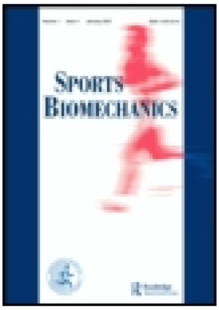

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Development of a fulcrum methodology to replicate the lateral ankle sprain mechanism and measure dynamic inversion speed

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Development of a fulcrum methodology to replicate the lateral ankle sprain mechanism and measure dynamic inversion speed

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Abstract
When the ankle is forced into inversion, the speed at which this movement occurs may affect the extent of injury. The purpose of this investigation was to develop a fulcrum device to mimic the mechanism of a lateral ankle sprain and to determine the reliability and validity of the temporal variables produced by this device. Additionally, this device was used to determine if a single previous lateral ankle sprain or ankle taping effected the time to maximum inversion and/or mean inversion speed. Twenty-six participants (13 with history of a single lateral ankle sprain and 13 with no history of injury) completed the testing. The participants completed testing on three separate days, performing 10 trials with the fulcrum per leg on each testing day, and tape was applied to both ankles on one testing day. No significant interactions or main effects were found for either previous injury or ankle taping, but good reliability was found for time to maximum inversion (ICC = .81) and mean inversion speed (ICC = .79). The findings suggest that although neither variable was influenced by the history of a single previous lateral ankle sprain or ankle taping, both variables demonstrated good reliability and construct validity, but not discriminative validity.

Keywords: *Movement speed, reliability, validity, taping, injury prevention, biomechanics*

Introduction

The lateral ankle sprain is one of the most common injuries in sports, and was the highest reported injury in NCAA sports from 1988 to 2004 (Hootman et al., 2007). The recurrence rate of lateral ankle sprains has been reported to be as high as 70–80% (Yeung et al., 1994; Ashton-Miller et al., 1996) and makes a previous ankle sprain the greatest predictor of a future ankle sprain (Hertel, 2002). Many lateral ankle sprains occur when landing from a jump onto the foot of another player, causing the person to 'roll their ankle' and sustain damage to the lateral structures (Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; McKay et al., 2001; Mitchell et al., 2008).

Since the lateral ankle sprain is the most common injury in sports (Hootman et al., 2007), developing interventions to help prevent this injury are critical to keeping athletes healthy

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and on the playing field. In order for this to happen, researchers must understand the mechanism of injury by developing the most accurate but safe simulation of this injury mechanism that can be tested in the laboratory. Up to this point, most studies attempting to replicate the inversion moment that occurs during a lateral ankle sprain have utilized a tilt platform, in which the floor unexpectedly falls away from beneath the participant (Lohrer et al., 1999; Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Vaes et al., 2002; Shima et al., 2005; Hopkins et al., 2007; Mitchell et al., 2008; Euchaute et al., 2009). While this methodology and research has provided valuable information about the mechanics of lateral ankle sprains, the validity of these devices to replicate the mechanism of a lateral ankle sprain has been questioned as ankle sprains do not typically occur when a person is standing on both legs while the floor falls away, with weight initially equally distributed on both legs (Lohrer et al., 1999; Shima et al., 2005; Hopkins et al., 2007; Mitchell et al., 2008). In addition, tilt platforms generally do not allow the participant to replicate the movements that usually occur prior to the initiation of the mechanism of injury, replicate the kinematics of an actual ankle sprain, nor provide for the proprioceptive cues that result from this mechanism of injury (Hopkins et al., 2007). Lastly, tilt platforms do not typically produce mean inversion speeds that are as fast as those that typically occur when running or landing from a jump (Fong et al., 2009).

Since many lateral ankle sprains occur when landing from a jump onto the foot of another player (McKay et al., 2001; Ubell et al., 2003; Midgley et al., 2007), an outer sole with fulcrum was developed to force the ankle into 25° of inversion upon landing from a step-down task and replicate this mechanism of injury. The development of this outer sole was based on a previous study (Ubell et al., 2003) that used a similar device to force the ankle into inversion and measure the effectiveness of ankle braces.

In addition to the expansion of the fulcrum methodology, this device was also utilized to measure temporal variables associated with lateral ankle sprains. When the ankle is unexpectedly forced into inversion, the speed of this movement will influence the likelihood of the person sustaining a lateral ankle sprain as well as the severity of the injury (Ashton-Miller et al., 1996). Previous tilt platform research has reported that mechanisms used to simulate inversion ankle sprains in laboratory settings can result in high inversion speeds (Eechaute et al., 2009). These previous speeds provide information about the ability of the participants to control the forced inversion, with shorter inversion times indicating less control of the inversion moment (Hertel, 2002). Specifically, time to complete the inversion range of motion (Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Vaes et al., 2002) and mean inversion speed (Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Vaes et al., 2002; Eechaute et al., 2009) have been studied. Eechaute et al. (2009) and Vaes et al. (2002) found no difference in time to maximum inversion between healthy participants and those with ankle instability. Ricard, Sherwood, et al. (2000) found that time to maximum inversion was increased with ankle taping, and mean inversion speed was significantly less with ankle taping. In addition, Ricard, Schulties, et al. (2000) reported that high top shoes also significantly reduced mean inversion speed.

In light of this previous work the researchers endeavored to develop a device, based on the methodology of Ubell et al. (2003) that would replicate the common mechanism of injury of a lateral ankle sprain. Specifically, the primary purpose was to develop a device that provides a simulation of the typical responses that occur prior to an inversion moment and to determine the reliability and validity (construct and discriminative) of the variables measured using the device. The secondary purpose was to determine the effects of a previous single lateral ankle sprain and ankle taping on the time to maximum inversion and mean inversion speed during the use of this device. It has been hypothesized that a lateral ankle sprain may affect the ability of the person to control the inversion moment, thus increasing the likelihood of recurrent ankle sprains (Ricard, Sherwood, et al., 2000). Further, it has been suggested that an external ankle support, which includes ankle taping and bracing, may reduce the inversion speed and thus reduce the likelihood of a lateral ankle sprain (Vaes et al., 1998; Ricard, Sherwood, et al., 2000). For the primary purpose, the authors hypothesized that the variables measured using the testing device would demonstrate good reliability and validity. For the secondary purpose, the authors hypothesized that the previous ankle sprain group would have a significantly smaller time to maximum inversion and significantly greater mean inversion speed than the control group, and that ankle taping would significantly increase time to maximum inversion and decrease mean inversion speed.

Methods

Participants

Twenty-six healthy, physically active (minimum of 30 minutes of physical activity/four times a week) participants completed the study. Thirteen participants (nine male, four female) with no history of a lateral ankle sprain comprised the control group, and 13 participants (eight female, five male) comprised the previous lateral ankle sprain (sprain) group. The specific descriptive characteristics of the participants can be found in Table I. Each participant in the sprain group had suffered a single lateral ankle sprain of one ankle as diagnosed by a physician, had missed at least one day of practice/physical activity due to the injury, and had no ankle/foot injury of the contralateral leg. The average amount of time from the previous ankle sprain to testing was 4.18 ± 1.17 years. Eight of the lateral ankle sprains occurred to the ankle of the dominant leg, and five occurred to the ankle of the non-dominant leg. Leg dominance was defined as the leg used to kick a ball. It has been suggested there is a deficit present in the central nervous system after a previous ankle sprain that may affect both ankles, and therefore comparisons should only be made to a healthy control group, not within a previously injured group (Vaes et al., 2002). Therefore, the individuals in the sprain group were matched with healthy controls of a similar mass (±3 kg) and height (±5 cm), and were also matched to the side of injury (dominant and non-dominant). This created the leg variable (sprain group injured leg with control group injured match; sprain group uninjured leg with control group uninjured match). All participants were free of any of the symptoms of chronic ankle instability, as the purpose of this study was to examine the effects of a single lateral ankle sprain. Exclusion factors included bilateral ankle sprains, a lower extremity fracture/surgery, or a foot size not compatible with the outer sole. All participants within the sprain group indicated that they had completed a rehabilitation program for the ankle sprain and had not sustained the ankle sprain within six months prior to testing. The study was approved by the institutional review board where data collection occurred, all participants signed an informed consent form, and the rights of the participants were protected.

Table I. Descriptive characteristics for participants (means and standard deviations).

Group	*N*	Age (years)	Mass (kg)	Height (m)
Control	13	21.61 ± 1.19	72.53 ± 14.53	1.75 ± 0.09
Previous lateral ankle sprain (Sprain)	13	21.31 ± 1.18	75.32 ± 15.01	1.75 ± 0.08
Total	26	21.46 ± 1.17	73.92 ± 14.55	1.75 ± 0.09

Data collection

Eight detachable outer soles (four with fulcrum and four flat), made of orthoplast, were developed for this project. The design of the outer sole with fulcrum was based on previous work by Ubell et al. (2003). A left and right fulcrum and flat outer sole was developed for the average men's shoe size (US men size 10–12) and the average women's shoe size (US women size 8–10). To produce 25° of inversion upon landing, a 6-mm thick, 30-mm high fulcrum was placed 20 mm from the medial border and ran the length of the outer sole. The design of the outer sole and fulcrum can be seen in Figures 1 and 2. The fulcrum was placed 20 mm from the medial border of the outer sole to ensure that the participants' ankle was forced into inversion upon landing. For this to occur, the center of pressure from the ground reaction force must be located medially from the subtalar joint axis of rotation (Fuller, 1999). The authors also choose to limit the amount of inversion to 25° in order to replicate the mechanism of a lateral ankle sprain while staying within the limits of safety, as injury to the lateral ankle ligaments may occur when the ankle exceeds 30° of inversion (Ashton-Miller et al., 1996), and an actual laboratory lateral ankle sprain occurred when the ankle reached 41° of inversion (Fong et al., 2009). The outer sole was attached to the athletic shoe of the participants using Velcro™ straps. Both the flat outer sole (0.134 kg) and outer sole with fulcrum (0.178 kg) were of

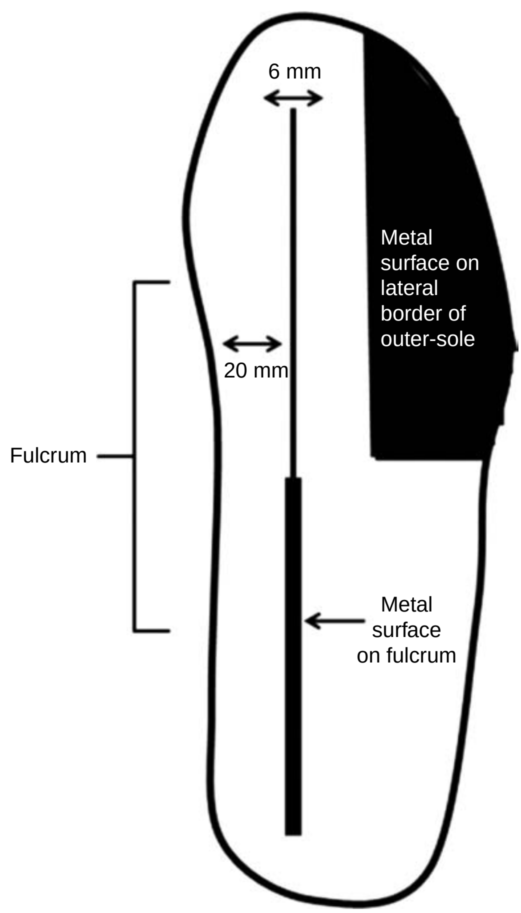

Figure 1. Sketch of the bottom of the outer sole with fulcrum.

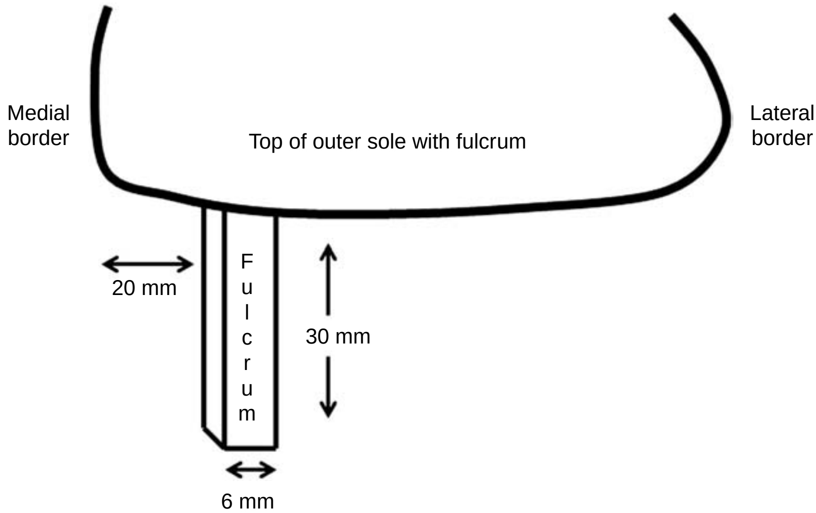

Figure 2. Sketch of a frontal plane view of the outer sole with fulcrum.

a similar mass to help prevent the participants from discerning which outer sole was strapped to their foot due to a large difference in mass. All participants were questioned following testing as to whether they could infer the type of outer sole strapped to the shoe, and all responded that they could not. All participants were required to wear low top, flat-soled athletic shoes that were commonly worn during physical activity. Running shoes were not allowed as running shoes often place the foot/ankle in a plantarflexed position.

A metal landing surface was developed and metal was also attached to the fulcrum and the lateral border of the outer sole. A circuit was completed when the fulcrum and lateral border of the outer sole made contact with the landing area (Figure 3). The signals from this circuit

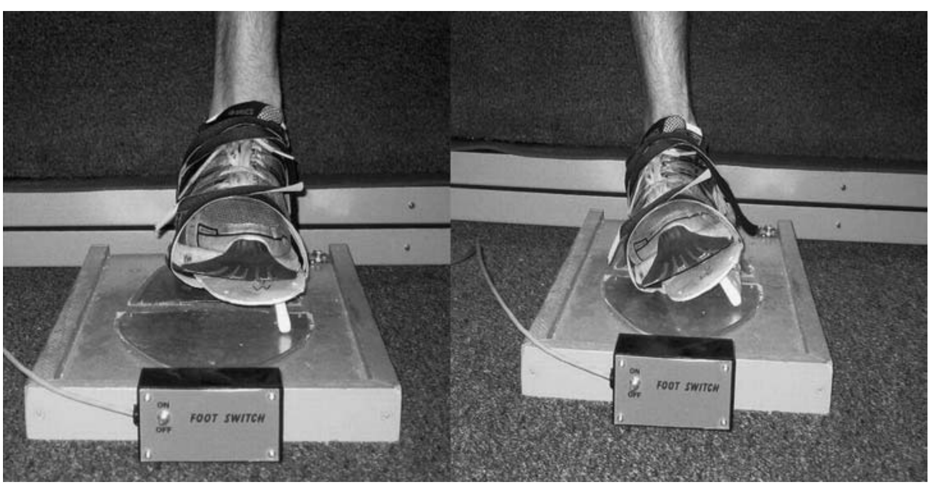

Figure 3. (Left) The participant landing on the fulcrum and initiating the 25° of inversion. This event was marked by a spike in channel one when the metal on the fulcrum made contact with the metal on the landing area. (Right) The participant completing the 25° of inversion. This event was marked by a spike in channel two when the metal on the lateral border of the outer sole made contact with the landing area.

were sent to a multichannel electromyography (EMG) amplifier/processor unit (MyoClinical; Noraxon USA Inc., Scottsdale, AZ, USA), with the frequency set at 1,000 Hz. When the fulcrum made contact with the landing area, a signal was sent to the EMG processor, producing a spike in one of the EMG channels, which indicated ground contact and the beginning of the inversion moment. When the lateral border of the outer sole made contact with the landing area, a second signal was sent to the EMG processor, producing a spike in a second EMG channel and indicating that the participant had completed the inversion task. The time from initial contact of the fulcrum with the landing area until touchdown of the lateral border of the outer sole was measured as time to maximum inversion. Similar to previous studies (Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Eechaute et al., 2009), mean inversion speed was calculated as the ratio of total angular displacement (25°) to time to maximum inversion.

The participants reported for testing on three separate occasions. Ankle taping was assigned randomly on one of the first two testing days. The third testing day, without ankle taping, was used to measure the reliability of the temporal variables with the first or second day without ankle taping. On the ankle taping day, the participant had one of his or her ankles taped in a standard, closed basket weave technique by the same Certified Athletic Trainer. After completing testing on the first leg, the tape was removed and the second ankle was taped, and this leg was tested. Foam pre-wrap (Z-wrap; Johnson & Johnson, Langhorne, PA, USA) was applied first, followed by 1.5 inch Coach™ Tape by Johnson & Johnson. Two anchor strips were placed just distal to the base of the gastrocnemius, and one anchor strip was placed around the foot just proximal to the base of the metatarsals. Next, three stirrups and horseshoes were placed around the foot/ankle in an alternating manner (closed basket weave), running from the medial side to the lateral side. Two figure of eight and two heel lock patterns were applied next, and lastly strips were applied to close any exposed areas on the lower leg (Ashton-Miller et al., 1996).

Once prepared for testing, the participants stood on a 27-cm high box on the non-testing leg, and moved the foot of the testing leg behind them by flexing the knee and extending the hip; this position prevented the participant from seeing which outer sole (fulcrum or flat) was affixed to the sole of the shoe. Next, either the outer sole with fulcrum or flat outer sole was secured to the participants' shoe with Velcro™, in random order (Figure 4). The purpose of the flat outer sole was to help prevent anticipation of the inversion perturbation. After the outer sole was secured, the participant was instructed to swing his or her leg forward and allow the foot to hang down in a natural position (Figure 5). When instructed to step down, the participants leaned forward and stepped down off the box onto the testing leg (Figure 3). In case the participant lost his or her balance after stepping down, spotters were present to help him/her regain balance. Trials in which the participant flexed the contralateral knee or hip to lower themselves down from the box were excluded. The participants were instructed to land flat-footed, which was verified visually. This instruction was employed in order to keep the initiation of the inversion moment as consistent as possible. The 25° of inversion was considered complete when the lateral border of the outer sole made contact with the landing area (Figure 5). After the testing leg made contact with the landing area, the non-testing leg was brought to the ground to maintain balance. Contact of the non-testing leg never occurred prior to the completion of inversion range of motion. After landing, the outer sole was removed and placed behind the participant. The same procedure was followed (with flat outer sole randomly interchanged with the outer sole with fulcrum) until 10 trials had been performed with the outer sole and fulcrum, and then the other leg was tested. The time to maximum inversion and mean inversion speed were averaged separately across the 10 trials for each leg during each testing session. Therefore,

Figure 4. Placement of testing foot behind the participant to strap on the outer sole.

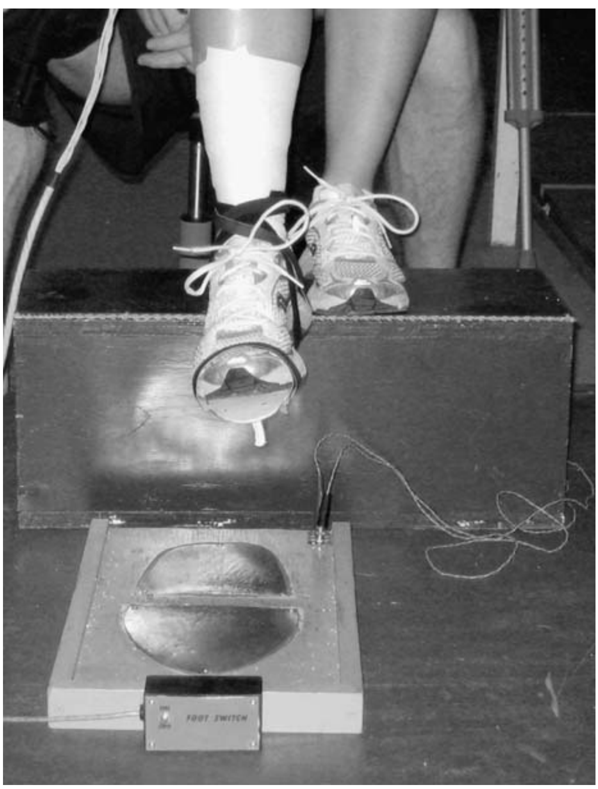

Figure 5. Placement of testing leg in front of the participant after the outer sole has been attached to the testing foot.

each participant had a mean time to maximum inversion and mean inversion speed for each testing leg during each testing session.

Statistical analysis

The data were exported into Microsoft™ Excel (Microsoft Corporation, Redmund, WA, USA), and both the time to maximum inversion and mean inversion speed were calculated. Independent samples *t*-tests were performed to assess differences in age, height, and mass between the two groups. Reliability coefficients, using intra-class correlation coefficients (ICC), were calculated between the two testing days without ankle taping. A 2 (injury group) × 2 (leg) × 2 (ankle support) analysis of variance with repeated measures on the last two variables was conducted to determine if there was a significant difference in the time to maximum inversion among the different injury groups, testing legs, and different ankle support conditions. A separate 2 (injury group) × 2 (leg) × 2 (ankle support) repeated measures ANOVA was conducted on mean inversion speed data. The a priori alpha level was set at $p < .05$. All statistical analyses were conducted with the Statistical Package for Social Sciences v 16.0 (SPSS) for Windows.

Results

The ICC for the time to maximum inversion data was .81 (SEM = 6.2), and the ICC for the mean inversion speed data was .79 (SEM = 89.7), demonstrating good reliability between the testing days (Table II).

No significant differences were found for age ($t = .661$, $p = .515$), height ($t = -.480$, $p = .635$), or mass ($t = .072$, $p = .943$) between the participants in the control and sprain groups. For the time to maximum inversion data, the results revealed no significant three-way interaction ($F_{1,24} = .220$, $p = .643$), no significant interaction between testing leg and injury condition ($F_{1,24} = 1.51$, $p = .231$), no significant interaction between the testing leg and ankle support condition ($F_{1,24} = .142$, $p = .710$), and no significant interaction between the injury history and ankle support condition ($F_{1,24} = .205$, $p = .655$). There were also no significant main effects for injury group ($F_{1,24} = .185$, $p = .671$), testing leg ($F_{1,24} = 2.056$, $p = .165$), or ankle support condition ($F_{1,24} = 2.555$, $p = .123$). The means and standard deviations can be found in Tables II and III.

For the mean inversion speed data, the results revealed no significant three-way interaction ($F_{1,24} = .223$, $p = .641$), no significant interaction between testing leg and injury condition ($F_{1,24} = .878$, $p = .358$), no significant interaction between the testing leg and ankle support condition ($F_{1,24} = .451$, $p = .508$), and no significant interaction between the injury history and ankle support condition ($F_{1,24} = .056$, $p = .815$). There were also no significant main effects for injury group ($F_{1,24} = .343$, $p = .563$), testing leg ($F_{1,24} = .007$, $p = .934$), or ankle support condition ($F_{1,24} = 2.268$, $p = .145$). The means and standard deviations can be found in Tables II and III.

Discussion

The primary purpose of this study was to utilize a unique testing protocol to mimic the mechanism of a lateral ankle sprain and determine the reliability and validity of the variables produced by this device. The secondary purpose was to determine if a previous lateral ankle sprain or ankle taping affected the time to maximum inversion and mean inversion speed. Through the use of a different device to cause inversion at the ankle than previous studies

Table II. Means and standard deviations for the time to maximum inversion (TMI) and mean inversion speed (MIS) data without ankle taping.

Variable	Sprain (injured ankle)	Control (injured match)	Sprain (uninjured ankle)	Control (uninjured match)	Sprain (retest)	Control (retest)	ICC	SEM
TMI (ms)	46.5 ± 18.9	51.1 ± 18.6	47.9 ± 15.6	46.2 ± 12.1	48.3 ± 18.0	45.9 ± 15.4	.81	6.2
MIS (°/s)	625.9 ± 245.6	558.8 ± 214.8	573.5 ± 176.9	572.9 ± 133.0	596.1 ± 230.5	603.8 ± 194.3	.79	89.7

Note: sprain = previous lateral ankle sprain group; control = control group.

Table III. Means and standard deviations for the time to maximum inversion (TMI) and mean inversion speed (MIS) data with ankle taping.

Variable	Sprain (injured ankle)	Control (injured match)	Sprain (uninjured ankle)	Control (uninjured match)
TMI (ms)	51.0 ± 20.2	55.9 ± 19.2	48.9 ± 17.4	51.3 ± 16.5
MIS (°/s)	567.5 ± 218.7	514.0 ± 215.6	574.0 ± 199.1	538.3 ± 177.9

Note: sprain = previous lateral ankle sprain group; control = control group.

(Lohrer et al., 1999; Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Vaes et al., 2002; Shima et al., 2005; Hopkins et al., 2007; Mitchell et al., 2008; Euchaute et al., 2009), the goal was to create a more accurate laboratory replication of the mechanism of a lateral ankle sprain in order to provide a positive contribution to this body of research.

For both the healthy and previously injured participants, the results revealed good reliability for time to maximum inversion and mean inversion speed. This indicates that these variables may be helpful in determining possible defects in the control of a dynamic forced inversion associated with a lateral ankle sprain. While previous research using a tilt platform found similar reliability for mean inversion speed (ICC = .80) (Eechaute et al., 2009), the fulcrum methodology in the current study was found to have a greater reliability for time to maximum inversion (ICC = .61) (Eechaute et al., 2009). In addition to measuring the reliability of the variables produced by the outer sole with fulcrum, it is also necessary to compare the temporal variables measured by the outer sole with fulcrum to the temporal variables that have been measured during an actual lateral ankle sprain, to determine the construct validity of these variables. Fong et al. (2009) was able to measure the inversion velocity during an accidental laboratory lateral ankle sprain and found that the angular inversion velocity reached 632°/s. The mean inversion speeds found in the current study (Tables II and III) approach this value, and are higher than those reported previously from research utilizing a tilt platform (293–528.1°/s) (Ricard, Schulties, et al., 2000; Ricard, Sherwood, et al., 2000; Vaes et al., 2002; Eechaute et al., 2009). When examining injury mechanisms that commonly occur in sports, the goal is to replicate the mechanism of injury as closely as possible, in a controlled laboratory setting, without causing an injury. In the present study, no injuries were sustained by the participants during testing, although the inversion speeds caused by the outer sole with fulcrum were similar to those reported during an actual lateral ankle sprain (Fong et al., 2009). The higher inversion speeds realized in the present study demonstrate construct validity, and the reliability of the outer sole with fulcrum supports the use of this mechanism in future research as an accurate representation of the mechanism of a lateral ankle sprain.

The temporal results of this study also support previous literature in that they revealed no differences in time to maximum inversion between the different injury groups and ankle support conditions. This is in agreement with studies by Eechaute et al. (2009) and Vaes et al. (2002) that failed to find a difference in time to maximum inversion between healthy participants and those with ankle instability. There was also no difference in mean inversion speed in the current study between the control group and previously injured participants, which is similar to the results reported by Eechaute et al. (2009). There may be two possible explanations for the lack of differences between groups. Firstly, this study attempted to determine the effects of a single lateral ankle sprain on these temporal variables, and the single sprain previously suffered by the participants in this study may not have caused permanent damage to the lateral structures of the ankle. Secondly, if the single lateral ankle sprain did cause damage to the lateral structures of the ankle, the rehabilitation program completed by the participants in the present study may have restored any deficits caused by the initial injury. Support for this explanation comes from a recent study that found participants that completed a supervised, proprioceptive-based rehabilitation program after suffering a lateral ankle sprain have a lower recurrence rate and lower cost of care than participants that did not complete a supervised rehabilitation program (Hupperets et al., 2010). Thus, based on previous work (Vaes et al., 2002; Eechaute et al., 2009) and the results of the current study, a history of a single previous lateral ankle sprain does not have a detrimental effect on time to maximum inversion or mean inversion speed. Therefore, in regards to the time to maximum inversion and mean inversion speed variables, we are not able to discriminate between healthy participants and those with a history of a single lateral ankle sprain. This is consistent with the findings of Eechaute et al. (2009) who could not discriminate between time to maximum inversion and mean inversion speed variables in healthy subjects and those with chronic ankle instability.

The results also revealed no difference in time to maximum inversion and mean inversion speed between ankle support conditions. This is in disagreement with the previous work (Ricard, Sherwood, et al., 2000), which found ankle taping significantly increased time to maximum inversion and reduced mean inversion speed. The differences between the two studies are likely to be methodological, as Ricard, Sherwood, et al. (2000) used a tilt platform with a foot-support base that rotated 37° after pulling a string to drop the trap door and force the ankle into inversion, and only healthy participants were tested. The methodology utilized in the present study resulted in higher inversion speeds than the previous study (Ricard, Sherwood, et al., 2000), perhaps due to the current study using a dynamic landing task as opposed to a static standing task (Ricard, Sherwood, et al., 2000), which may have negated any affects ankle taping had on the dynamic inversion speed and contributed to the different findings. The effects of both ankle taping and bracing on time to maximum inversion and mean inversion speed should be examined further among participants with both functional and mechanical ankle instability.

There were several limitations of the present study. The participants were only tested immediately after ankle taping. It is known that tape begins to lose some of its restrictive properties after 10 minutes of physical activity (Ashton-Miller et al., 1996). Future research should measure the effects of taping on time to maximum inversion and mean inversion speed after physical activity. Second, the outer sole with fulcrum only forced the ankle into inversion upon landing, while some lateral ankle sprains occur as a result of inversion and plantar flexion, although Fong et al. (2009) found a lateral ankle sprain can occur without plantar flexion at the talocrural joint. However, as this was an initial study using this mechanism, the action of an inversion perturbation in isolation first needed to be examined. An additional limitation was that only participants with a single lateral ankle sprain were recruited, and no control was in place for the length of the rehabilitation program of the participants. All participants were required to have completed a supervised rehabilitation program for the injured ankle, but these varied in length and intensity. Also, the rehabilitation program may have restored any deficits caused by the lateral ankle sprain that may have resulted in differences between the two injury groups.

Conclusions

This study advances the field of lateral ankle sprain research by using a different device to simulate the mechanism of a lateral ankle sprain with higher levels of reliability than has been reported using a tilt platform (Eechaute et al., 2009). Furthermore, the mean inversion speed produced by the outer sole with fulcrum was similar to those reported during an actual lateral ankle sprain, demonstrating the construct validity of this variable produced by the outer sole with fulcrum and helping support the use of this device to replicate the mechanism of a lateral ankle sprain in a laboratory. Neither a single lateral ankle sprain nor ankle taping produced differences in time to maximum inversion and mean inversion speed between the experimental and control groups. Therefore, time to maximum inversion and mean inversion speed cannot be used to discriminate between participants with a history of a single lateral ankle sprain and those without a history of an ankle sprain. It seems that ankle taping offers no benefit to time to maximum inversion and mean inversion speed to individuals with a history of a single lateral ankle sprain who have completed a rehabilitation program compared to healthy controls.

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