was placed at the mid-distal foot and a proximal anchor was placed just below the belly of the gastrocnemius muscle.

5. A strip of tape was attached to the medial aspect of the leg at the proximal anchor. This strip was then pulled down under the heel and up the lateral side of the ankle to the lateral aspect of the proximal anchor. This strip is known as a stirrup.

6. A strip of tape is then attached to the medial aspect of the foot at the distal anchor and pulled down around the back of the heel and attached to the foot at the lateral aspect of the distal anchor. This strip is known as a horseshoe.

7. Steps 5 & 6 are repeated three times in an alternating manner overlapping each horseshoe and stirrup by half thus creating a basket weave.

8. Closing strips are then placed over the proximal and distal anchors to keep the horseshoes and stirrups from lifting.
9. Four heel locks (two on the medial side, and two on the lateral side of the ankle) and two figure-of-eights were applied with a continuous technique in the following manner. Starting with the tail end of the tape over the lateral ankle, the tape was pulled over the front of the ankle and down the medial aspect of the foot. Pulling under the foot and up the lateral aspect of the foot continuing over the foot and around the medial ankle. This would complete the first figure-of-eight. The tape was then continued around the ankle and back down the medial foot. The tape was then pulled under the foot back around the lateral heel and passed back over the front of the ankle. It then was pulled from over the front of the ankle down the lateral foot and pulled under the foot back around the medial heel and passed back over the front of the ankle. This completes two of the four heel locks. The same procedure was followed to complete two more heel locks followed by one more figure-of-eight technique. The tape was then spiraled up to the proximal anchor to complete the tape job.
Appendix B

Cotton Ankle Wrap / Louisiana Wrap
Cotton Ankle Wrap / Louisiana Wrap

1. Subjects were asked to wear calf height crew socks which were to be used as a base for the cotton wraps.

2. Heel and lace pads (Cramer) were placed over the socks at the posterior heel and Achilles, and over the anterior ankle to decrease the chance of the ankle support causing blisters or sores.

3. Using a cotton ankle wrap (Cramer) four heel locks and two figure-of-eights were applied in a continuous technique in the following manner. Starting with the tail end of the wrap over the lateral ankle, the wrap was pulled over the front of the ankle and down the medial aspect of the foot. Pulling under the foot and up the lateral aspect of the foot continuing over the foot and around the medial ankle. This would complete the first figure-of-eight. The wrap was then continued around the ankle and back down the medial foot. The wrap was then pulled under the foot back around the lateral heel and passed back over the front of the ankle. It then was pulled from over the front of the ankle down the lateral foot and pulled under the foot back around the medial heel and passed back over the front of the ankle. This completes two of the four heel locks. The same procedure was followed to complete two more heel locks followed by one more figure-of-eight technique. The remaining wrap was the spiraled up the ankle to about three inches above the malleoli.

4. Using 1 ½ inch white zinc oxide tape (Alert Services, Tx) the same pattern as described above was repeated.
Appendix C

Modified Illinois Agility Test