5-1-2013

The Effects of Arch Taping on Shock Attenuation During Landing

Shun Jinnouchi
University of Nevada, Las Vegas

THE EFFECTS OF ARCH TAPING ON SHOCK ATTENUATION DURING LANDING

By

Shun Jinnouchi

Bachelor of Science in Athletic Training

University of Nevada, Las Vegas

2011

A thesis submitted in partial fulfillment

of the requirements for the

Master of Science in Kinesiology

Department of Kinesiology and Nutrition Sciences

School of Allied Health Sciences

The Graduate College

University of Nevada, Las Vegas

May 2013

THE GRADUATE COLLEGE

We recommend the dissertation prepared under our supervision by

Shun Jinnouchi

entitled

The Effects of Arch Taping on Shock Attenuation During Landing

be accepted in partial fulfillment of the requirements for the degree of

Master of Science in Kinesiology
Department of Kinesiology and Nutrition Sciences

John Mercer, Ph.D., Committee Chair

Tedd Girouard, Ph.D., Committee Member

Richard Tandy, Ph.D., Committee Member

Danny Young, Ph.D., Graduate College Representative

Tom Piechota, Ph.D., Interim Vice President for Research &
Dean of the Graduate College

May 2013

ABSTRACT

The Effects of Arch Taping on Shock Attenuation During Landing

By

Shun Jinnouchi

Dr. John Mercer, Examination Committee Chair
Association Professor of Kinesiology
University of Nevada, Las Vegas

The purpose of this study was to investigate the effects of two different arch taping techniques on shock attenuation during landing. Each subject (n=12, age 25.5 ± 3.37 years, height 1.73 ± 0.04 m, mass 82.06 ± 16.23) was instrumented with accelerometers at the leg and forehead (sample rate = 1000 Hz). Subjects performed landings from a 30 cm box under three taping conditions: no tape, Low Dye, and Weave. For each condition, subjects completed 5 landing trials. Rest was provided between each trial and order of conditions was counterbalanced. During each landing, accelerations were recorded at 1000 Hz for the leg and head respectively using light-weight accelerometers. Data were reduced by identifying the peak impact accelerations for the leg and head with shock attenuation calculated as [1- head peak impact acceleration/leg peak impact acceleration]*100. Peak impact accelerations as well as shock attenuation were the dependent variables. A repeated measures ANOVA was used to compare dependent variables between taping conditions. There was no significant difference for either leg peak accelerations ($F_{2,22}$= .532, $_{p}$ = .595), head peak accelerations ($F_{2,22}$= 1.479, p = .25), or shock attenuation ($F_{2,22}$= 1.022, p > .376) between conditions (i.e., no tape, Low Dye, Weave). Leg or head peak acceleration or shock attenuation was not influenced by arch taping techniques.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the guidance and help of many people along the way.

I would especially like to thank my thesis committee chair, Dr. John Mercer. He has been my biggest guide, helper, editor, and leader since he accepted my offer to be my thesis committee chair. I don't only look up to him as an inspiration in academia, but also as a human being. I would also like to thank Mr.Tedd Girouard. He is one of the reasons I started into graduate school and who I am here today. He had driven me the hardest to do my best work and set me up to succeed my career as an athletic trainer. I would like to thank Dr. Dick Tandy. He taught me everything I need to know about statistics since undergraduate class. Special thanks go to Dr. Danny Young. He looked out for my during my thesis process and made sure everything was objective and fair.

Lastly I would like to thank my fellow graduate assistants. With you, I could have finished on time. We had a lot of fun, made lasting friendships, and will have forever memories.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Participation in athletic events is beneficial for health; however, it may be accompanied by unwanted side effects in the form of athletic injuries. For example, the impact between the foot and ground has typically been related to overuse type injuries in sports that involve a lot of running (James, Bates, & Osterning, 1978). Shock attenuation describes the process in which the impact force that was caused by the collision between the ground and foot at each strike of running or walking is reduced (Mercer, Vance, Hreljac, & Hamill, 2002). There is a strong body of literature on shock attenuation during activities like running (e.g., Derrick 2004; Flynn, Holmes, & Andrews, 2004; Mercer et al. 2002). It makes sense that shock attenuation has been explored during running because ground reaction force impact peaks can be 2 to 3 times body weight (Cavanagh & Lafortune, 1980). Interestingly, there is very little research on shock attenuation landing even though impact forces can be much higher than running (Zhang, Derrick, Evans, & Yu, 2008).

The current research on shock attenuation during landing or running has been focused on the attenuation between the foot and head segments (Conventry, O'Connor, Hart, Earl, & Ebersole, 2006; Derrick, 2004; Flynn, et al. 2004; Mercer, et al. 2002; Zhang, et al. 2008). It is understood that the amount of shock attenuated is influenced by active movements (e.g., knee flexion, hip flexion) as well as passive structures such as the ground, shoes, heel pad, cartilage, and bone (Nigg, Cole, & Bruggemann, 1995). Of course, muscles are considered to play a major role in shock attenuation because of the ability to absorb kinematic energy during human body movements such as running or landing (Derrick, Hamill, & Caldwell, 1998). However, anatomical structures like bone, cartilage, and joint alignment at contact are considered to influence shock attenuation. Likewise, the foot arch is considered to play a role in shock attenuation since it has the ability to change shape during landing and locomotion in a way that can influence shock attenuation (Sun, Shih, Chen, Hsu, Yang, & Chen, 2012).

It is common to apply support (e.g., taping, bracing) to anatomical joints with the intent of preventing an injury. Arch taping has been widely used by clinic in the management of lower extremity conditions such as heel pain or plantar fasciitis (Franettovich, Chapman, & Vicenzino, 2008). The common arch taping techniques include Low Dye and weave techniques. The two arch taping techniques are chosen because Low Dye technique is one of the most common arch taping techniques and the weave technique is the most supportive arch taping technique. Vicenzino, McPoil, and Buckland (2006) investigated the effect of an augmented Low Dye taping technique on the medial longitudinal arch of the foot during dynamic tasks such as walking and jogging and demonstrated that arch taping produced changes significant increases in lateral mid-foot plantar pressure. The research on arch taping has studied the effects of arch taping during both static and dynamic activities, including mechanical and neuromuscular effects (Vicenzino, Franettovich, McPoil, Russell, & Skardoon, 2005). Dynamic activities that researchers have studied on arch taping are limited to walking, jogging, and running (Franettovich, Chapman, & Vicenzino, 2008; Vicenzino, Dip, McPoil, & Buckland, 2007; Vicenzino, Franettovich, McPoil, Russell, & Skardoon, 2005; Ator, Gunn, McPoil, & Knecht, 1991). However, there are no data on the influence of arch taping on shock attenuation during landing. Therefore, the purpose of this study is to investigate the effects of two different arch taping techniques on shock attenuation during landing.

Research Hypothesis

The research hypotheses of this study are:

1. Shock attenuation is influenced by arch taping techniques.
2. Leg peak impact acceleration is influenced by arch taping techniques.
3. Head peak impact acceleration is influenced by arch taping techniques.

Null and alternate hypotheses of this study are:

H_{0TSA} $\mu_{Control} = \mu_{Low\ Dye} = \mu_{Weave}$ H_{1TSA}: At Least Two Means will be Different

H_{0LP} $\mu_{Control} = \mu_{Low\ Dye} = \mu_{Weave}$ H_{1LP}: At Least Two Means will be Different

H_{0HP} $\mu_{Control} = \mu_{Low\ Dye} = \mu_{Weave}$ H_{1HP}: At Least Two Means will be Different

1. <u>Independent variable</u>: arch taping (no taping, Low Dye, weave)
2. <u>Dependent variables</u>: peak impact acceleration (head, leg) and shock attenuation

Definition of Terms

The following definitions are given for the purpose of clarification:

1. Acceleration: The rate of change in velocity.
2. Leg peak impact acceleration: Peak acceleration of the lower leg recorded by an accelerometer mounted on the medial aspect of the distal tibia immediately after ground contact.
3. Head peak impact acceleration: Peak acceleration of the head recorded by an accelerometer mounted on the forehead immediately after the ground contact.
4. Shock Attenuation: The process by in which the impact shock caused by the collision between the ground and foot is reduced. Mathematically it is the measure of the reduction of the peak impact acceleration between two segments. The formula in the time domain is:

$$\text{Shock Attenuation (\%)} = 100^{*} \left(1 - \text{Peak}_{\text{Segment A}} / \text{Peak}_{\text{Segment B}}\right)$$

5. Shock Wave: A wave initiated by the foot-ground contact that travels through the musculoskeletal system in the body up to the head.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Participation in athletic events is beneficial for health; however, it may accompanied by unwanted side effects in the form of athletic injuries. Non-contact injuries are prevalent in sports that require jumping and landing. Sports like volleyball and basketball that usually require jumping and landing are predisposing factors for ankle and knee injuries (Herman, Weinhold, Guskiewicz, Garrett, Yu, & Padua, 2008). In response to the high injury rate, arch taping has been widely used by clinic in the management of lower extremity conditions such as heel pain and plantar fasciitis (Franettovich, Chapman, Blanch, & Vicenzino, 2008). The purpose of this study is to investigate the effects of 2 different arch taping techniques on shock attenuation during landing. The focus of this chapter is to review the literature that relates to understanding mechanisms of landing from a jump and the effects of arch taping. The research on landing has focused on the biomechanical implications of landing and the resulting loads on the lower extremity. The research on arch taping studied the effects of arch taping during both static and dynamic activities.

Landing

Landing movements are integral features of many athletic activities and have been investigated by numerous researchers (e.g., Devita & Skelly, 1992; Dufek & Bates, 1990; Gross & Nelson, 1988). The research on landing has focused on the biomechanical implications of impact and the resulting loads placed on the lower extremity (Dufek & Bates, 1990; Gross & Nelson, 1988).

Devita and Skelly (1992) examined the effect of landing stiffness on joint kinetics and energetics in the lower extremity. Eight healthy, female, intercollegiate basketball and volleyball players were recruited for this study. The subjects completed five successful step-off-landing trials under each of two landing conditions; soft and stiff landings. Ground reaction forces, joint position, joint moments, and muscle powers in the lower extremity were measured and compared between soft and stiff landings from a vertical fall of 59 cm. A force platform was used to measure vertical ground reaction force. Soft and stiff landings had less than and greater than 90 degrees of the knee flexion after floor contact, respectively. The ratio of muscular work parameter values at each joint to the summated work values across the hip, knee, and ankle joints were used to identify the relative contribution of each muscle group to the landing tasks. The researchers in this study reported that larger hip extensor and knee flexor moments were observed during decent in the stiff landing, which produced a more erect body posture and a flexed knee position at impact. The stiff landing had larger ground reaction forces, but only the ankle plantar flexors produced a larger moment. The hip and knee muscles absorbed more energy in the soft landing, while the ankle muscles absorbed more in the stiff landing. Overall, the muscular system absorbed 19% more of the kinetic energy in the soft landing compared to the stiff landing to reduce the impact stress on other tissues. The results of this study further cement the belief that soft landings will aid to lower ground reaction force, effectively lower the amount of shock attenuation performed by the body. Understanding the work the muscle groups are doing can help us understand which anatomical structures are under stress, mechanism of injury, and how to better prevent lower extremity injuries. Subjects in this study were only female and many researchers have been interested in females to possess a higher rate of non-contact anterior cruciate ligament injury compared to males during athletic competition (Decker, Torry, Wyland, Sterett, & Steadman, 2003).

A reason that there is a wealth of research on landing biomechanics is that some injuries may be able to be prevented through a better understanding of what is proper landing mechanics. For example, anterior cruciate ligament injuries frequently occur in non-contact athletic maneuvers during significant and rapid decelerations of the body's center of mass such as those that occur with cutting or landing from a jump (Boden, et al. 2000). The mechanism of injury for anterior cruciate ligament injury is internal rotation of the knee and valgus force (Bahr & Krosshaug, 2005; Tillman, Haas, Brunt, & Bennett, 2004). An understanding of landing techniques is important for the prevention of injuries in a number of athletic events.

Laughlin, Weinhandl, Kernozek, Cobb, Keena, and O'Connor (2011) studied landing to determine the influence of single-leg landing technique on anterior cruciate ligament loading in recreationally active females. The researchers hypothesized that verbally instructing subjects to land with a soft technique would result in a decrease in peak anterior cruciate ligament force. Fifteen healthy recreationally active females were recruited for this study. Electromyography data were measured for a qualitative comparison to model predicted muscle activations. Electromyography data of the subject's vastus medialis, vastus lateralis, semimembranosus, and biceps femoris long head of the right leg were collected during single-leg landings. The single leg-landing task consisted of a stiff landing and a soft landing. Each subject completed five successful trials of each landing technique and the order in which the techniques were completed was counterbalanced between subjects. Subjects stood atop a 37 cm box positioned 15 cm from the edge of the force plate landing only on the right leg. Verbal instructions given to subjects were limited to the following: “land with a stiff leg and minimize bending of the leg” or “land with a soft leg and maximize bending of the leg.” Subjects were also instructed to land with a fore-foot to rear-foot contact pattern during both techniques and no further instructions were provided. A successful landing trial was one where subjects landed with the correct foot contact pattern, as determined by visual analysis, and maintained their balance on their right leg until the body’s center of mass came to a complete stop. If any of these conditions were not met, the trial was repeated again. Laughlin and colleagues (2011) in this study reported that instructing subjects to land softly resulted in a significant decrease in peak anterior cruciate ligament force, and a significant increase in hip and knee flexion both at initial contact and the time of peak anterior cruciate ligament force. The researchers in this study concluded that altering landing technique with simple verbal instruction may result in lower extremity alignment that decreases the resultant load on the anterior cruciate ligament.

Decker, et al. (2003) studied to determine whether gender differences exist in lower extremity joint motions and energy absorption for landing strategies between age and skill matched recreational athletes during landing from a drop-jump. Twelve male and nine female recreational athletes were recruited for this study. All subjects were athletes involved in competitive intramural court sports such as volleyball and basketball. The subjects completed eight vertical drop-landings from a 60 cm box onto landing platform. Lower extremity joint kinematics, kinetics and energetic profiles were measured. The researchers in this study reported that females showed a more erect landing posture and utilized greater hip and ankle joint range of motions and maximum joint angular velocities compared to males. Females exhibited more energy absorption and peak powers from the ankle plantar flexors and knee extensors than males. This study revealed that the knee was the main shock absorber for both males and females, whereas the hip extensors muscles were the second largest contributor to energy absorption for males and the ankle plantar-flexors muscles for the females. The researchers in this study concluded that females may choose to maximize the energy absorption in this study concluded that females may choose to maximize the energy absorption from the joints most proximal to ground contact by landing in a more erect posture.

Haas, et al. (2005) examined biomechanical differences on lower extremity between pre-pubescent and post-pubescent female recreational athletes during three drop landing sequences to determine whether maturation influenced injury risk. Sixteen recreational active pre-pubescent girls; 8 to 11 years of age, and sixteen recreational active post-pubescent women; 18 to 25 years of age, were recruited for this study. The researchers concluded that there was a significant maturation level main effect for the ground reaction force and joint force. Pre-pubescent subjects produced significantly greater peak ground reaction force than the post-pubescent group. The pre-pubescent subjects displayed a lateral directed force at the knee that was significantly different than the medial directed force displayed by post-pubescent subjects.

Fong, Blackburn, Norcross, McGrath, and Padua (2011) examined relationships between ankle dorsiflexion range of motion and landing biomechanics. The purpose of this study was to assess the relationships between ankle dorsiflexion range of motion and landing biomechanics such as knee flexion displacement, knee-valgus displacement, and vertical and posterior ground reaction forces. Thirty-five physically active individuals (seventeen males, eighteen females) were recruited for this study. Before subjects performed landings, passive ankle dorsiflexion range of motion was assessed under flexed knee and extended knee conditions using a standard manual goniometer. Five measurements were taken at each position and collected by the same investigator. The subjects completed 5 successful trials. Subjects started landing with standing atop of a box 30 cm in height placed 40% of the subject's height from the landing edge of the force plate. Each subject was instructed to jump off the box horizontally and land on both feet. The dominant foot landed on the force plate. Ankle dorsiflexion range of motion and knee-flexion displacement, knee-valgus displacement, and vertical and posterior ground reaction forces were calculated during landing tasks. Simple correlations were used to assess relationships between ankle dorsiflexion range of motion and each biomechanical variable. The researchers in this study reported that significant correlations were noted between ankle dorsiflexion at extended knee position and knee flexion displacement and vertical and posterior ground reaction forces. All correlations for ankle dorsiflexion range of motion at flexed knee position and knee valgus displacement were not significant. The researchers in this study concluded that greater ankle dorsiflexion range of motion was associated with greater knee-flexion displacement and smaller ground reaction forces during landing, thus inducing a landing posture consistent with decreases in anterior cruciate ligament injury risk and limiting the forces the lower extremity must absorb. These findings suggest that clinical techniques to increase the extensibility of ankle plantar flexors and ankle dorsiflexion range of motion may be important for anterior cruciate ligament injury prevention programs.

Understanding the landing techniques is a large step in understanding why certain injuries occur. If coaches and athletes know proper landing techniques and where and how the body will absorb the force from landing, then the program can be administered to prevent foreseeable injuries from happening.

Bracing Effects during Landing

In the study by Cordova, et al. (2010), the effects of external ankle support on lower extremity joint mechanics and vertical ground-reaction forces during drop-landings were investigated. Landing from a jump is common in many sports that serve as the primary mechanism of lower extremity injuries. This is especially the case in volleyball and basketball, in which athletes tend to use external ankle support prophylactically. A decrease in ankle plantar flexion and dorsiflexion during drop landings with ankle taping appear to result in less energy absorbed by the tissues controlling ankle motion, especially by eccentric action of the posterior ankle musculature, resulting in greater peak vertical ground reaction forces at heel contact (Yi, et al. 2003). These alterations led the researchers in this study to hypothesis that ankle taping and bracing may influence impact absorption during drop landings, which may lead to an increase in energy absorption at the knee and hip joints. Thirteen male recreationally active basketball players were recruited to this study. The subjects performed a single drop landing from a standardized height under different ankle-support conditions: basket-weave tape application, semirigid ankle brace, and no support. All subjects performed five successful landing trials under each of the three ankle-support conditions. A series of vertical ground reaction force variables and lower extremity joint kinematic variables were measured. The vertical ground reaction force variables included first peak vertical impact force, second peak vertical impact force, time to first peak vertical impact force, and time to second peak vertical impact force. The lower extremity joint kinematic variables included sagittal-plane angular displacement of the hip, knee, and ankle from initial contact of the toe on the force platform to the maximum joint angle that occurred for each joint during the landing. The tape condition demonstrated less first peak vertical impact force than the control and semirigid conditions, and the second peak vertical impact force was unaffected. Knee joint displacement was larger in the non-support than in the semirigid condition. The researchers in this study reported that external ankle support reduces ankle- and knee-joint displacement, which appear to influence the spatial and temporal characteristics of ground reaction force during drop landings.

Understanding the bracing effects during landing is important for athletic trainers or physical therapists to implement the prophylactic or rehabilitative programs. Further research is needed to understand how athletes respond to having a joint movement restricted through bracing and/or taping.

Shock Attenuation

There is a wealth of research on shock attenuation are on during running (e.g., Derrick 2004; Flynn et al. 2004; Mercer et al. 2002). Shock attenuation is defined as the process by in which the impact shock caused by the collision between the ground and foot is reduced. Mathematically it is the measure of the reduction of the peak impact acceleration between two segments. A common measurement used to examine shock attenuation is to measure shock wave transmission from the lower extremity to the head using accelerometers (Derrick, 2004). It is understood that the amount of shock attenuated is influenced by active movements (e.g., knee flexion, hip flexion) as well as passive structures such as the ground, shoes, heel pad, cartilage, and bone (Nigg, Cole, & Burggemann, 1995; Coventry, O'Connor, Hart, Earl, & Ebersole, 2006).

Compared to running, landing from a jump has much larger impact forces. For example, the magnitude of the vertical component of the ground reaction force at initial contact during running can be 3 to 5 times as high as body weight (Cavanagh & Lafortune, 1980) while during landing the magnitude of the ground reaction force can be as high as 6.2 times body weight (Salci, Kentel, Heycan, Akin, & Korkusuz, 2004). Although the vast majority of research on shock attenuation is focused on running (e.g., Derrick, 2004; Flynn et al. 2004; Mercer et al. 2002), there has been a growing body of research shock attenuation during landing (Zhang et al. 2008; Coventry, O'Connor, Hart, Earl, & Ebersole, 2006; Decker et al. 2003; Gross & Nelson, 1988).

The aim of this section is to further understand shock attenuation during landing. The impact loading that is stressed on the body from landing must be attenuated primarily in the lower extremity (Coventry, O'Connor, Hart, Earl, & Ebersole, 2006). Decker et al. (2003) demonstrated that the primary shock absorber was the knee for both genders during landing. The second largest shock absorber for the females was the ankle plantar-flexors; on the other hand, the second largest shock absorber for the males was the hip extensors. The question is to what severity specific anatomical structures bear the burden of the attenuated impact load.

In the study by Zhang et al. (2008), the purpose was to examine shock attenuation during landing from different heights. Ten healthy, physically active males were recruited for the study. The subjects completed five successful step-off landing trials from each of five heights: 30, 45, 60, 75, and 90 cm. The kinematics of right sagittal plane, ground reaction force, and acceleration of leg and head segments were measured simultaneously. Zhang et al. (2008) reported increased range of motion for the ankle, knee, and hip joints at higher landing heights. The peaks of the vertical ground reaction force, forehead and tibial accelerations, and eccentric muscle work by lower extremity joints were increased with higher landing heights. Shock attenuation showed increased at higher height, but changes were minimal across five heights. Unlike the responses observed for moderate activities such as walking and running (Shorten & Winslow, 1992), the shock attenuation during landing did not show significant improvement with increased mechanical demands. As the landing height was elevated from 30 cm to 90 cm, the net joint eccentric work increased from 0.99 J/ kg to 2.84 J/ kg for the ankle plantar flexors, from 1.50 J/ kg to 3.16 J/ kg for the knee extensors, and from 0.99 J/ kg to 2.84 J/ kg for the hip extensors. The total amount of eccentric work performed by all lower extremity muscles that related to ankle knee, and hip joints increased from 3.47 J/ kg to 7.71 J/ kg.

The results of Zhang et al. (2008) observed a relationship between landing height and eccentric work performed in the muscles. The higher the drop from, the more work the muscles will do. The limitation of using accelerometers on the leg and head is what we do not know where the impact energy was absorbed (e.g. knee, hip, trunk). Zhang et al. (2008) demonstrated that muscles definitely play a role in shock attenuation during landing, but could not determine how muscles play a role.

Another key paper that investigated shock attenuation during landing that needs to be reviewed is by Coventry, O'Connor, Hart, Earl, & Ebersole (2006). In this experiment, the researchers attempted to determine the effect of lower extremity fatigue on shock attenuation and joint mechanics related to shock attenuation during a single-leg landing. The researchers hypothesized that lower extremity fatigue would cause a decrease in the shock attenuation capacity of the musculoskeletal system in addition to changing joint mechanics as compared to a non-fatigue state during a drop single-leg landing. Ten active male subjects were recruited to this study from a mid-western US college population, but eight were used for analysis due to technical difficulty. All subjects were physically active for at least 30 minutes, most days of the week and had no previous history of lower extremity injury at least for 6 months leading up to the testing. Each subject took part in a fatigue landing protocol, including cycles of a drop landing, a maximal countermovement jump, and five squats, repeated until exhaustion. Accelerometers were attached to the skin for the distal anteromedial aspect of tibia and forehead. Lower extremity kinematics were measured using an electromagnetic tracking system and kinetics were measured using a force platform. The researchers observed that fatigued was induced; however, there were no significant changes in shock attenuation throughout the body during single-leg landing. Knee and hip flexion increased and ankle plantar flexion decreased at touchdown with fatigue compared to non-fatigue state. The hip flexed more 5.2 degrees, the knee flexed more 5.8 degrees, and the ankle less plantar-flexed 3.3 degrees at touch down during the fatigued condition. Hip joint work increased and ankle work decreased with fatigue compared to non-fatigue state. The researchers concluded that this change in work distribution is thought to be a compensatory response to utilize the larger hip extensors that are better suited for shock absorption. Based upon an analysis of the results, the authors suggested that the lower extremity has an ability to adapt to fatigue though altering kinematics at impact and redistributing work to larger proximal muscles.

Coventry et al. (2006) also looked at landing strategy that changed as fatigue progressed in a way that maintained the same level of shock attenuation during single-leg landing. The energy absorption in the lower extremity indicated a shift from the ankle to the hip, but knee dynamics remained the same, even though the fatiguing exercises focused on knee muscle group. This result seems to indicate that an overriding goal of neuromuscular system is to maintain the function at the knee joint for shock attenuation. The compensatory body mechanism is quite interesting. This mechanism shows a type of recruitment of muscles to take the burden of the shock attenuation. The question that this mechanism brings to mind is does altering kinematics at impact predispose the individual with fatigue to injury in sacrifice of the shock attenuation during landing.

In a study by Gross and Nelson (1988), shock attenuation at the ankle was examined during barefoot landing from vertical jump. The experiment conditions included landing from vertical jumps with two landing techniques; toe and toe heel onto three different landing surfaces; a midsole foam, a tartan rubber, and a cast aluminum. Two uniaxial accelerometers were used to measure accelerations at the tibia and the calcaneus. Eleven male recreational basketball players were recruited for this study to perform three symmetric barefoot countermovement vertical jumps on each surface. In pilot data, damping factors of 0.239 and 0.552 were determined for the calcaneus and the tibia, respectively. Based upon an analysis of the results, the authors concluded that the acceleration measurement at the tibia was more attenuated than at the calcaneus. Peak acceleration at metatarsal contact varied little across landing surfaces. The average of peak accelerations at the calcaneus and tibia across the three surface conditions were 20.8 g and 14.3 g, respectively. However, no significant difference was found between the peak calcaneal and tibial accelerations across the three surfaces. There was also no significant difference between the peak calcaneal and tibial accelerations between the two landing techniques. The researchers in this study hypothesized an increased shock attenuation role of the ankle with increased damping demands, but they were unable to support their hypothesis with their conditions of landing surfaces. They reported discrepancies in landing technique that definitely played a role in shock attenuation. By landing on the toes and avoiding a heel-toe transfer at landing, subjects were able to greatly reduce the impact applied to the lower extremity.

When shock attenuation is studied, it is most common to place an accelerometer on the leg and head segments (e.g., Zhang et al. 2008; Coventry et al. 2006). Another approach has been to place an accelerometer on another location between the head and leg to try to determine where shock attenuation is occurring. For example, Dufek, Mercer, Teramot, Mangus, and Freedman (2008) studied the activity of running, but created another measure of shock attenuation by adding the third accelerometer placed in the hip region. In this study, Dufek, et al. (2008) increased running demands for thirty-one female subjects, and measured shock attenuation to see if increased demands caused increased shock attenuation. The relevance to the Dufek, et al. (2008) study on the current research was their instrumentation of the accelerometers. The researchers added the third accelerometer attached to the lower back at approximately the fifth lumbar vertebrae to the data collection. The third accelerometer was placed on the lower back of subjects, in addition to the tibial and forehead accelerometers. Adding the third accelerometer to the lower back effectively divided the body into two parts: upper body and lower body. This extra accelerometer allowed the researchers to quantify the upper body and lower body shock attenuation, and three accelerometers did not just rely on total body shock attenuation to understand how the body attenuates impact forces. The researchers quantified contributions of the lower extremity and back and the variability of impact generation among three groups to address possible lifespan changes during running. Three groups included prepubescent girls, normally menstruating women, and postmenopausal women. Lower extremity attenuation and variability were the greatest for the prepubescent girls while impact variability was least for normally menstruating women. The method to study the body in two parts for shock attenuation allows researchers to have alternative ways to quantify shock attenuation.

There continues to be more research conducted on shock attenuation with new ideas in regards to accelerometer attachments (e.g., Dufek, et al. 2008), and more articles are being made specifically in the shock attenuation in landing (Coventry, et al. 2006; Zhang, et al. 2008). The question of the ground reaction force producing a shock wave to transmit through the body and where is that shock wave being attenuated is a question without definite answers. Researches have reported various factors that play a role in shock attenuation, but one main key is the lower extremity kinematic-relationship with shock attenuation. The body shows a kinematic compensation by increasing angles of lower extremity joints, which attenuate the impact loading on the body. Altering kinematics should be measured in various ways to determine a relationship between kinematics and shock attenuation. However, it is still not clear how shock attenuation is influenced when a joint is restricted to move via bracing and/or taping.

Arch Taping

Pronation of the foot in a closed kinetic chain causes a decrease in medial longitudinal arch height (Manter, 1941). The height of the medical longitudinal arch of the foot is commonly thought to be a predisposing factor to injuries (Franettovich, et al. 2008). Subotnick (1985) reported that 60% of the population has normal arches, 20% of the population have a pes cavus or high ached food, and 20% of the population have a pes planus or low arched foot. Since its original description in 1939 by Dye (Dye, 1939) anti-pronation taping has been widely used by clinicians as the management of lower extremity injuries such as plantar fasciitis and heel pain (Franettovich, et al. 2008).

In a study by Ator, Gunn, McPoil, and Knecht (1991), the researchers compared the ability of two methods of adhesive strapping to provide support to the medial longitudinal arch before and after a standardized exercise of 10 minutes of jogging. Ten females were recruited to this study. Two methods of adhesive strapping in this study included the Low Dye and the double X techniques. The researchers in this study hypothesized that the Low Dye arch taping procedure might be less likely to cause athletic tape fatigue compared to double X taping procedure. To determine the position of the medial longitudinal arch, the height of navicular tuberosity from the floor was measured bilaterally while each subject was standing. The measurements were taken for the following three conditions: barefoot, before exercise with arches taped, and after exercise with arches taped. The researchers reported no differences exist in the medial longitudinal arch support provided by the Low Dye and double X arch taping procedures. In addition, neither taping procedure was effective in significantly altering the position of the medial longitudinal arch compared to the initial barefoot position after a 10-minute exercise program.

Few studies have investigated the effect of arch taping techniques on dynamic measures of foot motion and posture; that is, the effect of arch taping during activity. In the study by Vicenzino, Franettovich, McPoil, Russell, and Skardoon (2005), the main purpose was to examine the effect of an augmented Low Dye taping technique on the medial longitudinal arch of the foot during dynamic tasks such as walking and jogging. A secondary purpose was to evaluate the relationship between tape induced changes in static and dynamic foot posture. Five males and twelve females were recruited for this study. The foot with the greatest navicular drop was selected for angumented Low Dye tape application; the other foot acted as the control. Video footage was taken before and after application of the tape with subject standing, walking, and jogging to measure medial longitudinal arch height. Video footage in three trials was collected. For the walking and jogging conditions, the subject was instructed to walk or jog over the 12 m runway at a self-selected speed, which was monitored for consistency of foot placement on the platform across all trials. Compared to the no tape control condition, tape produced a significant increase in the medial longitudinal arch height index of 0.031, 0.026, and 0.016 during standing, walking, and jogging respectively. The relative increase in medial longitudinal arch height demonstrated an anti-pronation effect. The tape induced changes in the medial longitudinal arch height measured during standing correlated strongly with the medial longitudinal arch height measured during dynamic tasks. The researchers in this study concluded the augmented Low Dye tape was effective in controlling pronation during both static and dynamic tasks. Tape induced changes in static foot posture paralleled those during dynamic tasks. This study has reported mechanical changes induced by arch taping, including decreased calcaneal eversion, decreased internal tibial rotation, and increased navicular height in both resting standing posture and during walking and running.

There is a lack of specific research on any possible neuromuscular effects of arch taping. It is probable that arch taping will engender neuromuscular effects because athletic tape has been shown to produce these effects at other regions, especially in the ankle. Ankle inversion taping techniques for inversion ankle sprain have been shown to alter the peroneal muscle response latency to an inversion perturbation in unstable ankles (Karlsson & Andreasson, 1992; Shima, Maeda, & Hirohashi, 2005) as well change activity of leg muscles (Alt, Lohrer, & Gollhofer, 1999; Yi, Brunt, Kim, & Fiolkowski, 2003). It would reasonable to expect that arch taping may change neuromuscular control of the foot and ankle as ankle inversion taping technique can change neuromuscular control of the ankle.

On the basis of arch taping-induced anti-pronation effects (Vicenzino, et al. 2005), the researchers in a study by Franettovich, Chapman, and Vicenzino (2008) hypothesized that the application of arch taping technique would decrease the requirement from the muscular system in the control of foot posture, and that arch taping would decrease the activity of leg muscles during walking. Their purpose was to conduct a preliminary evaluation of the initial effects of an arch taping on muscle activity during walking in asymptomatic individuals who exhibit lower arch foot posture. Three female and two male asymptomatic individuals were recruited for this study from a sports and musculoskeletal physiotherapist. Electromyographic (EMG) activities of tibialis anterior, tibialist posterior, and peroneus longus muscles were measured using bipolar intramuscular or surface electrodes. Arch height in standing as well as peak and average amplitude, duration, time of onset, and time of offset of recorded EMG activity during walking were measured and analyzed for each condition. The taping technique was the augmented Low Dye technique, consisting of spurs and mini-stirrups with the addition of two calcaneal slings and three reverse sixes that are anchored on the distal third of the leg. A rigid sports tape was applied to all subjects by an experienced sports and musculoskeletal physiotherapist. All subjects walked on a treadmill for 10 minutes before and after the application of the augmented Low Dye technique. The researchers in this study reported that arch taping produced an increase in arch height of 12.9%. Mean reductions in peak and average Electromyography activation of tibialis anterior (-23.9%, -7.8% respectively) and tibialis posterior (-45.5%, -21.1% respectively) were observed when walking with arch taping. The arch taping also produced a small increase in duration of tibialis anterior electromyography activity of 3.7% of the stride cycle duration, largely because of an earlier onset of electromyography activity. The researchers in this study concluded that arch taping decreases activity of the tibialis anterior and tibialis posterior muscles during walking while increasing arch height, which provides preliminary evidence of its role in reducing the load of these key extrinsic muscles of the ankle and the foot.

The study by Vicenzino, et al. (2005) showed the augmented Low Dye tape was effective in controlling pronation during both static and dynamic tasks. In addition, Franettovich, et al. (2008) showed that arch taping decreases muscular activities while increasing arch height during walking. Dynamic activities that researchers have studied on arch taping are limited to walking, jogging, and running. No research has been done on the influence of taping on shock attenuation. This is important because shock attenuation describes how impact energy is absorbed. If a joint is restricted to move, that might mean less impact energy is absorbed. However, it might also mean that another joint changes movement to increase the amount of energy absorbed to compensate for the restricted joint. Both of these observations are important to better understand how to prevent injuries during landing.

Summary of Literature Review

In both running and jumping, a force is applied to the body when the foot makes contact with the ground. The difference between running and jumping is the magnitude of that force applied to the body. The ground reaction force of landing can be two or three times greater than the ground reaction force of running (McNitt- Gray, 2009).

Knee kinematics during landing are able to attenuate the amount of loading force applied to the body (Devita & Skelly, 1992; Laughlin, et al., 2011). Specifically a more bent knee approach to landing softened the impact the body had to overcome. This understanding of kinematics in landing can help to determine proper landing technique and instruction to be less susceptible to injury.

Researchers have found that impact loading on the body is primarily attenuated in the lower extremity (Coventry, et al. 2006). A common way to examine the shock attenuation is to measure shock wave transmission from the lower leg to the head using two accelerometers (Derrick, 2004; Zhang et al. 2008). Though ground reaction force reduction can be achieved by knee extensors primarily, further investigation is needed to say for certain the lower extremity is attenuating the bulk of the force.

There is preliminary evidence of the clinical utility of arch taping technique as a treatment technique in the management of lower extremity conditions such as plantar fasciitis. Vicenzino, et al (2005) reported that the augmented Low Dye tape was effective in controlling pronation during both static and dynamic activity such as walking and jogging. There is no study on the effects of arch taping on shock attenuation during landing.

CHAPTER 3

METHODOLOGY

Subjects

Twelve healthy male college students (age 25.5 ± 3.37 years, height 1.73 ± 0.04 m, mass 82.06 ± 16.23 kg) were recruited for this study. Subjects were included as long as there was no current lower extremity injuries or neurological disorder that would adversely affect the subject's ability to jump or land from a jump. Prior to volunteering for the research experiment, all subjects read and signed a University of Nevada, Las Vegas Institutional Review Board approved informed consent form.

Instrumentation

Subjects wore shoes (Asics Gel) provided by the biomechanical laboratory but wore their own clothing. Accelerometers (PCB Piezotronics, Depew, NY, model: 353C67, 6.7 grams, ±50- g range, frequency range= .5 Hz-5KHz) were used to measure impact accelerations at the leg and head segments; one was secured on the leg, the other on the head. The sensitive axes of each accelerometer was aligned vertically with subject in standing positioned. All data were collected at 1000 Hz using Bioware data acquisition software (Kistler Instrument Corporation, Depew, NY; version 4.10).

Experimental Protocol

Upon reporting to the laboratory and giving consent, subject's age, height, and weight were recorded. Subjects were fitted for a standardized shoe. Subjects performed a standard warm-up by riding a stationary bike for 5 minutes.

After warm-up, all subjects were given time to practice landing from a box. All subjects performed bi-lateral landings from a 30 cm box. Subjects were asked to stand at the edge of the box and drop off with feet landing simultaneously on the ground. The researcher then demonstrated the task the subject would be asked to do and the subject was allowed time to practice landing. Enough time practice was allowed so subjects were comfortable with landing tasks. After subjects learned proper landing technique, accelerometers were attached to the leg and forehead.

An accelerometer was attached to the distal aspect of the right tibia on the medial side of the leg using a flexible elastic band with athletic tape. The accelerometer was fixed by tightening the strap to the subject's tolerance. The accelerometer for forehead was mounted onto the anterior portion of a head-gear. The head-gear was then placed on the tightened to the subject's head with the accelerometer flush to the forehead. After the accelerometers were attached to the leg and head, the researcher made sure that the sensitive axes of two accelerometers were aligned vertically with the subject in a standing position.

All conditions consisted of the subject performing landings onto the ground. Subjects completed five successful trials in each of three randomized conditions (no arch taping, Low Dye technique, and weave technique). The order of the three conditions was counterbalanced between subjects. For either taping conditions, both feet were taped. Five trials were deemed satisfactory to account for overall fatigue during landing activities (Zhang, 2008). A trial was successful if the subject stepped off and landed bilaterally with their both feet making contact completely for no less than three seconds without falling way. Each subject performed landing from a box under all three taping conditions. Each condition consisted of the same step-off landing protocol, but with no arch taping, Low Dye technique, and weave technique. Data collection was initiated 0.1 sec before contact and commenced after 0.5 sec had elapsed.

A certified athletic trainer taped each subject with either Low Dye or weave technique. Below you would have “Figure 1: Illustration of Low Dye taping technique. Each number refers to a different step in the taping procedure.” At first, two or three of one-inch adhesive tape strips were applied just proximal to the lateral aspect of the fifth

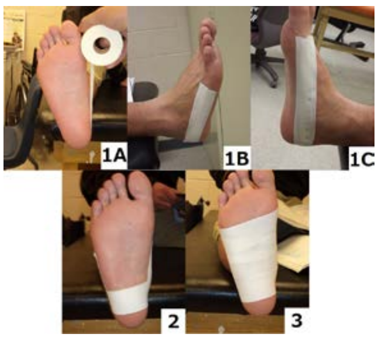

Figure 1: Illustration of Low Dye taping technique

metatarsal head first, wrapped around the posterior aspect of the calcaneus, and attached proximal to the medial aspect of the first metatarsal head. Next, three to four strips of 1 and half-inch adhesive tape were then applied to the medial longitudinal arch, starting from the lateral side of the foot, passed under the medial longitudinal arch, and attached to the medial side of the foot. Below you would have “Figure 2: Illustration of Weave taping technique. Each number refers to a different step in the taping procedure.” For At first, one-inch adhesive tape was applied to the dorsal aspect of the first metatarsal head first, wrapped around the plantar aspect of the metatarsal heads, and attached to the lateral aspect of the fifth metatarsal head. The second strip of the adhesive tape were then applied to the plantar aspect of the third metatarsal head, passed around the posterior aspect of the calcaneus, and attached back to the third metatarsal head. The third strip of the adhesive tape was applied to the aspect of the fourth metatarsal head, passed around the posterior aspect of the calcaneus, and attached back to the forth-metatarsal head. The fifth strip of the adhesive tape was applied to the second metatarsal head, passed around the posterior aspect of the calcaneus, and attached back to the second metatarsal head. The sixth strip of the adhesive tape was applied to the fifth metatarsal head, passed around the posterior aspect of the calcaneus, and attached back to the fifth metatarsal head. The seventh strip of the adhesive tape was applied to the first metatarsal head,

Figure 2: Illustration of Weave taping technique

passed around the posterior aspect of the calcaneus, and attached back to the first metatarsal head. Three to four strips of one and half-inch adhesive tape were then applied to the medial longitudinal arch, starting from the lateral side of the foot, passed under the medial longitudinal arch, and attached to the medial side of the foot.

Data Reduction

Peak impact accelerations were identified for the leg and head respectively. The acceleration measurements from the leg and head accelerometers were expressed in multiples of gravitational acceleration (g). After peak impact accelerations were identified, total body shock attenuation was calculated by using the formula "[1- (Peak Head/ Peak Leg)] * 100".

Statistical Analysis

Three dependent variables were analyzed in this study: 1) Impact acceleration of the leg, 2) Impact acceleration of the head and 3) Shock Attenuation. There was one independent variable: Taping technique (three levels: no taping, Low Dye, weave). Repeated measures ANOVAs were used to compare each dependent variable between landing conditions. When the results of the repeated measures revealed significant differences, pairwise comparisons were made to determine where the differences occurred. All statistical tests were conducted using Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL; version 17.0).

CHAPTER 4

RESULTS

Impact Peak Accelerations

Descriptive data for the impact acceleration measures (leg peak acceleration, head peak acceleration) are given in Table 1. There was no significant difference for either leg peak accelerations ($F_{2,22}$= .532, $_{p}$ = .595) or head peak accelerations ($F_{2,22}$= 1.479, p = .25) between taping condition (i.e., no tape, Low Dye, Weave) (Figure 3).

Table 1 Mean and standard deviations for impact peak accelerations under landing conditions

	Landing Conditions		
	No Tape	Low Dye	Weave
Leg (g)	22.7 (12.7)	23.3 (13.3)	21.1 (11.2)
Head (g)	2.4 (1.7)	2.7 (1.6)	2.5 (1.4)

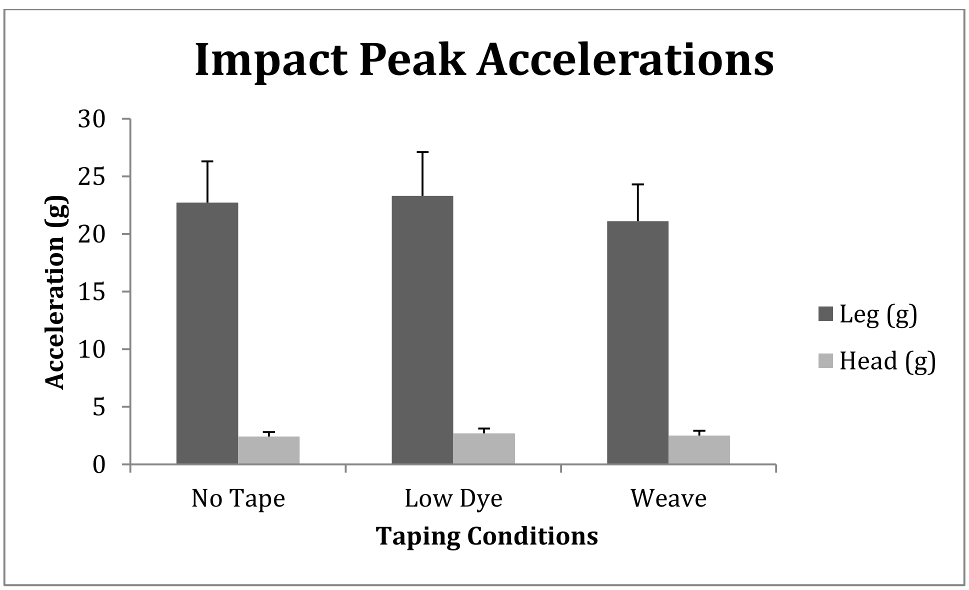

Figure 3. Mean impact peak accelerations for the Leg and Head under no tape, Low Dye, and weave techniques. Each parameter illustrated is represented by the mean and standard errors of 12 subjects under each taping condition.

Shock Attenuation

Descriptive data for the shock attenuation measure is given in Table 2. Shock attenuation was not influenced by taping condition ($F_{2,22}$= 1.022, $p > .376$, Table 2, Figure 4).

Table 2 Mean and standard deviations for shock attenuation under landing conditions

	Landing Conditions		
	No Tape	Low Dye	Weave
Shock Attenuation (%)	88.5 (4.9)	87.8 (4.9)	87.3 (5.1)

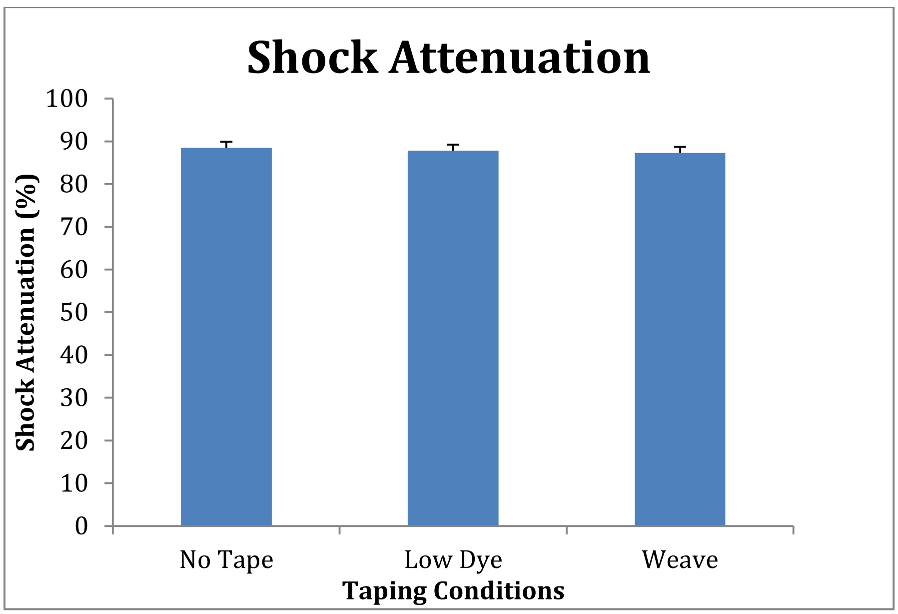

Figure 4. Shock attenuations under no tape, Low Dye, and weave techniques. Each parameter illustrated is represented by the mean and standard errors of 12 subjects under each taping condition.

CHAPTER 5

DISCUSSION

The purpose of this study was to investigate the effects of two different arch taping techniques on shock attenuation during landing. Specifically, the unique aspect of this study was that shock attenuation was examined during landing under arch taping conditions. Furthermore, impact characteristics during landing under different arch taping conditions were measured and examined in order to understand the effects of arch taping on shock attenuation during landing. In the current study, the most important observation was that the taping conditions had no influence on leg or head peak impact acceleration or shock attenuation. The hypotheses that 1) shock attenuation is influenced by arch taping techniques, 2) leg peak impact acceleration is influenced by arch taping techniques, 3) head peak impact acceleration is influenced by arch taping techniques, are rejected.

Peak leg accelerations from any condition (22.7 ± 12.7 g for no tape, 23.3 ± 13.3 g for Low Dye, 21.1 ± 11.2 g for Weave) in the present study were similar. Peak head accelerations from any condition (2.4 ± 1.7 g for no tape, 2.7 ± 1.6 g for Low Dye, 2.5 ± 1.4 g for Weave) in the present study were also similar. Appleqiust (2013) reported the peak leg acceleration (21.97 ± 6.16 g) from a 30 cm box and the peak head acceleration (3.23 ± 1.38 g) from a 30 cm box whereas Zhang, et al. (2008) reported peak leg accelerations to be 15.6 g during landing from the same height. The peak leg acceleration (22.7 ± 12.7 g) under no taping condition from the present study seems comparable to Applequist (2013) but higher than Zhang et al. (2008). It is not clear why there is a difference between studies but it may have something to do with the other conditions included in an experiment. For example, in Zhang et al. (2008), subjects performed five successful step-off landing trials in each of five randomized conditions: 30, 45, 60, 75, and 90 cm. In the present study, subjects performed all step-off landings trials from a 30 cm box. It may be that landing from different heights prior to landing from 30 cm may influence the landing style used and ultimately influence peak leg acceleration. It may also be that the instructions for landing vary between studies and this may influence landing style. For example, in the present study, the researcher provided standard instructions to land bilaterally but with no instruction on how ‘soft’ or ‘stiff’ to land. It was qualitatively observed that subjects performed landing using a variety of landing styles and each subject seemed to use different landing styles each trial. Different landing techniques would affect the peak leg acceleration. It may be that landing from a height of 30 cm is not very mechanically demanding and this led to subjects being able to successfully use a variety of landing styles.

On the other hand, the peak head acceleration (2.4 ± 1.7 g) under no taping condition from this study was close to 2.2 g that reported in landings from a 30 cm box, respectively (Zhang, et al., 2008). In addition, shock attenuation under no taping condition from this study (88.5 ± 4.9 %) was close to 83.99% that reported in landings from a 30 cm box as high as the present study (Applequist, 2013). Shock attenuations from any condition (88.5 ± 4.9 % for no tape, 87.8 ± 4.9% for Low Dye, 87.3 ± 5.1% for Weave) in this present study were similar.

A confounding factor to this study was that subjects could have a lack of experience in landing technique. Since subjects were not screened for previous experience levels (e.g., collegiate basketball or volleyball player), the effects of previous experience levels of subject on accelerations are not clear. It may be that the experienced person has been used to same landing style, so it is hard for her or him to change landing style when arch is taped. However, subjects were given detailed instruction and demonstration of the step-off landing techniques as well as time to become acclimated to the activity.

A confounding factor to this study was that subjects could have experienced fatigue. Flynn et al. (2004) examined the effect of localized leg muscle fatigue on tibial impact acceleration and reported that local leg muscle fatigue resulted in a significant decrease in peak tibial acceleration and acceleration slope following fatigue, which is opposite to the response documented following full body fatigue. In the present study, it was planed to give subjects rest between trials and conditions in order to minimize any influence of fatigue. Furthermore, condition order was counterbalanced to avoid any order effect.

Gender differences and landing techniques such as soft or stiff landings were not accounted for. Dicker et al. (2003) reported that females showed a more erect landing posture and utilized greater hip and ankle joint range of motions and maximum joint angular velocities compared to males. Females exhibited more energy absorption and peak powers from the ankle plantar flexors and knee extensors than males. This study revealed that the knee was the main shock absorber for both males and females, whereas the hip extensors muscles were the second largest contributor to energy absorption for males and the ankle plantar-flexors muscles for the females. Landing cues in the present study were to land both feet at same time and land naturally, so subjects in the present study performed either ‘soft’ or ‘stiff’ landing. It is not known how the results would be different if landing technique was constrained to a ‘stiff landing.’

Another limitation of this study was foot types such as ‘pes cavus’ or ‘pes planus.’ Since arch taping is done to support the arch, it is not clear if the outcome of the study would be different if arch type was controlled.

Taking the limitations and confounding factors into consideration, in the present study, a constraint was placed on the arch by taping technique, but that did not influence the impact accelerations or shock attenuation. There are four possible reasons why the measures were not influenced by taping: 1. The tape does not make a difference on acceleration and shock attenuation, 2. The tape does make a difference but subjects accommodated landing style to achieve the same impact characteristics, 3. Taping does influence arch height, or 4. Shock attenuation is not related to arch height.

Previous research has been conducted on the effect of adhesive strapping on medial longitudinal arch support before and after exercise (Ator et al., 1991). In that study, it was reported that no differences exist in the medial longitudinal arch support provided by the arch taping methods. In addition, the arch taping methods was not effective in significantly altering the position of the medial longitudinal arch compared to the initial barefoot position after a 10-minute exercise program. The limitation of the present study was that foot types were not controlled as same as the present study (Ator et al., 1991). However, Franettovich et al. (2008) examined the asymptomatic individuals who were rated as having a lower medial longitudinal arch height during the stance phase of walking to evaluate the initial effects of arch taping on foot posture and electromyographic activity during walking. In that study, it was reported that arch taping increased height of the medial longitudinal arch. In addition, Vicenzino et al. (2005) examined the initial effects of an augmented Low Dye taping technique on the medial longitudinal arch during walking and running. Seventeen subjects who were asymptomatic and exhibited a navicular drop greater than 10 mm were recruited. In that study, it was reported that the taping technique produced a significant mean increase in the medial longitudinal arch height index during standing, walking, and jogging

Given that Franettevich et al. (2008) and Vicenzino et al. (2005) demonstrated the effects of arch taping on the medial longitudinal arch height, it does seem that arch taping does influence arch performance difference. That seems to suggest that the subjects accommodated landing style to achieve the same impact characteristics. A person could accommodate the arch constraint via lower extremity movements (e.g., more knee flexion during landing as the arch is taped). However, future research is needed in this area to understand if arch type, arch height, and/or landing style are important factors determining head and leg impact accelerations.

Conclusions and Recommendations

For Further Study

In conclusion, this study was designed to better understand the effects of arch taping on shock attenuation during landing. There were no significant differences on leg and head peak impact accelerations and shock attenuation between taping conditions for this group. This information is important for athletic trainers to decide to utilize the arch taping techniques for the athletes. The arch taping technique for a person without any current lower extremity injuries or neurological disorder that would adversely affect the subject’s ability to jump or land from a jump would not change on either leg and head peak impact accelerations or shock attenuation. This study did not control the foot types of subjects, so further study would control the foot types of subjects to better understand the effects of arch taping on shock attenuation during landing.

APPENDIX A

Informed Consent

INFORMED CONSENT

Department of <u>Kinesiology and Nutrition Sciences</u>

TITLE OF STUDY: <u>The effects of arch taping on shock attenuation during landing</u>

INVESTIGATOR: <u>John Mercer, Ph.D. and Shun Jinnouchi</u>

CONTACT PHONE NUMBER: <u>Dr. Mercer: 895-4672 and Shun Jinnouchi: 569-2490</u>

<u>Purpose of the Study</u>
The purpose of this study is to investigate the effects of arch taping on shock attenuation during landing.

<u>Participants</u>
You are being asked to participate in the study because you are over 18 years old, apparently healthy, you do not have any injury that would interfere with your ability to land, you are not pregnant or think you are pregnant, and you are not allergic to medical adhesives.

<u>Procedures</u>
If you volunteer to participate in this study, you will be asked to do the following:

- Attend a testing session that will last about 1-2 hours.
- Perform many landings from a height of 30 cm (about knee-high) while having your arches taped. We will use two different taping techniques and you'll be asked to land while not having any tape applied to your feet (you will always wear shoes during landing).
- During all landings, we will put sensors on your leg and forehead to measure how hard you land on the ground. These sensors are small stickers about the size of an eraser on the end of a pencil. To make the sensors work well, we will need to wrap the sensors tightly onto your leg and head.
- Please wear clothing that you are comfortable landing from a jump in.
- You will be given time between each landing to rest as needed.

Benefits of Participation

There *may not* be direct benefits to you as a participant in this study. However, we hope to learn more about how people land when their arches are taped.

Risks of Participation

There are risks involved in all research studies. This study may include only minimal risks with the main risks during the landing sessions are muscle soreness and allergic reactions to tape adhesive. If you know you are allergic to medical adhesives, you will not be allowed to participate in the study. A Certified Athletic Trainer will be applying all tape.

Cost /Compensation

There *will not* be financial cost to you to participate in this study. The study will take about 1-2 hours of your time. You *will not* be compensated for your time.

Contact Information

If you have any questions or concerns about the study, you may contact Dr. John Mercer at 895-4672 or Shun Jinnouchi at 569-2490**.** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office Research Integrity, Human Subjects (702-895-2794).**

Voluntary Participation

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the study.

Confidentiality

All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for at least 3 years after completion of the study. After the storage time the identifying information gathered will be destroyed.

Participant Consent:

I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

____ ____________________

Signature of Participant Date

____

Participant Name (Please Print)

Participant Note: Please do not sign this document if the Approval Stamp is missing or is expired.

APPENDIX B

Statistical Tables

Subject 1

Subject 1			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	15.906	1.104	93.1
T2	15.547	0.899	94.3
T3	13.503	1.315	90.3
T4	11.64	1.117	90.5
T5	12.845	1.337	89.6
Condition 2: Low Dye			
T1	9.34	1.049	88.8
T2	8.708	1.054	87.9
T3	14.876	1.48	90.1
T4	10.427	1.029	90.2
T5	9.585	0.932	90.3
Condition 3: Weave			
T1	11.159	1.313	88.3
T2	9.318	0.924	90.1
T3	10.754	1.167	89.2
T4	9.381	0.978	89.6
T5	9.855	1.406	85.8

Subject 2

Subject 2			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	9.99	1	90
T2	8.809	1.234	86
T3	10.229	1.088	89.4
T4	9.668	1.498	84.6
T5	9.352	1.23	86.9
Condition 2: Low Dye			
T1	7.686	1.417	81.6
T2	7.557	0.818	89.2
T3	9.076	1.709	81.2
T4	6.785	1.198	83.4
T5	7.142	1.349	81.2
Condition 3: Weave			
T1	11.67	1.511	87.1
T2	10.201	1.039	89.9
T3	7.334	1.375	81.3
T4	9.329	1.055	88.7
T5	8.131	0.958	88.3

Subject 3

Subject 3			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	5.601	0.092	98.4
T2	5.739	0.183	96.9
T3	5.703	0.163	97.2
T4	5.663	0.149	97.4
T5	5.74	0.118	98
Condition 2: Low Dye			
T1	3.982	0.132	96.7
T2	4.509	0.147	96.8
T3	5.587	0.095	98.3
T4	5.443	0.141	97.5
T5	5.299	0.148	97.2
Condition 3: Weave			
T1	5.673	0.218	96.2
T2	5.317	0.208	96.1
T3	5.596	0.157	97.2
T4	5.72	0.155	97.3
T5	5.706	0.224	96.1

Subject 4

Subject 4			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	8.429	1.433	83
T2	22.833	2.19	90.5
T3	23.699	1.589	93.3
T4	17.093	1.814	89.4
T5	12.862	1.25	90.3
Condition 2: Low Dye			
T1	13.783	2.204	84.1
T2	37.528	2.832	92.5
T3	19.033	2.023	89.4
T4	27.985	1.594	94.4
T5	11.268	2.018	82.1
Condition 3: Weave			
T1	18.851	5.586	86.3
T2	25.83	2.146	91.7
T3	28.389	1.752	93.9
T4	23.363	1.919	91.8
T5	19.581	2.018	89.7

Subject 5

Subject 5			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	10.744	1.812	83.2
T2	16.315	2.087	87.3
T3	14.263	1.576	89
T4	13.655	2.182	84.1
T5	12.905	2.395	81.5
Condition 2: Low Dye			
T1	13.025	1.567	88
T2	11.263	1.694	85
T3	12.575	1.63	87.1
T4	10.948	2.031	81.5
T5	13.115	2.48	81.1
Condition 3: Weave			
T1	26.925	3.03	88.8
T2	13.285	2.387	82.1
T3	13.602	1.895	86.1
T4	13.263	1.652	87.6
T5	14.457	1.473	89.9

Subject 6

Subject 6			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	15.534	4.077	73.8
T2	23.658	3.916	83.5
T3	19.529	3.703	81.1
T4	20.931	3.152	85
T5	19.75	4.224	78.7
Condition 2: Low Dye			
T1	22.017	4.91	77.7
T2	21.492	4.601	78.6
T3	25.297	4.906	80.7
T4	16.182	3.505	78.4
T5	13.975	2.622	81.3
Condition 3: Weave			
T1	17.764	2.757	84.5
T2	17.716	4.258	76
T3	15.593	3.013	80.7
T4	14.563	4.819	67
T5	17.817	3.165	82.3

Subject 7

Subject 7			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	14.899	2.083	86.1
T2	18.679	1.629	91.3
T3	31.125	2.899	90.7
T4	51.147	2.677	94.8
T5	70.142	3.266	95.4
Condition 2: Low Dye			
T1	16.461	2.367	85.7
T2	43.168	3.643	91.6
T3	48.538	3.324	93.2
T4	26.571	2.046	92.3
T5	34.586	3.375	90.3
Condition 3: Weave			
T1	14.984	2.907	80.6
T2	42.511	3.672	91.4
T3	32.007	3.579	88.9
T4	27.344	4.778	82.6
T5	24.777	4.952	80.1

Subject 8

Subject 8			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	22.524	1.844	91.9
T2	15.178	2.786	81.7
T3	24.282	4.91	79.8
T4	13.957	2.281	83.7
T5	23.636	3.176	86.6
Condition 2: Low Dye			
T1	30.99	4.459	85.7
T2	28.745	4.452	84.6
T3	24.881	4.107	83.5
T4	32.068	4.996	84.5
T5	43.866	6.804	84.5
Condition 3: Weave			
T1	23.474	2.486	89.5
T2	17.544	2.509	85.7
T3	30.037	4.296	85.7
T4	30.772	3.613	88.3
T5	23.955	2.336	90.3

Subject 9

Subject 9			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	32.782	6.316	80.8
T2	40.436	8.295	79.5
T3	56.441	6.804	88
T4	46.163	8.222	82.2
T5	35.625	4.79	86.6
Condition 2: Low Dye			
T1	25.012	4.291	82.9
T2	44.295	6.191	86.1
T3	37.084	5.471	85.3
T4	57.585	7.175	87.6
T5	44.42	6.179	86.1
Condition 3: Weave			
T1	26.866	4.028	85.1
T2	20.609	5.396	73.9
T3	47.976	5.774	88
T4	35.978	4.21	88.3
T5	28.822	8.056	72.1

Subject 10

Subject 10			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	19.529	2.664	86.4
T2	19.775	2.73	86.2
T3	18.948	2.896	84.8
T4	16.738	3.082	81.6
T5	41.533	3.189	92.4
Condition 2: Low Dye			
T1	18.933	2.399	87.4
T2	23.101	3.387	85.4
T3	22.549	2.015	91.1
T4	21.233	2.969	86.1
T5	38.579	4.717	77.8
Condition 3: Weave			
T1	16.02	2.236	86.2
T2	20.87	2.543	87.9
T3	20.039	2.873	85.7
T4	16.552	2.751	83.4
T5	17.277	2.079	88

Subject 11

Subject 11			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	14.212	1.971	86.2
T2	27.468	1.888	93.2
T3	28.237	2.054	92.8
T4	23.538	1.887	92
T5	33.297	1.781	94.7
Condition 2: Low Dye			
T1	21.679	1.551	92.9
T2	29.528	2.265	92.4
T3	23.553	1.787	92.5
T4	19.333	1.621	91.7
T5	26.983	1.86	93.2
Condition 3: Weave			
T1	10.441	3.28	68.6
T2	23.718	3.271	86.3
T3	23.435	3.215	86.3
T4	30.753	2.71	91.2
T5	24.984	2.243	91.1

Subject 12

Subject 12			
Condition 1: No Tape	Leg Peak Acceleration	Head Peak Acceleration	Shock Attenuation
T1	32.511	3.676	88.7
T2	59.332	2.11	96.5
T3	40.608	2.541	93.8
T4	49.455	1.995	96
T5	44.909	2.183	95.2
Condition 2: Low Dye			
T1	52.361	4.196	92
T2	31.179	2.57	91.8
T3	57.947	2.327	96
T4	35.215	3.508	90.1
T5	56.679	3.438	94
Condition 3: Weave			
T1	57.143	2.504	95.7
T2	28.458	2.324	91.9
T3	59.331	1.754	97.1
T4	47.649	1.753	96.4
T5	39.131	1.804	95.4

APPENDIX C

SUMMARY OF STATISTICS

Leg Peak Acceleration

Within-Subjects Factors

Measure:MEASURE_1

factor1	Dependent Variable
1	NoTape
2	LowDye
3	Weave

Mauchly's Test of Sphericityb

Measure:MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.934	.687	2	.709	.938	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.
b. Design: Intercept
Within Subjects Design: factor1

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	30.594	2	15.297	1.479	.250
	Greenhouse-Geisser	30.594	1.875	16.313	1.479	.251
	Huynh-Feldt	30.594	2.000	15.297	1.479	.250
	Lower-bound	30.594	1.000	30.594	1.479	.249
Error(factor1)	Sphericity Assumed	227.546	22	10.343		
	Greenhouse-Geisser	227.546	20.630	11.030		
	Huynh-Feldt	227.546	22.000	10.343		
	Lower-bound	227.546	11.000	20.686		

Head Peak Acceleration

Within-Subjects Factors

Measure:MEASURE_1

factor1	Dependent Variable
1	NoTape
2	LowDye
3	Weave

Mauchly's Test of Sphericityb

Measure:MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.948	.530	2	.767	.951	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept

Within Subjects Design: factor1

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	.321	2	.160	.532	.595
	Greenhouse-Geisser	.321	1.902	.169	.532	.587
	Huynh-Feldt	.321	2.000	.160	.532	.595
	Lower-bound	.321	1.000	.321	.532	.481
Error(factor1)	Sphericity Assumed	6.633	22	.301		
	Greenhouse-Geisser	6.633	20.919	.317		
	Huynh-Feldt	6.633	22.000	.301		
	Lower-bound	6.633	11.000	.603		

Shock Attenuation

Within-Subjects Factors

Measure:MEASURE_1

factor1	Dependent Variable
1	NoTape
2	LowDye
3	Weave

Mauchly's Test of Sphericityb

Measure:MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.380	9.684	2	.008	.617	.656	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept

Within Subjects Design: factor1

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	9.137	2	4.569	1.022	.376
	Greenhouse-Geisser	9.137	1.234	7.403	1.022	.348
	Huynh-Feldt	9.137	1.312	6.965	1.022	.352
	Lower-bound	9.137	1.000	9.137	1.022	.334
Error(factor1)	Sphericity Assumed	98.383	22	4.472		
	Greenhouse-Geisser	98.383	13.578	7.246		
	Huynh-Feldt	98.383	14.432	6.817		
	Lower-bound	98.383	11.000	8.944		

REFERECES

Alt, W., Lohrer, H., and Gollhofer, A. (1999). Functional properties of adhesive ankle taping: neuromuscular and mechanical effects before and after exercise. *Foot and Ankle International*, 20 (4): 238.

Applequist, Bryon (2013). Shock Attenuation in Landing. Unpublished manuscript, University of Nevada Las Vegas, Las Vegas, NV.

Ator, R., Gunn, K., McPoil, T.G., Knecht, H.G. (1991). The effect of adhesive strapping on medial longitudinal arch support before and after exercise. *Journal of Orthopaedic & Sports Physical Therapy*, 14; 1: 18- 23.

Bahr, R., & Krosshaug, T. (2005). Understanding injury mechanisms: A key component of preventing injuries in sport. *British Journal of Sports Medicine*, 39 (6), 324-329.

Boden, B.P., Dean, G.S., Feagin Jr., J.A., Garrett Jr., W.E., 2000. Mechanisms of anterior cruciate ligament injury. *Orthopedics* 23, 573- 578.

Cavanagh, P. R., & Lafortune, M. A. (1980). Ground reaction forces in distance running. *Journal of Biomechanics, 13*(5), 397-406. Retrieved from SCOPUS database.

Cordova, M.L., Takahashi, Y., Kress, G.M., Brucker, J.B., and Finch, A.E. (2010). Influence of external ankle support on lower extremity joint mechanics during drop landings. *Journal of Sport Rehabilitation*, 19, 136-148.

Coventry, E., O'Connor, K. M., Hart, B. A., Earl, J. E., & Ebersole, K. T. (2006). The effect of lower extremity fatigue on shock attenuation during single-leg landing. *Clinical Biomechanics, 21*(10), 1090-1097

Decker, M.J., Torry. M.R., Wyland, D.J., Sterett, W.I., Steadman, J.R. (2003). Gender differences in lower extremity kinematics, kinetics, and energy absorption during landing. *Clinical Biomechanics*, 18, 662- 669.

Derrick, T.R., Hamill, J., and Caldwell, G.E. (1998). Energy absorption of impacts during running at various stride length. *Medicine and Science in Sports and Exercise*, 30, 128-135.

Derrick, T. R. (2004). The effects of knee contact angle on impact forces and accelerations. *Medicine and Science in Sports and Exercise, 36*(5), 832-837.

Devita, P., and Skelly, W. A. (1992) Effect of landing stiffness on joint kinetics and energetics in the lower extremity. *Medicine and Science in Sports and Exercises*, 24, 108- 115.

Dufek, J. S., Mercer, J. A., Teramoto, K., Mangus, B. C., & Freedman, J. A. (2008). Impact attenuation and variability during running in females: A lifespan investigation. *Journal of Sport Rehabilitation, 17*(3), 230-242.

Dufek, J. S., & Bates, B. T. (1990). The evaluation and prediction of impact forces during landings. *Medicine and Science in Sports and Exercise, 22*(3), 370-377.

Dye R.W. (1939). A strapping. *Journal of the National Association of Chiropodists*. 29: 11-2

Flynn, J. M., Holmes, J. D., & Andrews, D. M. (2004). The effect of localized leg muscle fatigue on tibial impact acceleration. *Clinical Biomechanics, 19*(7), 726-732.

Fong, C.M., Blackburn, J. T., Norcross, M. F., McGrath, M., and Padua, D. A. (2011). Ankle- Dorsiflexion Range of Motion and Landing Biomechanics. *Journal of Athletic Training*, 46 (1): 5- 10.

Franettovich, Melinda, Chapman, Andrew, Blanch, Peter, and Vicenzino, Bill. (2008). A physiological and psychological basis for anti- pronation taping from a critical review of the literature. *Sports Medicine*, 38 (8), 617- 631.

Franettovich, Melinda, Chapman, Andrew, and Vicenzino, Bill. (2008). Tape that increases medial longitudinal arch height also reduces leg muscle activity: a preliminary study. *Medicine and Science in Sports & Exercise*. 593- 600.

Fukuda, H. Biomechanical analysis of landing on surfaces with different stiffnesses. Biomechanics XI-B, G. DeGroot, A.P. Hollander, P.A. Hiujing, and G.J. van Ingen Schenau (Eds.) Amsterdam: Free University Press, 1988, 679- 624.

Gross, T.S., and Nelson, R.C (1988). The shock attenuation role of the ankle during landing from a vertical jump. *Medicine and Science in Sports and Exercise*, 20 (5): 506- 514.

Hass, C.J., Schick, E.A., Tillman, M.D., Chow, J.W., Brunt, D., and Cauraugh, J. (2005). Knee biomechanics during landings: comparison of pre- and postpubescent females. *Medicine and Science in Sports and Exercise*, 37 (1), 100-107.

Herman, D.C., Weinhold, P.S., Guskiewicz, K.M., Garrett, W.E., Yu, B., and Padua, D.A. (2008). The effects of strength training on the lower extremity biomechanics of female recrteational athletes during a stop- jump task. *American Journal of Sports Medicine*, 36 (4): 733- 740.

James, S.L., Bates, B. T. and Ostering, L.R. (1978) Injuries to runners. *American Journal of Sports Medicine*. 6, 40-50.

Karlsson, J. and Andreasson, G.O. (1992). The effect of external ankle support in chronic lateral ankle joint instability an electromyographic study. *American Journal of Sports Medicine*, 20 (3): 257.

Laughlin, W.A., Weinhandl, J.T., Kernozek, T.W., Cobb, S.C., Keenan, K.G., O'Connor, K.M. (2011). The effects of single- leg landing technique on ACL loading. *Journal of Biomechanics*, 44, 1845- 1851.

Manter, J.M. (1941). Movements of the subtalar and transverse tarsal joints. *Anatomy Record*. 80; 397-410.

McNitt- Gray, J.L. (1989). Influence of impact speed on joint kinematics and impulse characteristics of drop landings. *Journal of Biomechanics*, 22 (19), 1054.

Mercer, J. A., Vance, J., Hreljac, A., & Hamill, J. (2002). Relationship between shock attenuation and stride length during running at different velocities. *European Journal of Applied Physiology, 87*(4-5), 403-408.

Nigg, B.M., Cole, G.K., and Bruggemann, G. (1995). Impact forces during heel- toe running. *Journal of Applied Biomechanics*, 11, 407- 432.

Salci, Y., Kentel, B.B., Heycan, C., Akin, S., and Korkusuz, F. (2004) Comparsion of landing male and female college volleyball players. *Clinical Biomechanics*. 19 (6): 622-628.

Shima, N., Maeda, A., and Hirohashi, K. (2005). Delayed latency of peroneal reflex to sudden inversion with ankle taping or bracing. *International Journal of Sports Medicine*, 26 (6): 476.

Shoten, M.R., and Winslow, D.S. (1992). Spectral analysis of impact shock during running. *International Journal of Sports Biomechanics*, 8, 288- 304.

Subotinick S.I. (1985). The biomechanics of running: implications for the prevention of foot injuries. *Sports Medicine*. 2:144- 153.

Sun, P.C., Shih, S.L., Chen, Y.L., Hsu, Y.C., Yang, R.C., and Chen, C.S. (2012). Biomechanical analysis of foot with different foot arch heights: a finite element analysis. *Computer Methods in Biomechanics and Biomedical Engineering*. 15 (6): 563-569.

Tillman, M.D., Hass, C.J., Brunt, D., & Bennett, G.R. (2004). Jumping and landing techniques in elite women's volleyball. *Journal of Sports Science and Medicine*, 3 (1), 30- 36.

Vicenzino, B., Franettovich, M., Mcpoil, T., Russell, T., and Skardoon, G. (2005). Initial effects of anti-pronation tape on the medial longitudinal arch during walking and running. *British Journal of Sports Medicine*. 39 (12) 939.

Vicenzino B, Dip, G., McPoil T, Buckland S. (2007). Plantar foot pressures after the augmented low- dye taping technique. *Journal of Athletic Training*. 42 (3): 374-380.

Yi C.H., Brunt D, Kim H.D., Fiolkowski P. (2003). Effect of ankle taping and exercise on EMG and kinetics during landing. *Journal of Physical Therapy Science*; 15 (2): 81- 85.

Zhang, S., Derrick, T. R., Evans, W., & Yu, Y. J. (2008). Shock and impact reduction in moderate and strenuous landing activities. *Sports Biomechanics, 7*(2), 296-309.

VITA

Graduate College

University of Nevada, Las Vegas

Shun Jinnouchi, LAT, ATC, PES, CES

Home Address: 3839 Columbus Street
Las Vegas, NV 89121

Degrees: Bachelor of Science in Athletic Training 2011
Master of Science in Kinesiology,
Concentration in Athletic Training 2013

Special Honors: Far West Athletic Trainers' Association Quiz Bowl Champion Member
National Athletic Trainers' Association Quiz Bowl Champion Member
Graduate Assistant Department of Kinesiology and Nutrition Sciences 2011-2013

Thesis Title: The Effects of Arch Taping on Shock Attenuation during Landing

Thesis Examination Committee:
Chair, Dr. John Mercer, Ph.D.
Committee Member, Mr. Tedd Girouard, MS, LAT, ATC
Committee Member, Dr. Dick Tandy, Ph.D.
Graduate College Representative, Dr. Danny Young, Ph.D.