THE EFFECTS OF ANKLE PROPHYLACTIC DEVICES ON FORCE ABSORPTION DURING A DROP JUMP

A THESIS

Submitted to the Faculty of the School of Graduate Studies and Research of California University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Science

by

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THESIS APPROVAL

Graduate Athletic Training Education

We hereby approve the Thesis of

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<tr>
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First and foremost, I would like to thank the most important people in my life, my parents. Dad, I know you always wanted me to reach my goals and if you were still here, you would be so happy for me. You give me the power and courage to reach my goals. I miss you, love you, and there will always be a spot for you in my heart. Mom thanks so much for supporting everything I do. You are my hero. You told me to give 100% on everything and to never give up. I know you will always be there no matter what. You have given me the support needed to get through some hard times. Even though you are miles away, the support and love is still there. I love you and miss you!

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INTRODUCTION

Acute ankle injuries are very common in sports.\textsuperscript{1-5} Landing from a jump is one of the most common mechanisms of injury involving the ankle joint. Since ankle injuries have become so prevalent over the years, many techniques have been created to help with preventing these injuries.

Prophylactic devices are one of the most common ways utilized to prevent injuries and have become very popular over the last few years. Athletes have a choice between bracing and taping; however, the literature suggests that bracing is better than taping, because tape loses its motion limiting properties with exercise.\textsuperscript{6,7} Studies have examined how ankle taping and bracing effect ankle movement during a landing and stabilization time.\textsuperscript{8,9} Meanwhile, none have examined how ankle taping and bracing affect peak force and stabilization time during a drop jump.

Ankle injuries comprise forty-five percent of all sports injuries.\textsuperscript{5} There are many types of ankle injuries with a variety of mechanisms and levels of severity. Sprains are the most common. Eighty-six percent of these ankle
injuries are sprains to the lateral ligaments and ten percent are high ankle sprains.\textsuperscript{12,13} Seventy-three percent of the athletic population has sprained at least one of their ankles one or more times.\textsuperscript{10} One example of this high rate of injury comes from a study by Sacco et al.\textsuperscript{11}, the injury rate for basketball players is 3.85 per hundred exposures.

Various ankle structures can be injured during physical activity. Sprains, strains, and fractures are common; however, sprains are the most common of all. Sprains can occur to the deltoid ligament on the medial aspect, the anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament on the lateral side or the distal tibiofibular ligament on the anterior surface of the ankle joint.

Ankle injuries are correlated with abnormal ankle biomechanics.\textsuperscript{14} There are defined normal biomechanical patterns involved in gait.\textsuperscript{15} The forefoot, rear foot, and ankle joint work together in the three planes of movement during gait. Alterations to normal biomechanics can increase the stress on anatomical structures of the body.

Several different mechanisms can cause acute ankle sprains. The most common mechanism is inversion while the ankle is in plantarflexion.\textsuperscript{13,16,17} This mechanism will cause
damage to the anterior talofibular ligament, or the calcaneofibular ligament, or both. Another mechanism is eversion and dorsiflexion, which causes damage to the tibiofibular joint. If eversion is the only mechanism, then damage to the medial ligaments is likely to occur.

Direct blow, shearing, compression, or rotational forces, and falling are mechanisms for a fracture to a bone in ankle joint. A variety of mechanisms can cause injury to the muscles. The most common mechanism of injury is eccentrically contracting, which is forcing a muscle to contract while lengthening, or over stretching it. Overuse is another mechanism for ankle and muscle injuries that is seen regularly.

There are many ways to prevent ankle ligamentous injuries. A prophylactic device is the most common and is worn to provide support to the ankle joint. Two examples of prophylactic devices include braces and tape. Studies have been conducted to observe which is more effective: taping or bracing. Also, there have been studies evaluating if these devices prevent injury by limiting range of motion or by increasing proprioception.

Taping is one method performed to prevent ankle injuries. It used in a variety of sports, provides mechanical support, and increases proprioception. The
mechanical support that tape provides is created by limiting the range of motion; yet, it has been suggested that after as little as ten minutes of exercise, tape loses its motion limiting properties. However, an increase in proprioception may occur because cutaneous receptors are active. This may increase joint position sense. The effectiveness of tape on limiting motion is still unknown according to Bragg et al. The closed basket weave is a very basic taping style; although, it is a time consuming technique. Meanwhile, many athletic trainers change their closed basket weave taping technique to a more effortless and less time consuming way; at the same time, still maintaining the key components of the techniques just applying them in a different manner. The closed basket weave taping technique was used in a study by Ricard et al. This study found there was no difference in taping to the skin or over pre-wrap when looking at inversion restrictions. After exercise, both methods provided residual restrictions; however, the tape loosened significantly during exercise and still provided inversion restrictions for both methods.

Bracing is another common method used to prevent ankle injuries. There are soft-shell and semi-rigid (hard shell) braces. Braces can tie, strap on, slide on, or utilize a
combination of all these techniques. In recent years, bracing has became a very popular alternative to taping. Braces are considered a cost saving as well as a time saving technique to prevent injury since they can be re-used. Soft shell braces are made of exterior canvas and tie up, or slip on. Semi-rigid braces are made with hard plastic inserts, canvas exterior and slides on, or straps onto the ankles. Both types have been used in many studies. The comfort depends on the person’s foot structure and type of brace. The soft shells are the most comfortable; although, semi-rigid braces are better at limiting range of motion before and after activity.\(^6\)

During activity such as jumping, many forces are being applied to the body and the body is made to absorb shock. In gait and landing, the shock or vibration starts at the ankle and moves up, this is called a shock wave. Shock attenuation is the reduction of a shock wave; in addition, it is a reduction in the rate and amount of force on the subject’s body.\(^{19}\) If the ankle is in dorsiflexion or plantarflexion when landing, the force is then transferred to the knee.\(^{16}\) The three joints that absorb most of the force in the lower extremity include the ankles, knees, and hips. The amount of force applied to the ankle can be decreased by wearing shock absorbing footwear such as
tennis shoes with a padded heel. If the ankle cannot absorb forces in a timely manner, injury can occur; however, if the force is absorb promptly the risk of injury decreases.

High ankle supportive shoes can affect how the ankle absorbs force according to Brizula et al. An increase in impact force after jumping might occur because plantarflexion is limited by the high ankle support. During landing, impact forces are greatly increased. The forefoot and ankle absorb the shock to protect the bone and joint. The muscles shorten at this time causing a release of elastic energy.

Direct force is another way that leads to injury. If the forces causes the ligament to exceed its normal tensile strength it can create injury to the ligament. A longer stabilization time increases the risk of injury. Reducing how long the forces are acting on the body will help decrease the risk of injury for the lower extremity. This might be accomplished by taping or bracing the ankle. Ankle bracing may reduce the ability for the athlete to plantarflex; as an result, increasing the risk of injury and putting more demand on the knee and hip. Excessive force applied to the tissue can cause a number of overuse injuries like fractures and damage to the articular cartilage.
There are many ways to measure forces applied to the lower extremity. A force platform is one of the ways to measure these forces. A force platform is a plate that is embedded into the floor with the purpose of measuring force in three planes. It is a valid and reliable tool that provides precision measurements in gait, balance, and sport applications. Many studies have used force platforms to measure ground reaction force; in addition to, other measurements including center of pressure, impulse, and time to peak force.

Drop jumps are functionally applicable to many sports. These jumps simulate landing from a jump in a game and are good tools when attempting to measure the ability to absorb force. There are many ways a drop jump can be preformed. Studies have had subjects drop from one or three different box heights. The heights range from .2m to 1.03m. Other studies used the hanging drop landing, because it has been shown to minimize foot contact asymmetry.

Studies have looked at how bracing and landing style effect peak vertical ground reaction forces. One study found that there was an increase in peak vertical ground reaction force when braced, and another found an increase in peak vertical force with stiff knee landing. Other studies have had subjects do a vertical jump and then land
on the force platform, or perform a drop jump and then proceed directly into a vertical jump.\textsuperscript{8,25,30,31}

Maximum vertical force and knee angles have been examined in many studies, suggesting that performing training to keep the knees from turning inward might prevent injury. These studies found that children have a shorter time to maximum vertical force than adults with no differences between genders. They also found that greater valgus angles lead to anterior cruciate ligament (ACL) injuries.\textsuperscript{25,30,31} These studies suggest neuromuscular training may help decrease the risk of ACL injuries. One study did a vertical jump stop and found a difference in landing styles between genders. They also found that motion patterns are preprogrammed before the landing.\textsuperscript{32} In addition, this study found that females land with decreased hip and knee flexion, which increases the risk of ACL injuries.\textsuperscript{32}

The way a person lands may have an affect on injury and how forces are absorbed. Studies have been done examining how landing styles affect forces on the lower extremity. The types of landing styles include natural landing, stick the landing (stiff landing) like in gymnastics, and stick the landing with calf flexed (soft landing).\textsuperscript{29}
The purpose of this study is to determine if prophylactic devices applied to the ankle affect shock absorption during landing from a drop jump. The following questions were answered: 1. Will there be a difference in stabilization time for each prophylactic device condition when landing? 2. Will there be a difference in peak force for each prophylactic device condition when landing?
METHODS

The methods section provides an overview of how this study was conducted. This section includes the following subsections: Research Design, Subjects, Preliminary Research, Instruments, Procedures, Hypotheses, and Data Analysis.

Research Design

A quasi experimental within-subjects design was used for this study. The independent variable was prophylactic device condition (tape, brace, and no prophylactic device) and box height. The dependent variables were 1. stabilization time, and 2. peak force. An Advanced Mechanical Technology INC, model OR 6-7 force platform was used to collect data. The volunteer subjects attended an orientation session and a testing session. The researcher applied all braces and applied identical taping method to each subject. Strengths of the study are the within subjects design and the reliability of the force platform.
Limitations to this study are using physically active college students and Division II athletes from California University of Pennsylvania, a sample of convenience, and sample size, not having the subject do twenty minutes of activity before jumping to stress the tape and having to stop every time a train went by the building.

Subjects

The subjects were from the physically active population and varsity athletes currently enrolled at California University of Pennsylvania. Physically active was defined as a person who does physical activity a minimum of three days a week for at least thirty minutes a day. The subjects were from a convenience sample and were all volunteers. A previous injury screen was done and subjects were omitted if they have sustained an ankle or knee injury in the last six months. Before participating in the study, each subject completed an informed consent form and a demographic sheet that included questions about the volunteer subject’s height, weight, gender, age, sport and position, previous use of brace or tape, and previous surgery to the ankle or knee (Appendix C3).
Preliminary Research

Preliminary research was done to determine how long the test protocol would take for each subject. Further, it gave the researcher time to become familiar with the use of the testing instruments and to ensure validity and reliability.

Instruments

The demographic sheet, data collection sheet, and force platform are the instruments that were used in this study. The demographic sheet (Appendix C3) was used to document the subject’s height, weight, gender, age, sport, and position, type of physical activity, number of days of physical activity a week and length of each session, previous use of braces or tape, and previous surgery to ankle or knee. No names were used for this study; as an alternative, each subject was assigned a number. This was done to blind the researcher and to protect the subjects by using a number instead of their names. The data collection sheet (Appendix C4) was used to document the data from the jumps.
Prophylactic Devices

There were two prophylactic devices used for this study: the Ankle Stabilizing Orthosis® (ASO) and the modified Gibney closed ankle basket weave tape technique. The ASO is a soft-shell ankle brace that is comprised of a cool flex material and has polyester cotton laces. This brace has two nylon figure eight straps that lock the heel into place and keep the ankle joint in a neutral position, which provides extra support. The taping technique used was the modified Gibney closed basket weave. Step by step instructions are listed in Appendix C5.

Force Platform

The force platform that was used is the Advanced Mechanical Technology INC, model OR 6-7 and is 46.36 cm x 50.8cm (AMTI. Watertown, WA). The sampling rate was set at 100 Hz. This rate was used because the software would not support a sampling rate of 1000 Hz like other studies have used.\textsuperscript{8,9,20,28,33} The force platform has been validated and found to be a reliable tool as per pervious studies.\textsuperscript{8} The software used to collect the data was NetForce (AMTI. Watertown, WA) and was connected to a PC via a serial cable for data collection.
Procedures

The researcher received approval from California University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (IRB) (Appendix C1). Upon approval, the researcher emailed the California University of Pennsylvania athletes and undergraduate and graduate athletic training education students asking for volunteers who have not sustained any ankle or knee injuries in the last six months and who exercise a minimum of three days of physical activity for at least thirty minutes a day. The purpose of this study was explained to the volunteers through this email.

Subjects were asked to attend two sessions: an orientation session and the test/data collect session. At the orientation session, subjects completed their informed consent form and demographic form, and were informed about the study. Further, they were asked to participate in a trial-run during the initial meeting. Each subject went through a preliminary session, in order for them to become familiar with the testing protocol and the drop jump. Subjects performed two jumps from each box height (.3048m,
.6096m, .9144m) as the trial-run. This session lasted about 15 minutes for each subject.

During the second session, the subjects were assigned a number for coding process and the order of prophylactic devices to be applied. The order of the prophylactic device condition was randomized as they drew the order of prophylactic devices out of a bag.

After receiving the prophylactic device order, the researcher applied the appropriate prophylactic device. The researcher had precisely ten minutes to apply the device or taping to both ankles. If the subject was in the no prophylactic device condition group, he/she remained sitting quietly for ten minutes. Step by step taping instructions are listed on Appendix C5.

Once the prophylactic device was applied and the ten minutes were up, the subject began a five minute warm-up on the treadmill at 5.633 Km/h with no elevated grade. After the warm-up, the subject stood on the force platform so his/her weight could be measured. This was done by using the weigh button on the Net Force software. Once his/her weight was recorded he/she began the test. The box was .21m posterior to the back edge of the force platform. When on top of box, the subject was told to keep his/her shoulders at ninety degrees of flexion with the dominant
foot against the front edge of the box and his/her feet
.35m apart. There was two pieces of white tape were placed
.35m apart so he/she knew where to put his/her feet. When
the researcher was ready to start, she told the subject to
jump. The subject leaned forward and stepped off, landing
on both feet and staying in that position for five seconds.
This protocol was used by DeVita et al.\textsuperscript{33} Landing style was
the subject’s natural landing style.

Each subject performed five jumps from each box height
with twenty second rest in-between each jump before moving
on to the next box height. The order of the box height was
.3048m, .6096m and .9144m for each prophylactic device
condition and subject. If both feet did not land on the
force platform completely, the jump was omitted, and the
subject was instructed to repeat the jump. Ten minutes of
rest was given between the prophylactic device conditions.
During this time, the researcher applied the next
appropriate prophylactic device.

Once the prophylactic device was secured and the ten
minute time was complete, the subjects performed the five
minute treadmill warm-up again. If the subject was in the
no prophylactic device group, he/she remained sitting
quietly for the ten minutes, and then completed the five
minute treadmill warm-up. After the warm-up, the subject
began jumping. These steps were repeated for each box height and each prophylactic device condition. Subjects were tested under all three prophylactic device conditions in the testing session. The average of the five jumps for each height was the number used in the study. The testing session lasted about one hour for each subject.

Hypotheses

The following hypotheses were tested in this study:
1. There will be a difference in stabilization time for each prophylactic device condition when landing from different heights.
2. There will be a difference in peak force for each prophylactic device condition when landing from different heights.

Data Analysis

A within-subjects, repeated measures ANOVA was used to analyze both hypotheses. The level of significance for this study was set at ≤.05. SPSS version 14 was used to perform the statistical analysis.
RESULTS

The purpose of this study is to determine if prophylactic devices applied to the ankle affect shock absorption during landing from a drop jump. The following section includes data collected through the study and is divided into three sections: Demographic Information, Hypotheses Testing, and Additional Findings.

Demographic Information

A demographic sheet was used to collect basic information about the subjects and was completed during the orientation session. The subject’s height, weight, gender, age, sport, and position, type of physical activity, number of days per week of physical activity and length of each session, previous use of braces or tape, and previous surgery to ankle or knee were all questions asked on the demographic form.
Thirty subjects (n=30) were included in the study and consisted of California University of Pennsylvania undergraduate, and graduate athletic training students, and a few varsity athletes. There were nineteen undergraduate athletic training students, eight graduate athletic training students, one soccer player and two swimmers. Fourteen males (46.66%) and sixteen females (53.33%) participated in the study. The age range was 18 to 43 years old (22.33 ± 4.60). The subjects weight and height ranged from 48.53 to 117.93 Kg (70.59 ± 36.02) and 149.86 to 187.96 cm (169.47 ± 4.27), respectively. Nine subjects had previous use of tape during activity and twenty-one did not. Eight subjects had previous brace use during activity and twenty-two did not. The demographic information is presented in Table 1.

Table 1. Demographic Information of Subjects

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<th>Range</th>
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<td>Age</td>
<td>18- 43 yrs old</td>
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<td>Height</td>
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<tr>
<td>Weight</td>
<td>48.53- 117.93 Kg</td>
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Hypotheses Testing

The following hypotheses were tested for this study. All hypotheses were tested using an alpha level of \( \leq .05 \).

Hypothesis 1: There will be a difference in stabilization time for each prophylactic device condition when landing from different heights.

Conclusion: The stabilization time averages for each prophylactic device condition and each box height were compared using a repeated measures ANOVA. Means and standard deviations are presented in Table 2. No significant difference was found between prophylactic device condition and stabilization time \( (F_{2, 58} = 2.112, p>.05) \) (Table 3). A significant difference was found between box height and stabilization time \( (F_{2, 58} = 17.454, p<.001) \) (Table 3). No significant difference was found between prophylactic device conditions, and box height on stabilization time \( (F_{4, 16} = .774, p>.05) \) (Table 3).
Table 2. Descriptive Statistics for Stabilization Time

<table>
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<th>Box Height</th>
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<td>ASO Brace</td>
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<td>.7238</td>
<td>.1936</td>
</tr>
<tr>
<td></td>
<td>ASO Brace</td>
<td>30</td>
<td>.7171</td>
<td>.1530</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>30</td>
<td>.7168</td>
<td>.2102</td>
</tr>
</tbody>
</table>

Table 3. Repeated Measures ANOVA for the Effect of Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophylactic Device</td>
<td>.054</td>
<td>2</td>
<td>.027</td>
<td>2.112</td>
<td>.130</td>
</tr>
<tr>
<td>Box Height</td>
<td>.474</td>
<td>2</td>
<td>.237</td>
<td>17.454</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prophylactic Device x Box Height</td>
<td>.024</td>
<td>4</td>
<td>.006</td>
<td>.774</td>
<td>.544</td>
</tr>
<tr>
<td>Error</td>
<td>.886</td>
<td>116</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 2: There will be a difference in peak force for each prophylactic device condition when landing from different heights.
Conclusion: The peak force averages for each prophylactic device condition and each box height were compared using a repeated measure ANOVA. Means and standard deviations are presented in Table 4. No significant difference was found between prophylactic device condition and peak force ($F_{2, 58} = .581, p > .05$) (Table 5). A significant difference was found between box height and peak force ($F_{2, 58} = 44.895, p < .001$) (Table 5). No significant difference was found between prophylactic device conditions on peak force ($F_{4, 116} = 1.978, p > .05$) (Table 5).

Table 4. Descriptive Statistics for Peak Force

<table>
<thead>
<tr>
<th>Box Height</th>
<th>Prophylactic Device Condition</th>
<th>N</th>
<th>Mean (N)</th>
<th>SD (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tape</td>
<td>30</td>
<td>4514.153</td>
<td>1125.892</td>
</tr>
<tr>
<td></td>
<td>ASO Brace</td>
<td>30</td>
<td>4478.990</td>
<td>1084.833</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>30</td>
<td>4531.853</td>
<td>1197.771</td>
</tr>
<tr>
<td>2</td>
<td>Tape</td>
<td>30</td>
<td>5013.933</td>
<td>988.685</td>
</tr>
<tr>
<td></td>
<td>ASO Brace</td>
<td>30</td>
<td>5131.446</td>
<td>871.981</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>30</td>
<td>5024.137</td>
<td>923.904</td>
</tr>
<tr>
<td>3</td>
<td>Tape</td>
<td>30</td>
<td>5502.810</td>
<td>1005.781</td>
</tr>
<tr>
<td></td>
<td>ASO Brace</td>
<td>30</td>
<td>5516.924</td>
<td>818.057</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>30</td>
<td>5401.572</td>
<td>858.771</td>
</tr>
</tbody>
</table>
Table 5. Repeated Measures ANOVA for the Effect of Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophylactic Device</td>
<td>145049.613</td>
<td>2</td>
<td>72524.807</td>
<td>.581</td>
<td>.562</td>
</tr>
<tr>
<td>Box Height</td>
<td>42200101.066</td>
<td>2</td>
<td>21100050.533</td>
<td>44.895</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prophylactic Device X Box</td>
<td>39022.528</td>
<td>4</td>
<td>9755.632</td>
<td>1.978</td>
<td>.102</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>5721182.009</td>
<td>116</td>
<td>49320.535</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Findings

After testing the hypotheses, further statistical tests were conducted on the remaining data from the demographic sheet including previous use of braces, previous use of tape, gender, subjects’ weight, and height.

A repeated measures ANOVA was calculated examining the effect of previous use of a brace on stabilization time. No significant difference was found between the previous use of a brace and stabilization time ($F_{1, 28} = 2.332$, $p > .05$) (Table 6). No significant difference was found between the previous use of a brace and prophylactic device condition on stabilization time ($F_{2, 56} = 1.034$, $p > .05$) (Table 6). No significant difference was found between the previous use
of a brace and box height on stabilization time ($F_{2, 56} = .496, p > .05$) (Table 6). No significant difference was found between the previous use of a brace, condition, and box height on stabilization time ($F_{4, 112} = 2.330, p > .05$) (Table 6).

Table 6. Repeated Measures ANOVA for the Effect of Previous Brace use, Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Brace Use</td>
<td>.449</td>
<td>1</td>
<td>.449</td>
<td>2.332</td>
<td>.138</td>
</tr>
<tr>
<td>Prophylactic Device X Previous Brace Use</td>
<td>.027</td>
<td>2</td>
<td>.013</td>
<td>1.034</td>
<td>.362</td>
</tr>
<tr>
<td>Box Height X Previous Brace Use</td>
<td>.014</td>
<td>2</td>
<td>.007</td>
<td>.469</td>
<td>.612</td>
</tr>
<tr>
<td>Prophylactic Device X Box Height X Previous Brace Use</td>
<td>.068</td>
<td>4</td>
<td>.017</td>
<td>2.330</td>
<td>.060</td>
</tr>
<tr>
<td>Error</td>
<td>.818</td>
<td>112</td>
<td>.007</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of previous use of brace on peak force. A significant difference was found between previous use of a brace, prophylactic device condition, and box height on
peak force ($F_{4,112} = 2.70, p = .034$) (Table 7). No significant difference was found between previous use of a brace and peak force ($F_{1,28} = 1.240, p > .05$) (Table 7). No significant difference was found between previous use of a brace and prophylactic device condition on peak force ($F_{2,56} = .090, p > .05$) (Table 7). No significant difference was found between previous use of a brace and box height on peak force ($F_{2,56} = .313, p > .05$) (Table 7).

Table 7. Repeated Measures ANOVA for the Effect of Previous Brace use, Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Brace Use</td>
<td>9228134.478</td>
<td>1</td>
<td>9228134.478</td>
<td>1.240</td>
<td>.275</td>
</tr>
<tr>
<td>Prophylactic Device X Previous Brace Use</td>
<td>23093.555</td>
<td>2</td>
<td>11546.778</td>
<td>.090</td>
<td>.914</td>
</tr>
<tr>
<td>Box Height X Previous Brace Use</td>
<td>301781.198</td>
<td>2</td>
<td>150890.599</td>
<td>.313</td>
<td>.732</td>
</tr>
<tr>
<td>Prophylactic Device X Box Height X Previous Brace Use</td>
<td>503156.943</td>
<td>4</td>
<td>125789.236</td>
<td>2.700</td>
<td>.034</td>
</tr>
<tr>
<td>Error</td>
<td>5218025.066</td>
<td>112</td>
<td>46589.510</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A repeated measures ANOVA was calculated, examining the effect of previous use of tape on stabilization time. No significant difference was found between previous use of tape and stabilization time \( (F_{1,28} = .333, p > .05) \) (Table 8). No significant difference was found between previous use of tape and prophylactic device condition on stabilization time \( (F_{2,56} = .238, p > .05) \) (Table 8). No significant difference was found between previous use of tape and box height on stabilization time \( (F_{2,56} = .322, p > .05) \) (Table 8). No significant difference was found between previous use of tape, condition, and box height on stabilization time \( (F_{4,112} = .335, p > .05) \) (Table 8).
Table 8. Repeated Measures ANOVA for the Effect of Previous Tape use, Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Tape Use</td>
<td>.333</td>
<td>1</td>
<td>.333</td>
<td>1.695</td>
<td>.204</td>
</tr>
<tr>
<td>Prophylactic Device X Previous Tape Use</td>
<td>.006</td>
<td>2</td>
<td>.003</td>
<td>.238</td>
<td>.789</td>
</tr>
<tr>
<td>Box Height X Previous Tape Use</td>
<td>.009</td>
<td>2</td>
<td>.004</td>
<td>.322</td>
<td>.726</td>
</tr>
<tr>
<td>Prophylactic Device X Box Height X Previous Tape Use</td>
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<td>.003</td>
<td>.335</td>
<td>.854</td>
</tr>
<tr>
<td>Error</td>
<td>.876</td>
<td>112</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of previous use of tape on peak force. No significant difference was found between previous use of tape and peak force ($F_{1, 28} = 3.911$, $p > .05$) (Table 9). No significant difference was found between previous use of tape and prophylactic device condition on peak force ($F_{2, 56} = 1.371$, $p > .05$) (Table 9). No significant difference was found between previous use of tape and box height on peak force ($F_{2, 56} = .941$, $p > .05$) (Table 9). No significant
difference was found between previous use of tape, condition, and box height on peak force ($F_{4, 112} = .670, p>.05$) (Table 9).

Table 9. Repeated Measures ANOVA for the Effect of Previous Tape use, Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Tape Use</td>
<td>26666387.151</td>
<td>1</td>
<td>26666387.151</td>
<td>3.911</td>
<td>.058</td>
</tr>
<tr>
<td>Prophylactic Device X Previous Tape Use</td>
<td>337824.487</td>
<td>2</td>
<td>168912.243</td>
<td>1.371</td>
<td>.262</td>
</tr>
<tr>
<td>Box Height X Previous Tape Use</td>
<td>886308.703</td>
<td>2</td>
<td>443154.352</td>
<td>.941</td>
<td>.396</td>
</tr>
<tr>
<td>Prophylactic Device X Box Height X Previous Tape Use</td>
<td>133789.066</td>
<td>4</td>
<td>33447.266</td>
<td>.670</td>
<td>.614</td>
</tr>
<tr>
<td>Error</td>
<td>5587392.943</td>
<td>112</td>
<td>49887.437</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of gender on stabilization time. No significant difference was found between gender and stabilization time ($F_{1, 28} = .090, p>.05$) (Table 10). No significant difference was found between gender and prophylactic device condition on stabilization time ($F_{2, 56} = .577, p>.05$) (Table 10). No
significant difference was found between gender and box height on stabilization time ($F_{2, 56} = 2.693, p > .05$) (Table 10). No significant difference was found between gender, condition, and box height on stabilization time ($F_{4, 112} = .670, p > .05$) (Table 10).

Table 10. Repeated Measures ANOVA for the Effect of Gender, Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum Of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.090</td>
<td>1</td>
<td>.090</td>
<td>.437</td>
<td>.514</td>
</tr>
<tr>
<td>Prophylactic Device X Gender</td>
<td>.015</td>
<td>2</td>
<td>.008</td>
<td>.577</td>
<td>.565</td>
</tr>
<tr>
<td>Box Height X Gender</td>
<td>.069</td>
<td>2</td>
<td>.035</td>
<td>2.693</td>
<td>.076</td>
</tr>
<tr>
<td>Prophylactic Device X Box</td>
<td>.019</td>
<td>4</td>
<td>.005</td>
<td>.600</td>
<td>.663</td>
</tr>
<tr>
<td>Height X Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>.868</td>
<td>112</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of gender on peak force. A significant difference was found between gender and peak force ($F_{1, 28} = 6.645, p = .015$) (Table 11). A significant difference was found between gender and box height on peak force ($F_{2, 56} = 38.824, p < .001$) (Table 11). No significant difference was found
between gender and prophylactic device condition on peak force ($F_{2, 56} = .218, p>.05$) (Table 11). No significant difference was found between gender, condition, and box height on peak force ($F_{4, 112} = 1.531, p>.05$) (Table 11).

Table 11. Repeated Measures ANOVA for the Effect of Gender, Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>41728199.167</td>
<td>1</td>
<td>41728199.167</td>
<td>6.645</td>
<td>.015</td>
</tr>
<tr>
<td>Prophylactic Device X</td>
<td>55812.256</td>
<td>2</td>
<td>27906.128</td>
<td>.218</td>
<td>.805</td>
</tr>
<tr>
<td>Prophylactic Device X Box</td>
<td>296676.540</td>
<td>4</td>
<td>74169.135</td>
<td>1.531</td>
<td>.198</td>
</tr>
<tr>
<td>Error</td>
<td>5424505.469</td>
<td>112</td>
<td>48433.085</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of subject’s weight on stabilization time. No significant difference was found between subject’s weight and stabilization time ($F_{1, 28} = 1.928, p>.05$) (Table 12). No significant difference was found between subject’s weight and prophylactic device condition on stabilization time ($F_{2, 56} = .401, p>.05$) (Table 12). No significant difference was
found between subject’s weight and box height on stabilization time \((F_{2, 56} = 2.587, p > .05)\) (Table 12). No significant difference was found between subject’s weight, condition, and box height on stabilization time \((F_{4, 112} = 1.251, p > .05)\) (Table 12).

Table 12. Repeated Measures ANOVA for the Effect of Weight, Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>.376</td>
<td>1</td>
<td>.376</td>
<td>1.928</td>
<td>.176</td>
</tr>
<tr>
<td>Prophylactic Device X Subject’s Weight</td>
<td>.011</td>
<td>2</td>
<td>.005</td>
<td>.401</td>
<td>.671</td>
</tr>
<tr>
<td>Box Height X Subject’s Weight</td>
<td>.067</td>
<td>2</td>
<td>.033</td>
<td>2.587</td>
<td>.084</td>
</tr>
<tr>
<td>Prophylactic Device x Box Height X Subject’s Weight</td>
<td>.038</td>
<td>4</td>
<td>.009</td>
<td>1.251</td>
<td>.294</td>
</tr>
<tr>
<td>Error</td>
<td>.849</td>
<td>112</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of subject’s weight on peak force. A significant difference was found between subject’s weight and peak force \((F_{1, 28} = 9.145, p = .005)\) (Table 13). A significant
difference was found between subject’s weight and box height on peak force ($F_{2,56}= 22.596, p<.001$) (Table 13). No significant difference was found between subject’s weight and prophylactic device condition on peak force ($F_{2,56}= .247, p>.05$) (Table 13). No significant difference was found between subject’s weight, condition, and box height on peak force ($F_{4,112}= .756, p>.05$) (Table 13).

Table 13. Repeated Measures ANOVA for the Effect of Weight, Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>53564333.005</td>
<td>1</td>
<td>53564333.005</td>
<td>9.145</td>
<td>.005</td>
</tr>
<tr>
<td>Prophylactic Device X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject’s Weight</td>
<td>63299.737</td>
<td>2</td>
<td>31649.868</td>
<td>.247</td>
<td>.782</td>
</tr>
<tr>
<td>Box Height X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject’s Weight</td>
<td>12174008.343</td>
<td>2</td>
<td>6087004.171</td>
<td>22.596</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prophylactic Device X Box</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height X</td>
<td>150320.374</td>
<td>4</td>
<td>37580.094</td>
<td>.756</td>
<td>.556</td>
</tr>
<tr>
<td>Error</td>
<td>5570861.635</td>
<td>112</td>
<td>49739.836</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A repeated measures ANOVA was calculated examining the effect of subject’s height on stabilization time. No
significant difference was found between subject’s height and stabilization time ($F_{1, 28} = .420, p > .05$) (Table 14). No significant difference was found between subject’s height and prophylactic device condition on stabilization time ($F_{2, 56} = 1.396, p > .05$) (Table 14). No significant difference was found between subject’s height and box height on stabilization time ($F_{2, 56} = 1.114, p > .05$) (Table 14). No significant difference was found between subject’s height, condition, and box height on stabilization time ($F_{4, 112} = 1.069, p > .05$) (Table 14).

Table 14. Repeated Measures ANOVA for the Effect of Height, Prophylactic Device Condition and Box Height on Stabilization Time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>.420</td>
<td>1</td>
<td>.420</td>
<td>2.173</td>
<td>.152</td>
</tr>
<tr>
<td>Prophylactic Device X Subject’s</td>
<td>.036</td>
<td>2</td>
<td>.018</td>
<td>1.396</td>
<td>.256</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box Height X Subject’s</td>
<td>.030</td>
<td>2</td>
<td>.015</td>
<td>1.114</td>
<td>.335</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prophylactic Device X Box Height</td>
<td>.033</td>
<td>4</td>
<td>.008</td>
<td>1.069</td>
<td>.375</td>
</tr>
<tr>
<td>X Subject’s Height</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>.854</td>
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<td>.008</td>
<td></td>
<td></td>
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</tbody>
</table>
A repeated measures ANOVA was calculated examining the effect of subject’s height on peak force. A significant difference was found between subject’s height and peak force ($F_{1, 28} = 7.304, p = .012$) (Table 15). A significant difference was found between subject’s height and box height on peak force ($F_{2, 56} = 15.652, p < .001$) (Table 15). No significant difference was found between subject’s height and prophylactic device condition on peak force ($F_{2, 56} = .073, p > .05$) (Table 15). No significant difference was found between subject’s height, condition, and box height on peak force ($F_{4, 112} = .080, p > .05$) (Table 15).
Table 15. Repeated Measures ANOVA for the Effect of Height, Prophylactic Device Condition and Box Height on Peak Force

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>45011410.117</td>
<td>1</td>
<td>45011410.117</td>
<td>7.304</td>
<td>.012</td>
</tr>
<tr>
<td>Prophylactic Device X Subject’s Height</td>
<td>18813.363</td>
<td>2</td>
<td>9406.681</td>
<td>.073</td>
<td>.930</td>
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<tr>
<td>Box Height X Subject’s Height</td>
<td>9774081.809</td>
<td>2</td>
<td>4887040.904</td>
<td>15.652</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prophylactic Device X Box Height X Subject’s Height</td>
<td>16259.349</td>
<td>4</td>
<td>4064.837</td>
<td>.080</td>
<td>.988</td>
</tr>
<tr>
<td>Error</td>
<td>5704922.660</td>
<td>112</td>
<td>50936.809</td>
<td></td>
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</tr>
</tbody>
</table>
DISCUSSION

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

Discussion of Results

The purpose of this study is to determine if prophylactic devices applied to the ankle affect shock absorption during landing from a drop jump. The researcher investigated this topic because the literature is mixed about what prophylactic device, if any, is better at preventing ankle and lower extremity injuries. This study suggested that there is no significant difference between taping and bracing on peak force and stabilization time except when looking at box height.

A significant difference was found when comparing gender, subject’s height, and weight, and previous brace use to box height when looking at peak force. A three way interaction was found between previous use of a brace, prophylactic device condition and box height.
It was initially hypothesized that there would be a difference in stabilization time for prophylactic device condition when drop jumping from different box heights. Statistical analysis suggested that stabilization times did not differ among each prophylactic device condition. Results suggested that prophylactic device condition does not have an effect on stabilization time; however, box height did have an effect on stabilization time.

The data from this study did not match part of the data found by Riemann et al. Riemann et al. found that ankle braces and tape decrease the time to peak force, which imposes higher stresses on the musculoskeletal system by decrease energy absorption time. The current study did match what Riemann et al. found about ankle stabilizers, which was ankle stabilizers did not have a significant effect on peak force. The current study also did not match what McCaw et al. found, which was some ankle stabilizers adversely affect the ankle joint kinematics when jumping off a .59 m box with three ankle braces, ankles taped and no prophylactic device. The researcher believes that box height caused a significant difference because the higher box heights cause more velocity when jumping; therefore, the body has to try to become stable from different speeds in timely manner to prevent injuries. Also, the subjects
were inexperienced with jumping from higher box heights and the subjects were not able to control their body as well when jumping from the higher heights.

Another original hypotheses that was presented stated there would be a difference in peak force for each prophylactic device condition when drop jumping from different box height. The statistical analysis performed suggests that there was a significant difference for box height; however, there was no difference in peak force when looking at the different prophylactic device conditions.

The researcher believes the difference may be caused by the longer air time, the more force you create; therefore, the subjects may land with more force as well as different landing styles. Landing style becomes a factor because landing certain ways cause different parts of the body to absorb more force than other parts. Studies have look and landing styles and found if the subject lands with a stiff knee, the ankle joint’s plantar flexors structures absorb more force, which may increase the risk of injury.\textsuperscript{9,20,35} Further, if the subject performs a soft landing, the hip absorbs more force, and this may decrease the risk of injury at the ankle. Those findings support what Zhang et al.\textsuperscript{34} and Seegmiller et al.\textsuperscript{35} found. Zhang et al.\textsuperscript{34} found landing styles may affect peak power when
jumping from higher box heights. According to Seegmiller et al.\textsuperscript{35}, the sixty and ninety centimeter box heights cause gymnasts to produce higher peak forces than recreational athletes.

After the hypotheses were tested, additional statistical test were completed on the remaining data. The affect of previous use of a brace on stabilization was one of the additional findings. There was no significant difference between previous brace use and stabilization. In addition, there was no significant difference between previous brace use and prophylactic device condition, previous brace use and box height, and previous brace use, prophylactic device condition and box height. The researcher was expecting to identify this since there was no significant difference when just looking at stabilization time. However, the researcher was assuming box height would cause a significant difference since it without previous brace use. This may suggest that if one has previous brace use, the brace may not have an impact on his/her performance, because his/her body learns how to adapt to the brace, further there may be a psychological factor included.

Another finding examined peak force and previous brace use. No significant difference was found between previous
brace use and peak fore. There was a three way interaction between prophylactic device conditions, box height, and previous brace use (See Figure 1). The researcher was not anticipating finding this difference. A significant difference was found for box height.

This may suggest that if you have previous brace use and are in a sport where jumping from a one foot or two foot height, or are jumping one to two feet in the air, having your ankles taped may be better than bracing or not having any prophylactic device. If you are jumping from a height of three feet, or are jumping three feet in the air, and have previous use of a brace, no device is better than tape or bracing. Bracing is only good if you are jumping from a one foot height or jumping one foot in the air. Tape is better for the one and two feet high objects and in the air. No device is better if you have no previous use of a brace for all heights and if you do, it is good at the three feet high object or jumping three feet in the air. The researcher believes that no device may be better at the three foot height with previous use of a brace, because the brace may put the ankle in a position that decrease the force absorbing abilities of the ankle and the body starts to rely on it after a while; therefore, not using a prophylactic device may allow the person to land with
normal force and normal style that decrease the peak force for that height. Another reason may be that a quarter of the subjects with previous brace use were heavier than the subjects with no previous brace use; however, it may just be a psychological factor for the subjects with previous brace use. Those subjects might think since they have used a brace before that they need to land with more force.

The next finding was comparing previous use of tape to stabilization time and peak force. Previous use of tape had no significant affect on stabilization time or peak force. No significant difference was found between previous tape use and prophylactic device condition, previous tape use and box height, and previous tape use, box height and prophylactic device condition on stabilization time or peak force. This may suggest that tape does not impair joint kinematics. Also, it may suggest that tape does not affect performance and the body can adapt to the tape in a timely manner.

Additional tests were calculated comparing stabilization and gender, and peak force and gender. No significant difference was found for stabilization time and gender, gender and prophylactic device on stabilization time, gender and box height on stabilization time and gender, box height, and prophylactic device condition on
stabilization time. This may have happened because both genders can jump the same way and land the same way; although, women have a greater tendency to land in a way that increases the risk of anterior cruciate ligament injury. A significant difference was found between gender and peak force. There was also a significant difference found between gender and box height on peak force. This may have occurred because males might have had some type of plyometric training; as a result, they know how to control their landing and how much force they will apply when landing. Women, on the other hand, may not have had plyometric training; as a result, they may not be able to control how much force they are going to land with and they may not land the same every jump. No significant difference was found between prophylactic device and gender on peak force and prophylactic device, box height and gender on peak force. This may have occurred because each gender may have landed the same way no matter what prophylactic device they used.

Another test was computed comparing the subject’s weight to stabilization time and one for peak force. No significant difference was found when comparing subject’s weight to stabilization time. The researcher was not anticipating finding this result, because if one weighs
more it should take them longer to stabilize; considering, they have more weight, which could change the center of gravity and cause a longer stabilization time. After all a heavier object takes longer to become stable than a lighter object according to Newton’s second law of motion. The range of the weight for this study was 48.53 to 117.93 Kg (See Table 1). This might be another reason no difference was observed. A significant difference was found for peak force comparing the subject’s weight to peak force, and subject’s weight and box height to peak force. This was an expected finding by the researcher. As a matter of fact, this is Newton’s second law of motion and simple physics. Heavier objects jumping from higher heights have more force acting against them causing them to land with that much more force.

Subject’s height and stabilization time and subject’s height and peak force were measurements of the last test calculated. No significant difference was identified between the subject’s height and stabilization time, subject’s height and box height, subject’s height and prophylactic device condition and stabilization time, and subject’s height, box height and prophylactic device condition. The researcher was not expecting this result
because a taller person has a higher center of gravity; therefore, it should take them longer to become stable.

A significant difference was found between subject’s height and peak force. Since the taller subjects in this study, weighted more they should have had longer stabilization times. There is a moderate relationship between height and weight of a subject. As previous stated this is based off of Newton’s second law of motion and basic physic principles.

There are limitations to this study. The one that sets the largest limitation was the sampling rate. Other studies have used a sampling rate of 1000 Hz.\textsuperscript{8,9,20,28,33} This study used a sampling rate of 100 Hz because this was new equipment, we were novice users and the amp and software would not allow a sampling rate of 1000 Hz to be used. Another major limitation was stopping data collection when a train was going by the building. The last major limitation was not performing twenty minutes or longer of activity before performing the test. If this factor was controlled, the warm-up may have made it more game like and more practical.
Conclusion

Based on the results identified, it may be concluded that ankle tape and brace have no effect on stabilization time or peak force. Box height can effect stabilization time and peak force. Peak force was affected when comparing box height to gender, previous use of brace, and subject’s weight and height. The results supported some of the literature. The study supported the results from what Seegmiller et al.\textsuperscript{35} found, which was that a gymnast produced a higher peak force at sixty and ninety centimeter high boxes. The current study did not support the finding of McCaw et al.\textsuperscript{16} which was ankle braces adversely affect ankle joint kinematics; in addition to, the study by Riemann et al.\textsuperscript{9} which found ankle tape and brace decrease time to peak force; however, it did match that ankle stabilizers did not significantly affect peak force.

Although the results were not what the researcher predicted, this study contributes to the literate on ankle bracing and taping. This study does suggest what prophylactic devices may be better if you have had previous use with an ankle brace or have not had pervious brace use. Further, it suggests what factors can affect one’s peak
force and stabilization time when jumping from different heights.

Recommendations

It is very important for Certified Athletic Trainers to understand what prophylactic devices can be used without causing any change to performance, stabilization time or peak force. Further, to know which prophylactic device helps decrease the risk of injury. Since soft shell and hard shell braces both limit different aspects and might affect different aspects. No device may be just as good as a brace or tape if one has had previous brace use. This is a generalization and cannot be assumed for all prophylactic devices. Further testing should be done using different types of braces, and with different populations of subjects to see if the same results can be produced. Another recommendation is to do twenty minutes of activity or more before jumping to take the tape to the time that literature shows it starts lose it motion limiting properties.\textsuperscript{6,7,36} This should be done to see if the tape will still produce the same results as when it has it’s motion limiting properties. The last recommendation is to do everything the same except change the sampling rate of 1000 Hz to see if
the same results are produced. The results from this study might help athletic trainers choose what prophylactic device may be better at preventing injury during activity, if any at all.
REFERENCES


APPENDIX A

Review of Literature
Acute ankle injuries are very common in sports.\textsuperscript{1-5} Landing after a jump is one of the most common mechanisms of injury involving the ankle joint. Since ankle injuries have become so prevalent over the years, many techniques have been created to help prevent these injuries. Prophylactic devices are among the most common ways utilized to prevent injuries; as a result, have become very popular. Athletes have a choice between bracing and taping; however, most of the literature suggest that bracing is better than taping because tape loses its motion limiting properties with exercise.\textsuperscript{6,7} Studies have also examined how taping and bracing effect the ankle movement during a landing and stabilization time.\textsuperscript{8,9}

The purpose of this literature review was to examine the role taping and bracing may have on balance and force absorption in the lower extremity. The topics that will be discussed include: 1. Ankle anatomy, 2. Mechanism of injuries, 3. Prophylactic devices, 4. Forces applied to lower body, 5. Functional testing, and 6. Summary.

Ankle Anatomy

The ankle complex is composed of 4 bones: distal tibia, distal fibula, talus and calcaneus. It is classified as a
hinge joint, and there are three separate joints in the ankle. Two are true joints, and one is a syndesmosis. The two true joints are talocrural, and subtalar joints and the distal tibiofibular is the syndesmosis. There are six movements of the ankle: dorsiflexion, plantar flexion, inversion, eversion, supination, and pronation. Ankle stability comes from the medial and lateral ligamentous structures on both sides of the ankle, the congruity of the articulation surfaces, and the distal leg and foot musculature.²

**Arthology**

The talocrural joint is composed of the medial malleolus, dome of the talus, and lateral malleolus.² This joint is considered to be the true ankle joint and is called the mortise joint.¹⁰ The mortise joint is considered to be adjustable meaning the adjustments come from the tibiofibular joints, both proximal and distal given this intricate anatomy. The most congruent joint in the human body is the ankle joint.¹¹ pg³⁸⁴

The subtalar joint is composed of the talus and calcaneus. The sustentaculum tali is the boney protuberance that is inferior to the medial malleolus. It is the attachment site for the spring ligament and supports the
There are two separate joint cavities and three articulations. The anterior subtalar joint and the posterior subtalar joint are the two joint cavities. The posterior subtalar joint is like a small ball and socket joint. Among the three articulations that occur with the talus and calcaneus, the posterior subtalar joint is the largest.

The distal tibiofibular joint is composed of the tibia and fibula. This joint is a fibrous union, because it has a fibrous structure between the bones called the interosseous membrane. The fibula supports up to 10% of body weight when bearing weight. There is very little movement at this joint and it is stabilized by the interosseous membrane and two ligaments. The two ligaments are called the anterior and posterior inferior tibiofibular ligaments; in fact, the anterior inferior tibiofibular ligament is injured more frequently.

There are ligaments on both sides of the ankle joint. The medial ligament is called the deltoid ligament, which is very strong and fan shaped. The lateral ligaments are divided into three bands: anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament. The anterior talofibular ligament is the most anterior lateral of the three and is
injured most frequently. The posterior talofibular ligament is the most posterior and injured the least of the three. The calcaneofibular ligament is the mid structure of the three and the second most common ligament injured.\textsuperscript{2} Both the deltoid and lateral ligaments support the talocrural and subtalar joint. The subtalar ligaments are very strong; they include the interosseous talocalcaneal, and the posterior and lateral talocalcaneal ligaments.\textsuperscript{11 pg388}

The muscles of the ankle are divided into four compartments. The anterior compartment houses the tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneus tertius muscles. The muscles that create the lateral compartment are the peroneus longus and brevis. The superficial posterior compartment muscles are the gastrocnemius, plantaris, and soleus. The tibialis posterior, flexor hallucis longus, and flexor digitorum are the muscles that create the deep posterior compartment.\textsuperscript{12 pg141} The muscle of the ankle and the lower leg provide dynamic protection from injury and give support to the ankle.\textsuperscript{2}

**Biomechanics**

Ankle injuries can be related to abnormal ankle biomechanics.\textsuperscript{10} There are defined normal biomechanical
patterns involved in gait.\textsuperscript{13} The rear foot, forefoot, and ankle joints work together in the three planes of movement; these planes include frontal, sagittal and transverse. Alterations in normal biomechanics can cause injury to the body due to the relationship one part of the body has with another part.

The movements of the talocrural joint are plantarflexion and dorsiflexion. The axis of movement is an axis of rotation that passes through the lateral and medial malleoli. The plane of movement is in the sagittal plane and very small amounts in the transverse plane.\textsuperscript{2}

The movements at the subtalar joint are pronation, supination, inversion, and eversion. The interdependence of this joint and the leg is the most important function of this joint.\textsuperscript{11 pg393} The axis of movement is an oblique axis of rotation. There is no set line through which the axis passes. The subtalar neutral position is the point at which the calcaneus will invert twice as many degrees as it will evert.\textsuperscript{11 pg391} When weight bearing during inversion, the joint goes into further inversion due to the anatomy and forces applied to it; hence, this is a common way of injuring the ankle. During eversion, the muscles are not strong enough to support the body and all of the forces
applied to it; therefore if a shear force is introduced injury is likely to occur.\textsuperscript{2}

There is very little movement at the distal tibiofibular joint. The interosseous membrane prevents the reduction in the movement. This joint is not a synovial joint; it is an articulation between the tibia and fibula. The two bones never approximate one another. The talocrural joint is dependent on the tibiofibular mortise.\textsuperscript{11 pg383} There is no axis of movement; this joint is easily injured by forced eversion.\textsuperscript{2}

Injuries Involving the Ankle

Ankle injuries comprise forty-five percent of all sports injuries.\textsuperscript{5} There are many types of ankle injuries with a variety of mechanisms and levels of severity. Eighty-six percent of ankle injuries are sprains to the lateral ligaments and ten percent are high ankle sprains.\textsuperscript{12 pg165,16} Seventy-three percent of the athletic population has sprained at least one of their ankles one or more times.\textsuperscript{14} The injury rate is 3.85 per hundred exposures for basketball players according to Sacco et al.\textsuperscript{15}

Various ankle structures can be injured while participating in athletics. Sprains, strains, and
fractures are common; however, sprains are the most common of all. Sprains can occur to the deltoid ligament, lateral ligaments, or the distal tibiofibular ligaments. The anterior talofibular ligament is the most often injured with calcaneofibular ligament following right behind it. When the anterior tibiofibular, posterior tibiofibular ligament, or the interosseous membrane becomes injured, it is called a high ankle sprain.\textsuperscript{12 pg165} Since ankle injuries happen so frequently, research is on going to identify mechanisms and methods of prevention.\textsuperscript{15,17}

The ankle can be injured by several different mechanisms. The most common mechanism is inversion while the ankle is in plantar flexion.\textsuperscript{16,18,19} This mechanism will cause damage to the anterior talofibular ligament, the calcaneofibular ligament or both. Another mechanism is eversion and dorsiflexion, which causes damage to the tibiofibular joint. If eversion is the only mechanism, damage to the medial ligaments is likely to occur. Direct blow, shear, compression, rotational forces, or falling are mechanisms for a fracture.\textsuperscript{12 pg44} Mechanisms that injure the muscles can happen in a variety of ways. The most common is forcing a muscle to contract while lengthening or to over stretch it. Overuse is another mechanism for ankle injuries.
Overall, the research is varied about the risk factors for ankle sprain. The most common risk factor for ankle sprains is a previous injury or sprain to that ankle according to Beynnon et al.\textsuperscript{20} There are intrinsic and extrinsic risk factors. Extrinsic risk factors include the type of shoe, the duration of activity, and the player position.

Intrinsic risk factors are gender, height, weight, foot type, foot size, and limb dominance, range of motion, muscle strength, and laxity. According to Beynnon et al.\textsuperscript{20} gender, biomechanical joint laxity, and foot type are not risk factors for injury.

Functional instability is another intrinsic risk factor. This is defined by Tropp et al.\textsuperscript{10} as, “the subjective feeling of ankle instability or recurrent, symptomatic ankle sprains due to proprioceptive and neuromuscular deficits.” This happens if an individual has any of the following: impaired neuromuscular control, ankle muscle strength deficits, proprioception problems, and delayed muscle reaction times.\textsuperscript{21} Functional instability can cause chronic instability, which is when a person continues to injure their ankles due to this instability.\textsuperscript{2} According to Ross et al.\textsuperscript{21}, it takes athletes longer to stabilize when they have functional ankle instability. Ross et al.\textsuperscript{21}
said, “Identifying this problem before we send the athlete back into activity will help decrease recurrent ankle injuries.”

**Prophylactic Devices**

A prophylactic device is a device that is worn to provide support to a body part. Two examples of prophylactic devices include braces and tape. Research has been conducted to observe which is more effective: taping or bracing. There also have been studies evaluating if these devices prevent injury by limiting range of motion or increasing proprioception. Very few studies have evaluated the forces applied to the ankle during weight bearing activities while wearing these devices.

**Tape**

Taping is one method performed to prevent ankle injuries, used in a variety of sports, provides mechanical support, and increases proprioception. Those are the most common theories behind ankle taping. The effectiveness of tape on limiting motion is still unknown according to Bragg et al. Tape can be very expensive, because it has to be
re-applied every day compared to a brace that can be reused.

Closed basket weave is a very basic taping style that is used; as a result, many athletic trainers change their close basket weave technique to a more effortless and less time consuming way. In the closed basket weave, horseshoe strips are interweaved with stirrups, and are followed by two Louisiana heel locks and two figures eights. The closed basket weave taping was used in a study by Ricard et al.\textsuperscript{19} This study found that there was no difference taping to the skin or over pre-warp when looking at inversion restrictions. After exercise both methods provided residual restrictions.\textsuperscript{19}

In comparison to the closed basket weave taping technique, a study done by Wilkerson et al.\textsuperscript{7} used the subtalar sling taping technique. The subtalar sling taping is similar to the closed basket weave taping except it has one more step. The subtalar sling taping has one or more strips of semi-elastic tape covering the forefoot, leg and all the joints in-between the two. The sling is applied after the stirrups and horseshoes are applied. Next, the strips are anchored on the plantar aspect of the foot, and then wrapped to the lateral side of the foot to the leg above the malleoli. Heel locks and figure eights are then
applied. The rest is covered by non-elastic tape. This technique can last two to three hours of physical activity and is not used very often.\(^7\)

Research has suggested that the main purpose of the tape is to limit excessive range of motion and to prevent injury.\(^7,23\) Tape also increases the mechanical support of the ankle. According to Bragg et al.\(^23\), tape loses its motion limiting properties after about twenty minutes of exercise. Another study says tape loses it’s motion limiting properties after ten minutes of exercise.\(^5,6\)

**Braces**

Bracing is another common method used to prevent ankle injuries. There are soft-shell and semi-rigid (hard shell) braces. Braces can tie, strap on, slide on, or use a combination of all these techniques. In recent years, bracing has become very popular as an alternative to taping. Braces are considered a cost saving technique to prevent injury, since they can be reused.

Soft shell braces are made of exterior canvas and tie up, or slip on. Semi-rigid braces are made with hard plastic inserts, canvas exterior and slide on, or strap on. Both types have been used in many studies. The comfort depends on the person’s foot structure and type of brace.
The soft shells are the most comfortable. Semi-rigid braces are better at limiting range of motion before and after activity.\textsuperscript{6}

Studies have compared soft braces to semi-rigid braces to see which technique prevents injury better. Wikstrom et al.\textsuperscript{14} found there was no difference between the two when looking at the vertical stability index. This is an average magnitude difference from subject’s body weight to standardize vertical scores and ground reaction force among subjects with different body weights.\textsuperscript{14}

Research has suggested bracing reduces the risk of injury by providing support; furthermore, limiting excessive range of motion, and enhances proprioception just like tape. Studies have also looked at how bracing affects the athlete’s performance. McCaw et al.\textsuperscript{18} and Simpson et al.\textsuperscript{24} found that braces impinge on normal kinematics and there is difference between the soft and semi-rigid braces.

One study looked at how a placebo ankle taping, which was a single piece of tape over the peroneal tendon, affected proprioception. The study was done by Sawkins et al.\textsuperscript{5} and they found that the placebo taping increased proprioception. They also found that the placebo and real ankle taping increased the subject’s perceptions of stability and confidence.\textsuperscript{5}
Forces Applied to the Ankle

The body experiences impact forces when coming in contact with the ground. This is Newton’s third law. The force is called the ground reaction force.\(^{25}\) The forces are transferred from the toes to the head.\(^{26}\) Forces are applied to the passive structures of the leg and contractile tissues. The passive structures, or non-contractile tissues include: ligaments, tendons, bone, and fascia and muscle is the contractile tissue.\(^{16}\)

The body is made to absorb shock. In gait and landing, the shock or vibration starts at the ankle and moves up, this is called a shock wave. Shock attenuation is the reduction of a shock wave and a reduction in rate and amount of force on the subject’s body.\(^{27}\) If the ankle is in dorsiflexion or plantarflexion, the forces are transferred to the knee.\(^{18}\) The three joints that absorb most of the forces include the ankles, knees, and hips. The amount of force applied to the ankle can be decreased by wearing shock absorbing footwear such as tennis shoes with a padded heel.

High ankle support shoes can affect how the ankle absorbs force according to Brizula et al.\(^{27}\) They found an increase in impact force after jumping, which might have
occurred because plantarflexion was limited by the high ankle support. During landing, impact forces are greatly increased and the forefoot and ankle absorb this shock to protect the bone and joint. The muscles shorten during this time causing a release of elastic energy.28

**Force Related to Injury**

Forces can create injury to a ligament if the forces causes the ligament to exceed its normal tensile strength.11 Direct force is another way to cause injuries. A longer stabilization time increases the risk of injury.8 Ankle bracing may reduce the ability to plantarflex, which increases the risk of injury and puts more demand on the knee and hip.9,18 Excessive forces to the tissue can cause a number of overuse injuries like fractures and damage to the articular cartilage.26,29 If the ankles can not absorb forces in a timely manner injury can occur. However, if the force is absorb promptly the risk of injury decreases. Prophylactic devices might cause a person to absorb forces slower or quicker than normally.

**Measuring Force**

Research suggests that there are many ways to measure forces applied to the lower extremity. A force platform is
one of the ways to measure these forces.\textsuperscript{21} Using a camera to see joint movement is another method used to help see what forces are being applied the body. A shock absorption test can also be done.\textsuperscript{27} Studies that have measured force measure peak ground reaction forces, time to stabilize, power, electromyography activity or all.\textsuperscript{17,25,28,30}

A force platform is a plate that is embedded into the floor, which measures forces in three planes. It is a valid and reliable tool that provides precision measurements in gait, balance and sport applications.\textsuperscript{8,31} Many studies have used force platforms to measure ground reaction force; in addition to, center of pressure, ground reaction force, and forces applied to the foot during gait.

**Functional Tests**

Functional tests are a good way to test lower body function. They help assess muscular strength, joint stability, and neuromuscular coordination.\textsuperscript{32} Athletic trainers usually use these test to determine return to play status. Studies have looked at how ankle bracing and taping affect the athlete’s performance. All of these studies used functional testing to evaluate the effects of prophylactic devices and taping on performance. Some of the tests used
included: the shuttle run, cutting drills, vertical jump, drop jump, hopping, sprinting drills.\textsuperscript{32}

\textbf{Drop Jumps}

Drop jumps are functionally applicable to many sports. These jumps simulate landing from a jump in a game.\textsuperscript{33} The jumps are good tools when attempting to measure ability to absorb force. There are many ways a drop jump can be preformed. Studies have had subjects drop from one or three different box heights.\textsuperscript{18,25,28,34,35} Zhang et al.\textsuperscript{25}, and Viitasalo et al.\textsuperscript{34} found that an increase in height increases peak ground reaction forces and power. The heights range from .2m to 1.03m. Other studies used the hanging drop landing, because it has been shown to minimize foot contact asymmetry.\textsuperscript{30,36}

Studies have looked at how bracing and landing style effect peak vertical ground reaction forces. Hodgson et al.\textsuperscript{30} found that there was an increase in peak vertical ground reaction force when braced. Self and Paine\textsuperscript{36} found that there was increase in peak vertical force with stiff knee landing. Studies have also had subjects do a vertical jump and land on the force platform, or they would perform a drop jump and then proceed directly into a vertical jump.\textsuperscript{8,33,37,38}
Maximum vertical force and knee angles have been examined in many studies. These studies suggest that performing training to keep the knees from turning inward might prevent injury. The studies found that children have a shorter time to maximum vertical force than adults, with no differences between genders. They also found that greater valgus angles lead to anterior cruciate ligament (ACL) injuries.\textsuperscript{33,37,38} These studies suggest neuromuscular training may help decrease the risk of ACL injuries. One study did a vertical jump stop. Chappell et al.\textsuperscript{39} found a difference in landing between genders and that motion patterns are preprogrammed before the landing. They also found that females land with decreased hip and knee flexion, which increases the risk of ACL injuries.\textsuperscript{39}

**Landing Styles**

The way one lands may have an affect on injury and how forces are absorbed. Studies have been done looking at how landing styles affect force on the lower leg. The types of landing styles include natural landing, stick the landing (stiff landing) like in gymnastics, and stick the landing with calf flexed (soft landing).\textsuperscript{36} One can also land on one leg or both.
There are many methods of landing. Landing on one leg has been used in studies by Nyska et al.\textsuperscript{3}, Wikstrom et al.\textsuperscript{8}, Ross et al.\textsuperscript{21}, Coventry et al.\textsuperscript{29}, Swartz et al.\textsuperscript{33} Each of these studies looked at landing style and how it affects shock absorption. Swartz et al.\textsuperscript{33} found that children land different than adults. Coventry et al.\textsuperscript{29} found that fatigue does change the way the body absorbs shock. Hip flexion increased and ankle plantar flexion decreased after fatigue\textsuperscript{29}. When landing on one leg with functional ankle instability, it takes longer to stabilize during a landing according to Nyska et al.\textsuperscript{3}, Wikstrom et al.\textsuperscript{8}, Ross et al.\textsuperscript{21}.

Landing on two feet has been done in many studies. McCaw et al.\textsuperscript{18} found a difference between landing style when looking at ankle angle at maximum knee flexion and ankle range of motion. Carica et al.\textsuperscript{35} found that hip abductor fatigue effects frontal-plane orientation. A study that used both a soft and stiff landing was done by Zhang et al.\textsuperscript{25} and found that plantar flexors absorb more energy during a stiff landing, and the hip and knee absorb more energy during a soft landing. Istavan et al.\textsuperscript{28} looked at forefoot landing and heel to toe landing. They found a difference between heel to toe landing and forefoot landing when looking at total power and torque.
The natural landing style was used in a couple of studies. Moran et al.\textsuperscript{26}, found that fatigue can reduce the capacity to attenuate impact on the tibia. The study done by Self and Pain\textsuperscript{36} looked at all the landing styles and found a difference between all landing styles when looking at maximum vertical force.

Seegmiller et al.\textsuperscript{40} looked at difference between gymnasts and recreational athletes landing styles. They found that gymnasts produce a higher peak force at the sixty and ninety centimeter box heights compared to recreational athletes. This might contribute to the incidence of lower extremity injuries that gymnasts experience.

Summary

Acute ankle sprains are the most common injuries in sports. A variety of mechanisms cause ankle sprains and there are many risk factors for ankle injuries. Many forces are applied to the body during a landing from a jump. A longer stabilization time may increase the risk of injury to the ankle and other parts of the body. The most common way to prevent ankle injuries is using prophylactic devices: brace or tape. Prophylactic devices do not affect
performance; however, they might affect the way the ankle absorbs force.
APPENDIX B

The Problem
Statement of the Problem

Ankle injuries are very common in sports. Because ankle injuries have become so prevalent over the years, many techniques have been created to help prevent these injuries. Prophylactic devices are among the most common ways utilized to prevent injuries; however, most of the literature suggest that bracing is better than taping because tape loses its motion limiting properties with exercise.6,7 The purpose of the study is to determine if different prophylactic devices affect shock absorption at the ankle joint during a landing.

Definition of Terms

The following terms were operationally defined for this study:

1. Stabilization Time- the time when the vertical-force component reaches and stays within five percent of the subject’s body weight after landing and it is an objective postural control measure.8,41

2. Peak force- the point at which ground reaction force is maximally applied to the body part during landing.

3. Prophylactic device- a device applied to the ankle to help prevent injury, improve support, and stability.
4. Soft-shell- a brace made of exterior canvas that ties up or slips on. An example is the Ankle Stabilizing Orthosis (ASO).

5. Drop jump- is when a subject stands on a box and steps off landing on two feet.

Basic Assumptions

The following are basic assumptions for this study:

1. All subjects were honest when reporting previous use of a brace or tape in addition to honestly reporting an ankle or knee injury in the last six months.

2. All subjects gave the best effort when doing the drop jumps.

3. The AMTI force platform was a valid and reliable tool to measure stabilization time and peak force.

Limitations of the Study

The following are possible limitations for this study:

1. Testing was done in a laboratory, which means results may not apply to the real sport setting.

2. Only the physically active students and Division II male and female athletes from California University of Pennsylvania were used for this study.

3. A sample of convenience was used for this study.
4. The external validity may be of concern due to size of the sample.

5. The activity was less than twenty minutes, so the motion limiting properties of the tape may not be experienced.

6. If there was a train going by data collection was stop and subjects sat and waited until it went by to start again.

7. The sample rate was set at a 100 Hz, instead of 1000 Hz like other studies have used.\(^8,9,28,30,42\)

**Significance of the study**

The body experiences impact forces when coming in contact with the ground. Newton’s third law states that the ground produces equal and opposite force and the force is known as the ground-reaction force (grf). The maximal grf when landing on one leg jump can be as high as 14.4 times the person’s body weight.\(^{25}\)

The body is made to absorb this shock, and the ankle is the first joint to feel the shock. In gait and landing, the shock or vibration starts at the ankle and moves up, this is called a shock wave. If the ankle can not absorb the shock wave in a timely manner, injuries can occur to the ankles, knees or hips. The hip and knee absorb most of
the force during a soft landing and the ankle absorbs most of the force during a stiff landing.\textsuperscript{25}

Since ankles injuries have became so common, many techniques have been established to help prevent injury. Prophylactic devices are among one of the most common ways utilized to prevent injuries; as a result, have become very popular over the years. Braces are a cost saving technique to prevent injury. Taping is used in a variety of sports and research suggest that it loses its motion limiting properties after ten minutes of exercise.\textsuperscript{23}

Very few studies have compared bracing to taping during drop jumps from different heights. Finding out if prophylactic devices affects the way ankle joint absorbs shock during landing will help the athletic trainer and the athlete decide which prophylactic device is better in reducing injuries for the ankle.
Appendix C

Additional Methods
APPENDIX C1

Institutional Review Board Form
California University of Pennsylvania

PROTOCOL for Research Involving Human Subjects

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

(Reference IRB Policies and Procedures for clarification)

Project Title: The Effects of Prophylactic Ankle Devices on Force Absorption during Drop Jump

Researcher/Project Director: Ms. Brina Wade

Phone: 719-214-3421 E-mail Address: Wad8120@cup.edu

Faculty Sponsor (if required): Dr. Linda Platt Meyer

Department: Health Science and Sports Studies

Project Dates: Fall 2007 to Spring 2008

Sponsoring Agent (if applicable):

Project to be Conducted at: California University of Pennsylvania

Project Purpose: [ ] Thesis [ ] Research [ ] Class Project [ ] Other

Keep a copy of this form for your records.

Required IRB Training

The training requirement can be satisfied by completing the online training session at http://ecm.nci.nih.gov/. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:

Previous Project Title

Date of Previous IRB Protocol

Draft, April 7, 2005
Please attach a typed, detailed summary of your project AND complete items 2 through 6.

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

   The purpose of this study is to determine if prophylactic devices affects shock absorption at the ankle joint during a drop jump. A quasi experimental within-subjects design will be used for this study. The dependent variables will be: 1. Stabilization time, and 2. Peak force. The independent variable will be prophylactic device condition (Brace, Tape, and no prophylactic device). The subjects will be the physically active population from California University of Pennsylvania including athletes, and will be volunteers. Physically active will be defined as a person who does physical activity a minimum of three days a week for at least thirty minutes a day. The study will consist of two sessions: an orientation and a testing/data collection session. Each subject will be tested under all three prophylactic device conditions for each box height and will be jumping off each box five times. The box heights are .3048m, .6096m, and .9144m. Stabilization time and peak forces will be measured using the Advanced Mechanical Technology, Inc Model OR 6-7 force platform. The researcher hypothesized that there will be a difference in stabilization time and peak force for each prophylactic device condition.

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

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

      The research will minimize the risk of injury by having subjects do a warm-up and will provide proper treatment if an injury occurs. The testing involves no more than normal physical exertion.

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

      The subjects will be based from a sample of convenience of physically activity population including...
athletes from California University of Pennsylvania. Subjects will be volunteers and will be excluded from the study if they have had an ankle or knee injury in the last six months. Subjects will be randomly assigned the order of the prophylactic device condition. The box heights will not be randomly assigned.

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

An informed consent form (appendix C2) will be obtained from each subject at the orientation meeting. No names will be used for this study; each subject will have a number assigned to them. The informed consent form will be kept on file and a copy will be given to each subject.

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

A data collection sheet will be used (appendix C4). The researcher will administer each testing session to ensure privacy and safety of the subjects. All forms containing identify information will be kept in a secure location where only Brina Wade and research advisor Dr. Linda Platt Meyer will have access to them. If the results of this study are published, the subject’s identity will not be revealed.

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

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

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

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

Title of the Grant Proposal ________________________________
6. Does your project involve the debriefing of those who participated? ☐ Yes or ☒ No

   If Yes, explain the debriefing process here.

7. If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix __ in the Policies and Procedures Manual.
The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

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

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

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

Professional Research

Project Director's Signature  
Department Chairperson's Signature

Student or Class Research

Student Researcher's Signature
Supervising Faculty Member's Signature if required  
Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

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

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

Approved  
Chairperson, Institutional Review Board  
Date: September 12, 2005
APENDIX C2

Informed Consent Sheet
Informed-Consent Form

1. Brina Wade, who is a Graduate-Assistant Athletic Trainer has requested my participation in a research study at California University of Pennsylvania. The title of the research is: The Effects of Prophylactic Ankle Devices on Forces Absorption during a Drop Jump.

2. "I have been informed that the purpose of the research is to determine if prophylactic ankle devices affect shock absorption during a landing. I understand that I have been asked to participate voluntarily, along with 30 other participants because I have had no previous injury to my ankles or knees in the past six months, and because I am currently part of the physically active population including athletes at California University of Pennsylvania."

3. "My participation will involve testing. The testing will be done three times; no prophylactic device, tape, and the ASO brace. My participation in this study will consist of an orientation meeting, and one meeting for testing and data collection."

4. "I understand there are foreseeable, minimal risks or discomforts to me if I agree to participate in the study. The possible risks and/or discomforts include possible ankle injury or knee injury. To minimize these risks and discomforts the researcher will have me perform a proper warm-up before participating in functional testing. The researcher will also provide any treatment needed if injury occurs."

5. "I understand that, in case of injury, I can expect to receive treatment or care in Hamer Hall’s Athletic Training Facility. This treatment will be provided by the researcher, Brina Wade, ATC. Additional services needed for prolonged care past thee days will be referred to the attending physician at the Downey Garofola Health Services located on campus."

6. "There are no feasible alternative procedures available for this study."

7. "I understand that the possible benefits of my participation in this study are to provide more current research to add to existing body of knowledge, which will
contribute to determining if taping or a bracing will be most effective in maximizing shock absorption.”

8. “I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Brina Wade, ATC, will maintain all documents in a secure location (filing cabinet in the researcher’s apartment), which only the student researcher and research advisor can access. Subjects will be assigned a number and will be referred to only by those numbers during the testing.”

9. “I have been informed that I will not be compensated for my participation.”

10. “I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Brina Wade, 261 California Road, Apt. #311 B, Brownsville, PA 15417, 719-214-3421, wad8120@cup.edu, or by Dr. Linda Platt Meyer (research advisor), Hamer Hall, 250 University Ave, California, PA 15419, 724-809-5883, meyer@cup.edu.”

11. “I understand that written responses may be used in quotations for publication but my identity will remain anonymous.”

12. “I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be provided to me.”

Subject’s signature: _______________________ Date: ________

Witness signature: _______________________ Date: ________
13. “I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.”

14. “I have provided the subject/participant a copy of this signed consent document.”

Researcher’s signature: _________________________________

Date: __________

APPENDIX C3

Demographic Information Sheet
**Demographic Information Sheet**

Please answer the following questions as accurate as possible and circle the correct answer. If any does not apply to you put N/A.

1. Age: __________
2. Height: __________
3. Weight: __________
4. Gender: __________
5. Sport: __________
6. Position: __________
7. Type of physical activity: ____________________
8. How many days a week of physical activity: ____________________
9. How much time at each session of physical activity: ____________________
10. **Dominant foot** (The foot you would use to kick a ball)
    - Right
    - Left
    Please circle one
11. **Previous use of brace**
    - Yes
    - No
    Please circle one
    *If yes, how long did you use: __________*
12. **Previous use of tape**
    - Yes
    - No
    Please circle one
    *If yes, how long did you use: __________*
13. **Previous surgery to ankle**

Yes   No  Please circle one

**If yes,** please give a detailed description of the surgery including how long ago:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

14. **Previous surgery to knee**

Yes   No  Please circle one

**If yes,** please give a detailed description of the surgery including how long ago:

________________________________________________________________________

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________________________________________________________________________

________________________________________________________________________
APPENDIX C4

Data Collection Sheet
**Data Collection Sheet**

Subject #_________Weight_________

5% above body Weight_________

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<th><strong>End time (time 2) (s)</strong></th>
<th><strong>Stab. Time (time 2-time 1) (s)</strong></th>
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APPENDIX C5

Ankle Taping Instruction Sheet
Ankle Taping Instructions
(Modified version from “Athletic taping and Bracing”
by David H. Perrin)

1. Position ankle joint to ninety degrees.

2. Apply tape adherent spray (Tuf-skin, Cramer inc. Gardner, KS)

3. Apply heel and lace pads (Heel and lace pads, Cramer inc. Gardner, KS) with Gel-lube on the pad (Skin lube, Cramer inc. Gardner, KS)

4. Apply foam pre-wrap (M Wrap, Mueller Sports Medicine inc. Prairie du Sac, WI)

5. Apply two proximal anchors at musculotendinous junction of gastrocnemius overlapping by half using 1 ½ inch white tape (Coach, Johnson and Johnson, New Brunswick, NJ)

6. Apply distal anchor at mid-foot (distal to styloid process).

7. Apply stirrup starting on medial side of proximal anchor pulling to lateral side proximal anchor.

8. Apply horizontal horseshoe distal to proximal starting at the level of the malleoli.

9. Apply stirrup starting on medial side of proximal anchor pulling to lateral side proximal anchor overlapping other stirrup by half.

10. Apply horizontal horseshoe distal to proximal overlapping other horseshoe by half.

11. Apply stirrup starting on medial side of proximal anchor pulling to lateral side proximal anchor overlapping other stirrup by half.

12. Close the taping with horizontal horseshoes (distal to proximal) overlapping by half.

13. Apply one figure eight and one heel lock to medial and lacteal sides of ankle pulling into eversion continuously then apply one figure eight and one heel lock continuously.
APPENDIX C6

Ankle Brace
The Ankle Stabilizing Orthosis® Ankle Brace

REFERENCES


Title: THE EFFECTS OF ANKLE PROPHYLACTIC DEVICES ON FORCE ABSORPTION DURING A DROP JUMP

Researcher: Brina J. Wade, ATC, PES

Advisor: Dr. Linda Platt Meyer, ATC, PES

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Purpose: The purpose of this study is to determine if ankle prophylactic devices (the Ankle Stabilizing Orthosis® (ASO) and the modified Gibney closed ankle basket weave tape technique) affect shock absorption during landing from a drop jump.

Problem: The literature is mixed on what prophylactic devices are better at preventing injury when jumping for a drop jump.

Methods: Thirty subjects participated in the study. The sample included undergraduate and graduate students and varsity athletes from California University of Pennsylvania. Subjects performed the five jumps from each box height under each prophylactic device condition. The order of the prophylactic device application was randomized. The box heights were the not (.3048m, .6096m, .9144m). The average of the five jumps from each height and each prophylactic device condition were used to calculate repeated measures ANOVA test using an alpha level of <.05.

Finding: No significant difference was found when comparing prophylactic device condition to stabilization time and peak force. However, a significant difference was found when comparing box height to stabilization time.
(F₂, 58 = 17.454, p<0.001) and peak force (F₂, 58 = 44.895, p<0.001).

Conclusion: Since there was no significant difference between prophylactic device conditions, either prophylactic devices or no device can still be used. Certain factors like gender, previous use of brace, and the subject’s height and weight can affect peak force and stabilization time. This study does suggest what prophylactic devices may be better if you have had previous ankle brace use or have not had previous brace use and what factors can affect one’s peak force and stabilization time when jumping from different heights. Further studies are needed to determine if the same results occur with different types of braces and populations and activity should be increased to twenty minutes or more before jumping to test what the literature says about tape losing its motion limiting properties after twenty minutes of activity.