



Original research

Locomotive biomechanics in persons with chronic ankle instability and lateral ankle sprain copers



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ABSTRACT

Objectives: To compare the locomotive biomechanics of participants with chronic ankle instability (CAI) to those of lateral ankle sprain (LAS) copers.

Design: Cross-sectional study.

Methods: Twenty-eight participants with CAI and 42 LAS copers each performed 5 self-selected paced gait trials. 3-D lower extremity temporal kinematic and kinetic data were collected for these participants from 200 ms pre- to 200 ms post-heel strike (period 1) and from 200 ms pre- to 200 ms post-toe off (period 2). **Results:** The CAI group displayed increased hip flexion bilaterally during period 1 compared to LAS copers. During period 2, CAI participants exhibited reduced hip extension bilaterally, increased knee flexion bilaterally and increased ankle inversion on the 'involved' limb. They also displayed a bilateral decrease in the flexor moment pattern at the knee.

Conclusions: Considering that all of the features which distinguished CAI participants from LAS copers were also evident in our previously published research (within 2-weeks following acute first-time LAS); these findings establish a potential link between these features and long-term outcome following first-time LAS. Clinicians must be cognizant of the capacity for these movement and motor control impairments to cascade proximally from the injured joint up the kinetic chain and recognise the value that gait re-training may have in rehabilitation planning to prevent CAI.

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1. Introduction

It has been posited that the high potential for recurrence following an initial lateral ankle sprain (LAS) injury during gait is predicated by inappropriate positioning of the lower extremity joints in the loading-unloading transitions between stance and swing.^{1,3,4} These patterns materialise immediately following the injury,⁵ and may persist into chronicity.⁶

Chronic ankle instability (CAI) is the name given to the cluster of chronic symptoms that may develop following an initial LAS, with ankle joint instability and LAS recurrence residing at the epicentre of this injury's chronic paradigm.⁷ During walking gait, laboratory analyses have revealed that individuals with CAI exhibit a more

inverted position of the foot at heel strike (HS)² and toe-off (TO),¹ as well as an increased rate of change in inversion over the course of the former event,¹ compared to non-injured controls. In other research, it has been documented that individuals with CAI also exhibit increased ankle joint plantar flexion around HS and TO compared to non-injured controls.^{3,4}

Recently however the value of comparing or matching a non-injured control to an individual with CAI has been questioned as the former does not possess the same injury exposure, thus undermining their suitability for such analyses.⁸ This is of particular pertinence in light of the availability of a more appropriate comparison group: those individuals who sustain a LAS but do not develop the chronic sequelae of CAI (herein referred to as LAS copers).⁸ Such a comparison would provide added insight as to the 'coping mechanisms' of gait motor control and movement that preside long-term outcome following acute LAS.⁹ A recent position-statement by the International Ankle Consortium (IAC) has advocated the need for

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Table 1
Participant anthropometrics, self-reported disability and function questionnaire scores (mean and 95% CI) for the involved limb of CAI and LAS copers groups.

Anthropometrics:		Questionnaires									
		Age (years)		Body mass (kg)		Height (m)		CAIT (/30)		FAAMadl (%)	
Gender	Females	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
n	Males										

CAI = chronic ankle instability; LAS = lateral ankle sprain; CAIT = Cumberland ankle instability tool; FAAMadl = activities of daily living subscale of the foot and ankle ability measure; FAAMsport = sport subscale of the foot and ankle ability measure. CI = confidence interval.

this comparison,⁷ while Wikstrom and Brown¹⁰ have outlined the necessary inclusionary criteria for a LAS coper group.

A number of publications comparing individuals with CAI to LAS copers during components of the gait cycle have recently been published.^{11,12} De Ridder et al.¹¹ delineated different components of motion at the 'involved' (previously sprained) foot-ankle complex using a multi-segmental model and recorded no differences between CAI participants and LAS copers during the stance phase of gait. Brown et al.¹² in an analysis which included both ankle and knee motion, observed a reduction in joint angular displacement at the ankle in the sagittal plane in CAI participants compared to LAS copers during walking. These analyses combine to advance current understanding of the emergent movement and motor control patterns belying CAI or LAS coper status. However, the LAS copers recruited for these studies were not defined according to recently published recommendations.¹⁰ Thus, we believe there is significant potential for expansion on these constructs with the use of a bilateral model of kinematic and kinetic parameters to evaluate participants with CAI in comparison to LAS copers around HS and TO.

Therefore, the aim of the current study was to perform an exploratory analysis of the locomotive kinematic and kinetic profiles of participants with CAI and those of a LAS coper group 1-year following first-time LAS injury.

2. Methods

All participants were recruited from a University affiliated hospital emergency department within 2-weeks of sustaining a first-time, acute LAS injury. Twelve months following recruitment, 83% (seventy-one) of the original eighty-six participants attended our laboratory to complete the current test protocol. Data has previously been published detailing an evaluation of these participants within 2-weeks⁵ of recruitment completing the same protocol. The participant exclusion criteria have previously been described.⁵ Furthermore, to be included in the study, participants must have reported to partake in a minimum of 1.5 h of physical activity per week.

Self-reported ankle instability was assessed for all participants on arrival to the laboratory prior to completion of the current test protocol with the Cumberland Ankle Instability Tool (CAIT);¹³ individuals with a score of <24 were designated as having CAI⁷ while participants with a score ≥24 were designated as LAS copers in the avoidance of false positives for this group.¹⁴ To be designated as a LAS coper, participants also must have reported to have returned to pre-injury levels of activity and function, with no injury recurrence.¹⁰ Second, the activities of daily living and sports subscales of the Foot and Ankle Ability Measure (FAAMadl and FAAMsport) were utilised as a means to evaluate the level of self-reported disability, but was not used as an inclusion criterion for either group.

Based on the CAIT, twenty-eight participants were designated as having CAI, and forty-two as LAS copers. One participant was excluded from the original group of seventy-one because they scored ≥24 on the CAIT but reported having not returned to pre-injury levels of sport participation. Participant characteristics and questionnaire scores are presented for the seventy included individuals in Table 1. Participants provided written informed consent, and the study was approved by the University's Human Research Ethics Committee.

Collection methods for this study have been previously documented.⁵ Briefly, gait data acquisition was made using 3 Codamotion cx1 units (Charnwood Dynamics Ltd, Leicestershire, UK). The Codamotion cx1 units were fully integrated with two AMTI walkway embedded force plates (Watertown, MA) and time

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