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Plantar Cutaneous Sensitivity With and Without Cognitive Loading in People With Chronic Ankle Instability, Copers, and Uninjured Controls

Lateral ankle sprains, while often considered an innocuous injury, represent a significant musculoskeletal health problem and financial burden on the health care system. Treatment and diagnostic health care costs for lateral ankle sprains were estimated to be around $2 billion in 1984, which is over $4.5 billion after an inflation adjustment for 2015.[27] Further, incidence rates have been reported to be as high as 2.15 for every 1000 person-years,[28] and lateral ankle sprains account for over half of all injuries reported during high school and intercollegiate sports in the United States alone.[10,15]

STUDY DESIGN: Controlled laboratory study.

BACKGROUND: Deficits in light touch have recently been identified on the plantar surface of the foot in those with chronic ankle instability (CAI) but not in uninjured controls. It is unknown whether copers display similar deficits. Similarly, cognitive loading has been shown to impact postural control in different populations, but it is unclear how it may impact sensory perception.

OBJECTIVES: To evaluate the difference in cutaneous sensation thresholds at rest and under cognitive loading, using Semmes-Weinstein monofilaments (SWMs), among uninjured controls, copers, and those with CAI.

METHODS: A total of 45 participants (mean ± SD age, 20.2 ± 2.8 years; height, 167.6 ± 9.9 cm; mass, 66.3 ± 14.7 kg) were recruited and categorized to a CAI, coper, or control group, based on Ankle Instability Instrument scores. Participants were assessed with SWMs for cutaneous thresholds using a 4-2-1 stepping algorithm at the head of the first metatarsal, base of the fifth metatarsal, calcaneus, and sinus tarsi. Each participant was then retested while generating random digits to the beat of a metronome in order to simulate cognitive loading.

RESULTS: Participants with CAI displayed significantly higher SWM thresholds at the head of the first metatarsal, base of the fifth metatarsal, and sinus tarsi than those of the control participants, and significantly higher thresholds at the base of the fifth metatarsal and calcaneus than those of copers (all, $P<.05$). Copers showed higher thresholds than those of controls at the sinus tarsi only ($P<.05$). A main effect of cognitive loading was identified at all 4 sites ($P<.05$).

CONCLUSION: People with CAI have deficits in plantar sensation relative to controls and copers. Cognitive loading increases plantar cutaneous sensation thresholds irrespective of CAI status.
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KEY WORDS: *deafferentation, dual-task interference, light touch, mechanoreceptor*

Unfortunately, a lateral ankle sprain often (reported rates of 30% to 75%) results in the development of chronic ankle instability (CAI).[1,31] The condition of CAI is defined by 2 hallmark characteristics: recurrent ankle sprains and complaints of instability or giving way.[31] The condition of CAI also limits an individual's ability to remain physically active. For example, college-aged individuals with CAI took nearly 25% fewer steps per day than their uninjured peers.[16]

One possible cause of CAI development is deafferentation, which was originally proposed 50 years ago.[11] It is thought that repetitive damage to the ankle ligaments, joint capsule, musculotendinous units, and skin may lead to sensorimotor constraints and ultimately to CAI.[19,20] More specifically, decreased sensory information is believed to impair the development of appropriate motor responses and the adaptability of the sensorimotor system, as evidenced by poor motor performance[5,21,22,30] and a predisposition to musculoskeletal injury,[20] which would further increase sensorimotor constraints.[19] Sensory insufficiencies (ie, increased detection thresholds) on the plantar surface of the foot have been identified in light-touch[25] and vibrotactile[14] stimuli in those with

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TABLE 1 GROUP DEMOGRAPHICS*

	Uninjured Controls (n = 15)	Copers (n = 15)	CAI (n = 15)
Age, y	20.27 ± 4.15	20.20 ± 2.08	20.13 ± 1.96
Height, cm	165.78 ± 8.34	167.13 ± 10.66	169.84 ± 10.64
Mass, kg	68.98 ± 21.51	64.05 ± 9.54	65.80 ± 10.60
Total sprains, n†	...	1.27 ± 0.59	2.27 ± 1.44
Giving-way episodes in the past 6 mo, n‡	...	...	3.87 ± 2.03
FAAM-ADL, %	100.00 ± 0.00	99.44 ± 1.34	88.85 ± 6.71
FAAM-sports, %	99.79 ± 0.81	97.92 ± 3.67	66.04 ± 22.16

Abbreviations: ADL, activities of daily living; CAI, chronic ankle instability; FAAM, Foot and Ankle Ability Measure.
**Values are mean ± SD.*
†The number of self-reported lateral ankle sprains.
‡Self-reported event of inversion instability at the ankle, typically with a reported sensation of the ankle giving way or rolling.

CAI relative to uninjured controls. Further, a moderate negative correlation between anterior/posterior time-to-boundary postural control measures and the Semmes-Weinstein monofilament (SWM) light-touch threshold at the base of the fifth metatarsal (5MT) suggests a relationship between higher light-touch thresholds and decreased control of posture in the sagittal plane.[25] However, the sensory insufficiencies (or lack thereof) in copers, those who have sprained their ankle but failed to develop CAI, remain unknown. Investigating copers could provide greater insight into the potential mechanisms of CAI development than a traditional comparison of those with CAI to uninjured controls because of the common injury history shared by copers and those with CAI.[19,29]

Recent research has also questioned the role of cognition, tested via dual-task paradigms, in the development of CAI. Dual-task studies on postural control typically involve a systematic investigation of individual cognitive and postural task performance relative to performance when the tasks are performed simultaneously. These investigations provide insight into the amount of cortical attention required to complete a postural task within a given population. For example, Rahnama et al[26] found that a serial recall task negatively affected the overall postural stability in athletes with CAI, suggesting that more neural resources are required for maintenance of static balance in this population. However, conflicting data do exist, as some researchers have reported deficits while dual tasking[13,26] and others have not.[3] To date, no investigation has examined the impact of cognitive loading (COG) on sensory performance in those with CAI or copers.

The primary aim of this investigation was to utilize SWM to compare light-touch thresholds on the plantar surface of the foot (head of the first metatarsal [1MT], 5MT, calcaneus [CAL]) and over the lateral ligaments (sinus tarsi [ST]) among controls, copers, and those with CAI. The secondary aim of this investigation was to characterize the effects of COG on light-touch thresholds among controls, copers, and those with CAI, to provide insight into the attentional demands of sensory perception among the groups. Based on the existing literature,[14,25] we hypothesized that SWM thresholds would be higher in those with CAI relative to both controls and copers. For our secondary aim, we hypothesized that COG would result in an increase in SWM thresholds in those with CAI but not in copers or controls. Finally, the relationship between SWM thresholds and self-reported disability in those with CAI was assessed.

METHODS

A total of 45 physically active volunteers (mean ± SD age, 20.2 ± 2.8 years; height, 167.6 ± 9.9 cm; mass, 66.3 ± 14.7 kg) were recruited for this investigation from the student body of a large public university (**TABLE 1**). Potential participants were screened for eligibility of membership in 1 of 3 groups of 15 participants: uninjured controls, copers, and those with CAI. Recruitment was conducted as a convenience sample of young, physically active adults and ceased once 15 eligible participants per group were tested. In this investigation, controls were defined as individuals having no history of ankle sprain, instability, or disability as measured by the Ankle Instability Instrument (AII)[8] and the Foot and Ankle Ability Measure[4] activities of daily living (FAAM-ADL) and sports (FAAM-sports) subscales. Specifically, control participants were required to have 0 answers of yes on the AII and disability scores no lower than 99% on the FAAM-ADL and 97% on the FAAM-sports.[24,34] Copers were defined as individuals who answered yes to no more than 3 questions on the AII, a maximum of 2 previous ankle sprains with at least 12 months since the most recent sprain, 0 episodes of the ankle giving way within the past 6 months, and disability scores no lower than 99% on the FAAM-ADL and 97% on the FAAM-sports.[29] Chronic ankle instability was defined as those individuals who (1) experienced at least 2 lateral ankle sprains in the past, (2) experienced at least 1 episode of giving way within the past 6 months, and (3) answered yes on 4 or more questions on the AII. Although FAAM-ADL and FAAM-sports scores were recorded for those with CAI, they were not used as inclusion criteria, as a specific amount of self-assessed disability was not required to achieve the objectives of the study.[12] While this investigation was initiated prior to the publication of the International Ankle Consortium recommendations, the criteria used are in line with the recommendations.[12] If an individual had bilateral instability, the limb with the lower FAAM-sports score defined the test limb.[12] The FAAM-ADL and FAAM-sports assess self-reported disability as it pertains to foot and ankle function and have been shown to be reliable (FAAM-ADL intraclass correlation coefficient [$ICC_{2,1}$] = 0.89; FAAM-sports $ICC_{2,1}$ = 0.87)[18] and valid measures of functional disability in those with CAI.[4,12] Exclusion criteria included known balance and vision problems, acute lower extremity and head injuries (less than 6 weeks), chronic musculoskeletal conditions known to affect balance (eg, anterior cruciate ligament deficiency), a history of lower extremity surgeries to fix internal derangements, and any conditions affecting cutaneous sensory function (eg, diabetes). The rights of all participants were protected, including confidentiality of data. This investigation was approved by the Institutional Review Board at the University of North Carolina at Charlotte.

Following the provision of informed consent, demographics were collected from participants, including age, height, and mass. Then, participants were asked to remove their shoes and socks, and the testing sites were palpated and marked with indelible ink. These marks remained present throughout the entire test session to ensure stability of measurement location during threshold testing. Cutaneous sensation was evaluated at 4 sites in the foot-ankle complex: 1MT, 5MT, and CAL, as previously described,[25] and at the ST.[24] The CAL was defined as the anterior-most point of the tuber calcanei on the plantar surface of the heel (ie, midpoint of the heel pad). The ST was defined as the midpoint of the skin overlying the bony landmark just inferior to the anterior talofibular ligament, identified through palpation by an athletic trainer with 4 years of experience. All sensory testing was performed in a controlled laboratory setting on the test limb.

TABLE 2 Semmes-Weinstein Monofilament Light-Touch Thresholds*

	Uninjured Controls (n = 15)	Copers (n = 15)	CAI (n = 15)
Baseline, 1MT	3.22 (2.83-3.61)	3.61 (2.83-3.61)	3.61 (3.22-4.08)†
Cognitive loading, 1MT‡	3.61 (2.83-3.61)†	3.61 (2.83-3.61)	3.61 (3.22-4.17)
Baseline, 5MT	3.22 (2.83-3.61)	3.22 (2.83-3.61)	3.61 (3.61-3.84)†§
Cognitive loading, 5MT‡	3.61 (2.83-3.61)†	3.61 (2.83-3.61)§	3.61 (3.22-4.08)
Baseline, CAL	3.61 (3.61-4.08)	3.61 (3.61-3.84)‖	4.17 (3.61-4.17)§
Cognitive loading, CAL‡	3.61 (3.61-4.17)	3.61 (3.61-3.84)	4.17 (3.61-4.17)
Baseline, ST	3.22 (2.83-3.84)	3.84 (3.61-3.84)†	4.08 (3.84-4.17)†
Cognitive loading, ST‡	3.61 (3.22-4.08)†	3.84 (3.61-4.08)§¶	4.08 (3.84-4.31)¶

Abbreviations: 1MT, head of the first metatarsal; 5MT, base of the fifth metatarsal; CAI, chronic ankle instability; CAL, calcaneus; ST, sinus tarsi.
**Values are median (first-third quartile) Semmes-Weinstein monofilament index number.*
†Significant difference from the control group baseline value.
‡Significant main effect of testing condition.
§Significant difference from the coper group baseline value.
‖Significant difference from the CAI group baseline value.
¶Significant difference between the baseline (no cognitive loading) and cognitive loading conditions.

Light-touch threshold was evaluated using a set of 20 clinically calibrated SWMs (Touch Test Sensory Evaluators; North Coast Medical Inc, Gilroy, CA). Each SWM had an index number (1.65, 2.36, 2.44, 2.83, 3.22, 3.61, 3.84, 4.08, 4.17, 4.31, 4.56, 4.74, 4.93, 5.07, 5.18, 5.46, 5.88, 6.10, 6.45, and 6.65) that was associated with a calibrated breaking force (ie, index 3.61 is the equivalent of 0.4 *g* of force). During testing, the SWM was applied perpendicularly to the skin at the marked site and pressure was applied until the nylon SWM bent to form a *C* shape and was held for 1 second, meaning the calibrated force was applied to the skin.[24,25] Once a participant was prepared for testing, the participant was given an example of the test stimulus on the forearm using a large-diameter SWM (4.56). During testing, participants were instructed to say "yes" every time they perceived a feeling of the SWM at one of the testing sites. Each participant was tested in a prone position, with the anterior surface of the shin supported by a standard treatment table and the foot in a relaxed position.[25] Participants were asked to remain as still as possible during testing and wore noise-canceling headphones to minimize the distraction of the investigator manipulating the SWM.[25] Light-touch thresholds were systematically evaluated using a 4-2-1 stepping algorithm as previously reported.[9,25] In brief, testing began at a set point for all participants (4.74), and then SWMs were moved up or down in index value by increments of 4, 2, and 1.[9,25] Increments (4, 2, or 1) were reduced each time 3 consecutive reversals occurred between the 2 monofilament values (eg, 3 positive sensations of SWM 4.74 and 3 negative sensations of SWM 4.08).[9,25] The SWM application occurred every few seconds to eliminate any potential for the subject to predict stimuli. The last detected SWM was used as the threshold for that site.[25] The sites were tested one at a time in each participant, in an order chosen at random by the investigator.

Following baseline testing, SWM thresholds were evaluated under a COG condition. In the COG condition, participants were asked to generate a random digit from 0 to 9 to the beat of a metronome set at 1 Hz, as previously de-

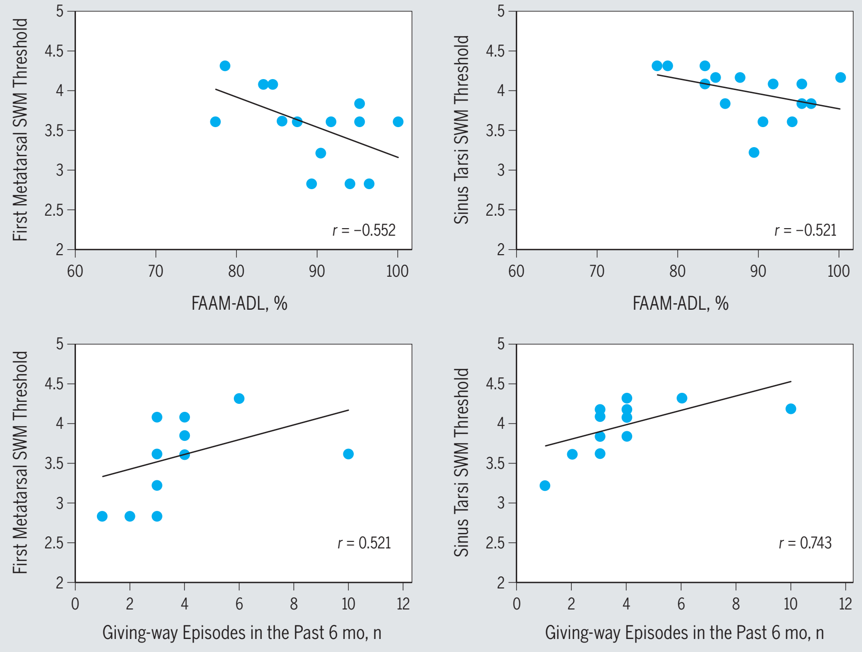

FIGURE. Significant correlations between measures of self-reported disability or recurring injury and SWM thresholds. "Giving way" is defined as the sensation or perception of the ankle rolling inward or feeling unstable. Abbreviations: ADL, activities of daily living; FAAM, Foot and Ankle Ability Measure; SWM, Semmes-Weinstein monofilament.

scribed.[3,6] This task was selected because it has previously been shown to alter postural control responses[3,6] and is thought to stress the central executive aspect of working memory.[2] In brief, participants would verbalize a random digit at 1 Hz, stopping only to acknowledge the perception of the monofilament on the foot/ankle. Patterns in the digit response (eg, 5-5-5-5-5 or phone numbers with local area codes) were not allowed, to standardize the cognitive load as much as possible. If patterns were detected, the testing was stopped and the participant was instructed on how to properly proceed. Application of SWMs occurred at various times during this test condition (ie, on or between the beat of the metronome). During COG, each site was tested in a random order for each participant using the same 4-2-1 stepping algorithm as described earlier. Participants were given a brief 30-second break between testing sites during both the baseline and COG conditions in order to minimize mental fatigue.

Due to the lack of uniform intervals between SWMs, data were treated as ordinal and analyzed using a nonparametric analysis. The Kruskal-Wallis *H* test was used to identify group main effects in SWM thresholds for both baseline and COG conditions at each of the 4 sites. Once group main effects were identified, Mann-Whitney *U* tests for both the baseline and COG data were used to determine which groups were different from each other at each site under each condition, as previously described.[25] To determine differences between the baseline and COG conditions, data from both conditions at each site were analyzed using separate Friedman tests for all subjects and then for each group. Spearman correlations were also calculated among all outcome measures, including baseline SWM thresholds, FAAM-ADL/FAAM-sports scores, number of sprains, and number of giving-way episodes in the past 6 months for those with CAI. The homogeneity of the self-reported disability measures for the control group and coper group resulted in a violation of test assumptions; therefore, no correlations were conducted on these data. All statistical analyses were conducted using SPSS Version 21 (IBM Corporation, Armonk, NY), and an alpha level of .05 was used for all tests.

RESULTS

Medians and the first and third quartiles for SWM thresholds are reported in **TABLE 2**. A significant main effect for group was detected for baseline SWM thresholds at the 1MT (χ^2 = 6.392, P = .041), 5MT (χ^2 = 7.974, P = .019), CAL (χ^2 = 6.749, P = .034), and ST (χ^2 = 12.660, P = .002). Specifically, significantly higher thresholds in those with CAI relative to controls were observed during baseline testing at the 1MT, 5MT, and ST. Similarly, the CAI group had higher thresholds at the ST during COG relative to controls (**TABLE 2**). Relative to copers, those with CAI had higher baseline SWM thresholds at the 5MT and CAL. A significant main effect for group was detected at the ST during COG (χ^2 = 9.966, P = .007). Copers, relative to the control group, had significantly higher ST thresholds during baseline and COG conditions.

Pooled differences between test conditions revealed overall higher SWM thresholds during COG relative to baseline at the 1MT (χ^2 = 5.762, P = .016), 5MT (χ^2 = 7.200, P = .007), CAL (χ^2 = 4.000, P = .046), and ST (χ^2 = 11.560, P = .001). Between test conditions, the control group had higher baseline SWM thresholds at the 1MT, 5MT, and ST, while the coper group had significantly higher baseline thresholds at the 5MT and ST (**TABLE 2**). However, no significant differences were identified between testing conditions for the CAI group at any site.

In the CAI group, significant correlations (**FIGURE**) were identified between the following measures: FAAM-ADL and baseline 1MT (r = −0.552, P = .033), FAAM-ADL and baseline ST (r = −0.521, P = .046), number of giving-way episodes or "rolls" in the past 6 months and baseline 1MT (r = 0.521, P = .047), and number of giving-way episodes or rolls in the past 6 months and baseline ST (r = 0.743, P = .002).

DISCUSSION

In this investigation, we assessed SWM light-touch thresholds at previously investigated sites on the sole of the foot[25] and the ST[24] among 3 different groups: uninjured controls, copers, and those with CAI. The primary results of this investigation indicate that those with CAI had higher SWM thresholds (ie, more force was required for sensation) at the 1MT and ST relative to controls and at the 5MT compared to both copers and controls (**TABLE 2**). Copers also exhibited higher SWM thresholds at the ST relative to controls. The pooled results also indicate that COG negatively impacts SWM thresholds; however, these results were not uniform across groups, as the controls had significantly higher thresholds at 3 of 4 sites and copers at 2 of 4 sites, while thresholds of those with CAI did not change. Perhaps most importantly, correlation results suggest that increased cutaneous thresholds may play a role in decreased function in those with CAI (**FIGURE**).

The CAI-specific results are consistent with the existing evidence of plantar sensory dysfunction in those with CAI.[14,25] Specifically, this investigation was able to replicate a significant portion of the results reported by Powell et al[25] on SWM threshold and postural control deficits in those with CAI. Utilizing the 4-2-1 stepping algorithm, Powell et al[25] identified significantly higher SWM thresholds at the 1MT (median, 4.08), 5MT (median, 4.31), and CAL (median, 4.56) in the CAI group relative to controls, while the present study was able to identify group differences at the 1MT, 5MT, and ST. However, our results at the CAL differ from those reported by Powell et al,[25] which may be due to differences in the number of giving-way episodes experienced by the current (mean, 3.87) versus previous (8.14) participant samples. Our results are also contrary to those of Plante and Wikstrom,[24] who failed to identify any significant differences among copers, controls, and those with CAI in SWM threshold at the ST, despite having a similar average number of giving-way episodes (mean, 4.0) to that of the current investigation. These conflicting results may be due to methodological differences between these 2 studies. Plante and Wikstrom[24] used a set of 6 SWMs, as opposed to the more sensitive set of 20 used in the current investigation, and threshold was determined using a sequential application technique, as opposed to the 4-2-1 stepping algorithm. Thus, we recommend that future research investigating mechanoreceptor thresholds in those with a history of ankle sprains use the most robust methodology possible (eg, larger sets of SWMs and the 4-2-1 stepping algorithm). Unfortunately, given the retrospective design of all these investigations, it is impossible to determine whether the identified deficits in those with CAI and in copers existed before the lateral ankle trauma occurred.

The current study also provided 2 important observations regarding the plantar cutaneous sensory function of copers relative to either those with CAI or uninjured controls. First, all subjects with a history of at least 1 lateral ankle sprain (copers and those with CAI) displayed significantly higher SWM thresholds at the ST relative to uninjured controls. This, while speculative, may suggest that the initial mechanism of injury to the lateral ankle resulted in mechanical damage to the local cutaneous mechanoreceptors or sensory tracts of the tibial and/or common peroneal nerve. Our hypothesis is based on the common injury history that both copers and those with CAI had previously sustained, and is in line with similar hypotheses reported in the literature.[29,33] Similarly, those with CAI had higher SWM thresholds relative to copers at the 5MT, which may suggest that recurrent sprains further decrease cutaneous sensation on the lateral aspect of the foot. Decreased 5MT sensation may be partially responsible for the more inverted position observed in those with CAI during walking and running gait.[5,7,21] This inverted position would increase the amount of pressure under the lateral aspect of the foot, which has been observed in those with CAI. Increased pressure could then potentially permit lateral plantar mechanoreceptors to provide sensory feedback earlier during weight acceptance. Unfortunately, such a compensation could also increase the risk for recurrent sprains. If true, these series of adaptations could represent a portion of the cascade of events proposed by Wikstrom and Brown,[29] but further research is needed to test this hypothesis. It has also been shown that a more serious ankle sprain (grade III versus grade II) has an increased prevalence of dysfunction in sensory nerve conduction.[23] Unfortunately, the current investigation failed to account for the initial grade of the ankle sprain, which should be an area of future research.

Cognitive loading is an important tool that is often used in sensorimotor research to test the capacity and relative attentional demands of the sensorimotor system. Yet, to date, a limited number of investigations have evaluated those with a history of ankle sprains using this experimental setup, and those studies have shown conflicting results.[3,13,26] It is important to note that the present investigation cannot be classified as a dual-task experiment for 2 reasons. First, both of the included tasks require working memory and therefore attention.[2] Second, the performance of the random number–generation task was not recorded and objectively analyzed as previously reported.[3,7] One potential explanation for the subtle group differences under COG is a ceiling effect with regard to cutaneous sensation around the foot and ankle. More specifically, the high baseline SWM threshold scores for those with CAI might have dramatically reduced any possible interference that

COG could have caused. For example, a higher-index SWM would require more force to break into a *C* shape, thus there would be a greater potential for overlapping receptive fields[17] to be activated, as the higher force would dissipate over a larger area once the skin was indented. Therefore, the intensity of the stimulus would activate multiple receptive fields, making it easier to identify the stimulus, even when the attentive systems were loaded through random-number generation. It may also be possible that the concentration required to detect SWM application maximally loaded the attentional capacity of those with CAI, thus negating the effects of additional loads. Given the mixed results within the CAI and COG literature, this possibility seems unlikely, but additional research is needed.[3,13,26] The results do suggest that the attentional capacity and/or sensory capabilities of copers are similar to those of controls, as these groups responded in a similar manner. However, the present investigation did not test the attentional capacity of these groups, so it is not possible to identify a mechanism for the observations regarding COG. Future investigations should systematically evaluate and observe the effects of COG and/or dual tasking on sensorimotor function in cross-sectional studies that include copers. Such investigations would be able to provide the scaffolding for the functional attentional demands and limitations of the sensorimotor system in populations with a history of lateral ankle sprain.

Cumulatively, it has been established that those with CAI have deficits in cutaneous sensory function on the sole of the foot.[14,25] However, it remains unknown how to treat these sensory deficits. LeClaire and Wikstrom[17] were able to improve force platform–derived measures of postural control following a single, 5-minute plantar massage consisting of a nonspecific combination of effleurage and light petrissage. More recent work by Wikstrom and McKeon[32] was able to show improvements in postural control and self-assessed disability after receiving a total of 6 plantar massage treatments over a 2-week period. While it might be possible that the massage treatment lowered cutaneous thresholds (ie, improved sensory function), neither investigation assessed sensory function, so it is impossible to determine whether the postural control improvements were due to improved sensory function or another mechanism. Future research is needed to characterize the sensory benefits of plantar massage and other commonly used therapeutic interventions. As hinted by Powell et al,[25] the clinical ease of use of SWM should not be overlooked, and may allow for a clinician to quantify progress in recovery from injury. Along these lines, it would be wise to include SWM thresholds in prospective studies following recovery from an acute lateral ankle sprain to determine their clinical utility in monitoring recovery and their potential in predicting long-term outcomes.

There are several limitations that should be considered when interpreting our results. The primary goal of this investigation was to characterize sensory dysfunction between groups; however, no measures of postural control or motor performance were measured, so it is unclear whether the observed group differences in sensory function reflect motor impairments.[25] It should also be noted that while some inference can be made for an individual case based on the current group data, some overlap among the groups does exist. Therefore, future research should examine the individual change in relative risk (sensitivity/specificity) or prognostic value of monofilament scores in those with CAI. Our testing was performed in a prone, non–weight-bearing position, so it is also hard to determine whether these increased SWM thresholds have any relationship to weight-bearing sensorimotor function in our subjects, but increased thresholds were correlated to greater levels of disability in those with CAI. Finally, the investigator was not blind to group assignment, and this may have resulted in unintentional bias.

CONCLUSION

This investigation was able to support previous research[25] that identified significantly higher plantar cutaneous mechanoreceptor thresholds in those with CAI relative to uninjured controls. Additionally, we were able to provide evidence that individuals with a history of lateral ankle sprain (copers and those with CAI) have significantly higher SWM thresholds over the ST contrasted against uninjured controls, while copers appear to behave similar to uninjured controls on the plantar aspect of the foot. Cognitive loading also increases cutaneous thresholds. ◉

KEY POINTS

FINDINGS: Deficits in plantar cutaneous sensation are present in those with CAI relative to both copers and uninjured controls. Cognitive loading negatively impacts cutaneous thresholds.

IMPLICATIONS: Moderate correlations between increased plantar cutaneous sensation thresholds and measures of function in those with CAI may suggest that sensory deficits contribute to the continuum of sensorimotor dysfunction observed in those with CAI and should be investigated further as potential targets for therapeutic interventions.

CAUTION: Due to the retrospective design and lack of motor performance testing, it is not possible to attribute causality or determine the relationship between higher thresholds and motor performance.

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