International Journal of EXERCISE SCIENCE

Original Research

Dorsiflexion Range of Motion in Copers and Those with Chronic Ankle Instability

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ABSTRACT

International Journal of Exercise Science 12(1): 614-622, 2019. The Cumberland Ankle Instability Tool (CAIT) is used to classify individuals as ankle sprain copers, or as one suffering from chronic ankle instability (CAI). However, literature examining factors contributing to these classifications on the CAIT is lacking, as the CAIT itself does not offer explanations for specific anthropometric measures that influence a patient's classification. Therefore, the purpose was to determine if there was a difference between dorsiflexion active range of motion (AROM) between copers, those with CAI, and a healthy control group. Twenty-two individuals with recent ankle sprains were recruited by a convenience sampling method and placed in the coper (5 females, 5 males, age: 21.9 ± 1.5 years, height: 173.74 ± 7.69 cm, weight: 69.75 ± 10.50 kg) or CAI (10 females, 2 males, age: 21.8 ± 2.3 years, height: 173.99 ± 10.86 cm, weight: 68.14 ± 10.63 kg) groups. The remaining 10 individuals (4 females, 6 males, age: 23.2 ± 1.5 years, height: 178.05 ± 12.92 cm, weight: 75.65 ± 8.00 kg) who participated in the study served as control, as they had never sustained a previous ankle sprain. Dorsiflexion AROM measurements were evaluated using an inclinometer during a weight-bearing lunge. Three measurements were taken for each participant and used for statistical analysis. There was no statistically significant difference in average dorsiflexion AROM between the coper, control, and CAI groups ($F_{2,29} = 2.063$, $p = 0.15$, $\omega = 0.06$, $1 - \beta = 0.40$). Further research is needed to determine if limited dorsiflexion AROM is indeed a contributing factor to an individual's classification as a coper or suffering from CAI, as defined by the CAIT.

KEY WORDS: Ankle sprain, weight-bearing lunge test, active range of motion, Cumberland Ankle Instability Tool

INTRODUCTION

Lateral ankle sprains are among the most common musculoskeletal injuries in the athletic population (23, 25). It has been reported that approximately 25% of all musculoskeletal injuries are lateral ankle sprains, (1) with approximately 50% of these injuries being caused by sport-related activity (25, 26). Because of the frequency, treatment of such injuries to the lateral ankle can place a greater financial burden on those affected compared to other ankle injuries (23, 25), as 7-10% of hospital emergency department cases involve lateral ankle sprains (23). One study reported that 59% of patients that suffered from recurrent lateral ankle sprains experienced residual symptoms such as pain, weakness, instability, and swelling, like those associated with Chronic ankle instability (CAI) (29). Chronic ankle instability is a musculoskeletal condition where one experiences residual symptoms of both functional and mechanical instability (13, 26).

Chronic ankle instability often develops as a result of recurrent ankle sprains, and can be characterized by the feeling of residual symptoms such as instability (9, 12, 14, 22), pain, weakness, swelling (6, 26), or feeling of the ankle "giving way" (16). However, some patients with a history of lateral ankle sprains experience no long-lasting symptoms like those of CAI, and are often referred to as copers (21, 24, 28). Copers do not experience symptoms of pain, instability (28), recurrent injury (28), or feeling of the ankle "giving way" (25, 28) for at least one year following the initial injury (21, 24).

The Cumberland Ankle Instability Tool (CAIT) is a valid and reliable tool for determining functional ankle instability (15). The CAIT is a 9-item self-reported questionnaire that is used to assess the severity of ankle instability and classify status as either a coper or suffering from CAI based on experiences during various physical activities of daily living (24). A coper, as defined by the CAIT is a patient that has suffered from an ankle sprain but experiences no long-lasting symptoms (24). Chronic ankle instability, as defined by the CAIT, is a patient that experiences outstanding symptoms from previous ankle injuries that are consistent with those of CAI (24).

Previous studies (6, 7, 21 ,28) suggest that a deficit in ankle dorsiflexion active range of motion (AROM) can predispose patients to recurrent lateral ankle sprains, and others reported that CAI develops in 40% (12) and up to 70% (8, 27) of people with a history of lateral ankle sprains. Furthermore, a previous study reported that dorsiflexion range of motion (ROM) measured using a weight-bearing lunge test (WBLT) was a significant contributor ($p < 0.05$) to a combination of mechanical and functional impairments that caused a variance in health related-quality of life of individuals reported to have CAI by the CAIT (18). However, there is little literature examining the difference in dorsiflexion AROM between patients that experience CAI by a tool such as the CAIT, and those that have not. If a difference in dorsiflexion AROM can be identified between patients that are determined to have CAI and those that do not (copers and a healthy population), then CAI can potentially be prevented in the future by emphasizing the importance of dorsiflexion range of motion rehabilitation following acute lateral ankle sprains. Therefore, the purpose of this work was to determine if there was a difference in dorsiflexion AROM between a healthy control population, patients classified as copers by the CAIT, and patients classified as having CAI by the CAIT. It was hypothesized that there would be a difference in dorsiflexion AROM between a coper, CAI, and control group members.

METHODS

Participants

An *a priori* statistical power analysis was performed with a two-sided test, effect size of 0.50, and 80% power which determined the need for 14 participants in the coper and CAI groups. After a screening of 37 total individuals that had volunteered to participate in the study by recruitment using a convenience sampling method, a total of 32 participants met the inclusionary criteria, whose demographic variables can be seen in Table 1.

Table 1. Mean and standard deviations of demographic variables.

	Men	Women
Age (years)	22.6 ± 1.3	22.0 ± 2.2
Height (cm)	184.83 ± 7.20	168.57 ± 6.62
Mass (kg)	79.86 ± 5.82	64.92 ± 7.49

All participants were between the ages of 18 and 26 years old and were recreationally active, defined in the current study as those that had subjectively reported participating in physical activity for a minimum of 90 minutes per week. Participants in the coper and control groups had both experienced a self-reported ankle sprain within 2 years, but no sooner than 6 months of the date that dorsiflexion AROM measurements were taken, while the control group had never experienced an ankle sprain (10). Participants with a previous history of at least one ankle sprain in the specified timeframe (6 months – 2 years prior to data collection) were classified into either the coper or CAI group based on their symptoms consistent with those of CAI, as determined by their CAIT score. Participants with a score of ≤ 27 on the CAIT were assigned to the CAI group, and those with a score of ≥ 28 were assigned to the coper group (27).

The definition of an ankle sprain in the current study was applied based on the position statement of the International Ankle Consortium (10). This defines an ankle sprain as "an acute traumatic injury to the lateral ligament complex of the ankle joint as a result of excessive inversion of the rear foot or a combined plantar flexion adduction of the foot" which required medical attention from a healthcare professional and resulted in at least 1 day of time loss from physical activity (10). Participant injury history was subjectively collected by the demographics sheets and questionnaires distributed by 1 of the primary investigators prior to dorsiflexion AROM measurements.

Of the initial 37 individuals that were screened for participation, 1 was excluded for failure to meet the required age range, and 4 were excluded for failure to meet timeline requirements for ankle sprains by reporting an injury that was too recent (within 6 months of data collection). This study was approved by the university's institutional review board, and all participants provided informed consent prior to data collection.

Outcome Measures: The CAIT questionnaire is a valid and reliable tool that consists of 9 questions and a 30-point scoring system (15). Based on score, participants with a history of ankle sprains were classified into 2 groups: CAI (score of ≤ 27) or coper (score of ≥ 28) (15). The Weight-Bearing Lunge Test (WBLT) was used to measure participant dorsiflexion AROM. This WBLT has been used in previous studies (1, 3, 19, 23), and has shown that use of WBLT using an inclinometer to measure dorsiflexion AROM resulted in higher reliability coefficients than goniometric measurements (11). The WBLT was performed against a wall, on low carpet. A millimeter measuring tape (2000 mm long) was attached to the ground parallel to the wall. A baseline bubble inclinometer (Fabrication Enterprise Inc. White Plains, New York) was used to assess the participant dorsiflexion AROM. Prior to data collection, the investigator using the baseline bubble inclinometer to measure dorsiflexion AROM was tested for intrarater reliability (t_9=1.00, p = 0.343, ICC (3,1)[1]=0.959, CI_{95} = 0.835, 0.990) on a pilot sample of 8 volunteers across 2 separate days, suggesting high intrarater reliability. Each participant performed 3 trials of the WBLT with 1 minute of rest in between. Dorsiflexion AROM measurements, starting distance for each trial, and the average of the 3 dorsiflexion AROM trial measurements for each participant were recorded in a Microsoft Excel spreadsheet.

Protocol

Participants reported to the data collection site during an allocated time for a single test session lasting approximately 20 minutes. One investigator administered a written informed consent form, a demographics form, and the CAIT and the other investigator conducted the WBLT to obtain dorsiflexion AROM measurements using the inclinometer in the connecting private laboratory.

The first investigator distributed a packet to each participant that contained 2 copies of the informed consent, 1 for the participant and 1 for the investigators, a demographics form, and the CAIT questionnaire. The participants were informed verbally about the research being conducted and verbally instructed how to complete the forms and the CAIT. Once the participants completed the packet, a pseudo code was created for them and used as confidential participant identification for all required documents.

Participants were verbally instructed on how to complete the CAIT based on the instructions provided on the questionnaire. The 9 questions asked the participant to rate his or her experience of ankle instability during different activities (19). Each rating corresponded to a score on a separate scoring sheet, which was used by the investigator to find a total score for each participant that would classify them into either the coper or CAI group.

The investigator that administered the CAIT questionnaire calculated the score of the CAIT and entered the scores and the group classification (CAI, coper, or control) into a Microsoft Excel spreadsheet that was kept separate from the other investigator. Participants were assigned to groups based on their score on the CAIT and whether or not they reported a previous ankle sprain. The CAI group reported a previous ankle sprain and received a score ≤ 27 on the CAIT, the coper group reported a previous ankle sprain and received a score of ≥ 28 on the CAIT, and the control group reported no history of a previous ankle sprain.

The participants performed the WBLT by beginning in a standing position, facing a wall, with the involved limb being used for dorsiflexion AROM measurements placed in front (19). Two fingers from each hand were placed on the wall in order to maintain balance during the WBLT procedures (19). Participants began with a starting distance of 10 cm between the wall and the great toe of the involved limb, and were then instructed to lunge forward while maintaining this position until their knee had touched the wall, placing the ankle of the involved limb into a dorsiflexed position. If participants were unable to reach the wall with their knee in this starting position, they were instructed to move forward until they could. Participants who were able to complete the motion from the starting 10 cm distance without lifting the heel of the involved limb were instructed to move back to the farthest point from which they could touch the wall with their knee while maintaining full contact between the heel and the ground and keeping the knee in line with the second toe (19). Once participants had reached the point of maximal dorsiflexion while maintaining the correct positioning for the WBLT, the dorsiflexion AROM was measured using baseline bubble inclinometer placed on the tibial tuberosity of the involved limb (19). Participants completed 3 trials of the WBLT, with a 1-minute rest between each, and the average of the 3 trials was recorded and used for statistical analysis.

In order to eliminate investigator bias, both investigators were blinded to the data being recorded by the other. Administration of the CAIT and measurement of dorsiflexion AROM were performed in separate rooms, with no communication between the 2 investigators. Therefore, the investigator administering the CAIT was not informed of the participants' dorsiflexion AROM measurements, and the investigator measuring the dorsiflexion AROM was not informed of the participants' CAIT scores or their assigned group.

Statistical Analysis

Descriptive statistics were calculated for each of the variables. A 1-way Analysis of Variance (ANOVA) was conducted to analyze differences in the average of 3 trials of dorsiflexion AROM between the 3 groups. Omega (ω) was calculated for measuring the effect size between groups. Also, 95% confidence intervals (CIs) were determined for the mean of each group. An *a priori* α level was set at $p = 0.05$ for the analysis. All data was first entered into a Microsoft Excel spreadsheet and the 1-way ANOVA statistical analysis was performed using SPSS (version 20.0; IBM Corporation, Armonk, NY) software.

RESULTS

There was no statistically significant difference between those in the coper, control, or CAI for age ($F_{2,29} = 1.946$, $p = 0.16$), height ($F_{2,29} = 0.524$, $p = 0.60$), or mass ($F_{2,29} = 1.702$, $p = 0.20$). The main finding was no statistically significant difference in average dorsiflexion AROM between those in the coper, control, and CAI groups ($F_{2,29} = 2.063$, $p = 0.15$, $\omega = 0.06$, $1 - \beta = 0.40$) as seen in Figure 1.

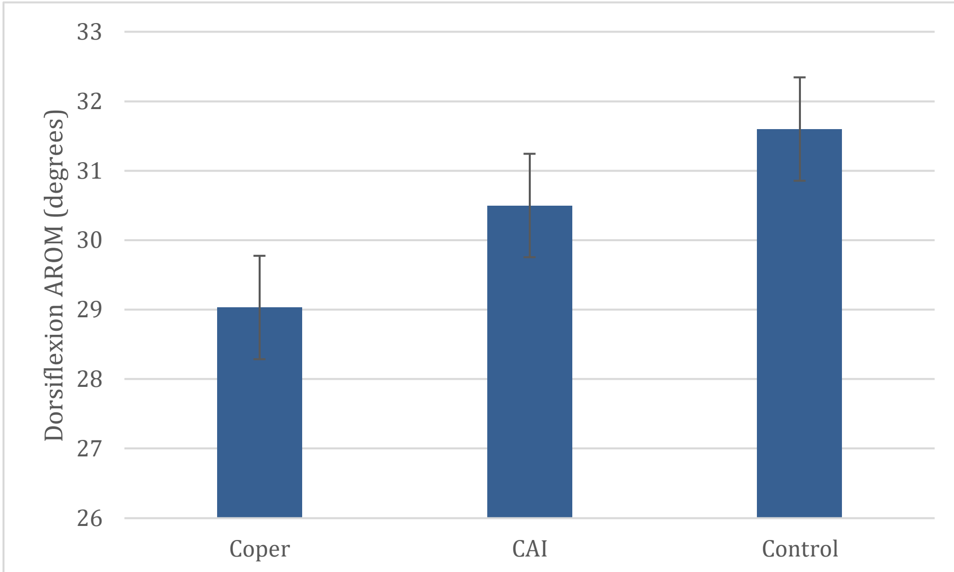

Figure 1. Average dorsiflexion active range of motion between groups.

DISCUSSION

The purpose of this study was to determine if there was a difference in dorsiflexion AROM between those with CAI, ankle sprain copers, and a control group of participants that had never sustained an ankle sprain. Although the primary interest was whether or not there was a difference between those with CAI and ankle sprain copers, the inclusion of the control group of uninjured participants was believed to be beneficial in determining whether or not there is a difference in patients with CAI and those without. The main findings of this study were that there was no statistically significant difference between average dorsiflexion AROM between coper, control, and CAI groups during a WBLT.

To our knowledge, this is one of the first studies to look at dorsiflexion AROM through the WBLT among coper, control, and CAI groups while previous studies (4, 5, 7, 16) only compared dorsiflexion AROM between the CAI group and a healthy population. A previous study (5), using similar methods, partially supports our dorsiflexion AROM results, which reported no differences between the healthy control and the CAI group. However, many of the previous studies (4, 7, 16) reported a significant decreased dorsiflexion AROM during landing, walking, and jogging in the CAI group compared to the healthy control group. The results from these previous studies indicate that individuals with CAI may experience limited dorsiflexion during dynamic and functional tasks such as landing, walking, and running, but may not during a static task, such as the WBLT. A previous study (22) reported that alternations in the central nervous system may be revealed during the dynamic movement and functional tasks in the CAI population, but alternations were not observed during the static task. Therefore, the static task assessment such as the WBLT may not be a proper assessment to compare dorsiflexion AROM between groups.

Previous researchers have found significantly less dorsiflexion ROM in individuals with CAI when compared to those without (4, 5, 17, 19, 23). However, these studies also did not examine the effects of rehabilitation on CAI. Cruz-Díaz et al. examined the effects of joint mobilization techniques to increase dorsiflexion ROM on levels of self-reported instability in patients with CAI (2). Results of this showed that performance of joint mobilizations significantly increased dorsiflexion ROM and improved scores on the CAIT in the CAI group compared to control and placebo groups ($p < 0.001$) (2).

In our results, the participants with CAI demonstrated greater dorsiflexion AROM than those in the coper group even though it was not statistically significant. A previous study (20) reported that the number of ankle sprains does not influence the joint laxity in the mechanical ROM measure. Although the CAI group experienced a greater number of ankle sprains than the coper group, this is not the cause of limited dorsiflexion.

One possibility for the current results could have been the participants' previous involvement in ankle rehabilitation following their ankle injury. Prior to dorsiflexion measurement, the participants completed a demographics page. One section of this demographic page asked the participants whether or not they completed formal rehabilitation following their ankle sprain, and if they had, to provide a brief explanation. Thirteen of the participants (5 coper, 8 CAI) reported having received formal rehabilitation from either an athletic trainer or a physical therapist, and 9 participants (5 coper, 4 CAI) reported that they had not. The majority of those that had reported they participated in formal rehabilitation appeared to have higher average dorsiflexion AROM measurements than those that did not.

The statistically insignificant findings in this study suggest an implication for additional research to further investigate whether or not there is a difference in dorsiflexion AROM through the dynamic and functional assessment and whether or not rehabilitation has an effect on patient classification between copers and CAI patients. This study also took place from a retrospective standpoint, attempting to examine whether or not established copers and CAI patients were limited in dorsiflexion AROM. However, it did not examine whether or not those with pre-existing limited dorsiflexion are predisposed to CAI following lateral ankle sprains.

The number of previous ankle sprains and experience of formal rehabilitation were not examined in the current study. These differences may lead to different dorsiflexion AROM. Further research could examine participants that had participated in previous formal rehabilitation, and those that had not, to determine whether or not dorsiflexion rehabilitation can prevent or reduce symptoms of CAI. Additionally, the relationship between the number of ankle sprains and dorsiflexion AROM among the groups needs to be investigated in future studies.

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