

Discriminating Between Copers and those with Chronic Ankle Instability with Clinical Outcomes

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Introduction: Chronic ankle instability (CAI) is a common consequence of lateral ankle sprains and a leading cause of post-traumatic ankle osteoarthritis. Despite a history of a lateral ankle sprain, there are some individuals (copers) who appear to have a mechanism that allows them to avoid recurrent lateral ankle sprains and giving way episodes. To date, research has identified differences in perceptual (e.g. self-assessed disability), mechanical (e.g. ligament laxity), and sensorimotor (e.g. balance) outcomes between copers and those with CAI. However, the vast majority of these outcomes are considered research and/or laboratory based and thus impractical for most clinicians to use on a daily basis. The identification of clinical tools, capable of discriminating between copers and those with CAI is the first step in developing an accurate clinical battery of tests that can be used to predict patients more likely to develop CAI after an initial lateral ankle sprain. Therefore, the purpose of this investigation was to establish the ability of clinical outcome measures to discriminate between copers and those with CAI.

Methods:

Participants- A total of 46 participants (21 copers and 25 with CAI) were enrolled and completed the investigation. All participants read and signed the university approved informed consent document prior to participation. All subjects were between the ages of 18-30 and participated in recreational activity for at least 90 minutes each week. Copers and those with CAI had a history of at least one moderate to severe ankle sprain that required acute care. Copers resumed all pre-injury activity without limitation and without recurrent episodes of injury/giving way for at least 12 months prior to testing and scored >24 on the ankle joint functional assessment tool (AJFAT). In comparison, those with CAI had at least one recurrent sprain within 6 months of testing and scored <20 on the AJFAT.

Protocol: Perceptual outcomes, the Foot Ankle Ability Measure (FAAM) and FAAM Sport (FAAM-S) were completed first. These questionnaires determine a subject's self-assessed limitations during daily and physical activities and lower scores represent greater disability. Next, mechanical adaptations were assessed via the the weight bearing lunge test (WBLT) and talar glide test. The WBLT measured ankle dorsiflexion range of motion using a modified lunge technique. Maximum dorsiflexion was defined as the furthest distance the subject's foot could be from a wall while the subject's knee was in contact with the wall and the subject's heel was flat on the ground. The talar glide test measures the magnitude of the talus' posterior glide by measuring the change in passive knee flexion, from 90°, while an examiner simultaneously pushes the talus posteriorly and pulls the foot into dorsiflexion until the point of capsular restriction. Finally, sensorimotor dysfunction was assessed with the Star Excursion Balance Test (SEBT) and isometric strength testing. The SEBT is a measure of dynamic postural control and measures the distance a subject can reach with their contralateral leg without losing their balance. Reach distance was defined as the farthest point that an individual could touch without accepting weight on their reach leg and maintaining balance through the return to a bilateral stance. Reach distance was normalized to each subject's leg length. Using a handheld

dynamometer, ankle dorsiflexion, plantar flexion, eversion, and inversion strength was assessed during 3-second maximal contractions. Strength was normalized to a subject's body weight. Statistical Analysis: Group differences in perceptual, mechanical, and sensorimotor outcomes were assessed with independent sample t-tests. If significance was achieved, the ability of an outcome to accurately discriminate between the groups was then assessed using the area under the curve (AUC) for receiver operating characteristic (ROC) curves. A ROC curve illustrates the "trade-off" between sensitivity and specificity throughout a measure's entire range of values. Finally, clinical meaningfulness was established by the calculation of cut-off scores and likelihood ratios for outcomes that successfully discriminated between copers and those with CAI. A traditional level of significance ($\alpha=0.05$) was used for all analyses.

RESULTS: The CAI group had significant perceptual and sensorimotor deficits relative to the coper group. Specifically, FAAM (Coper: 99.0±2.5%, CAI: 89.2±9.5%), FAAM-S (Coper: 96.6±4.1%, CAI: 79.3±16.2%), normalized posteromedial SEBT reach distance (Coper: 91.2±8.1%, CAI: 83.5±6.5%), and normalized dorsiflexion strength (Coper: 74.5±19.9%, CAI: 62.9±12.8%) were lower in those with CAI relative to copers. The secondary analysis revealed that the FAAM ($P<0.01$), FAAM-S ($p<0.01$), and posteromedial SEBT reach distance ($p<0.01$) accurately discriminated between copers and those with CAI. The AUC scores, cut-off scores, and likelihood ratios can be seen in the table below. No differences existed with regards to talar glide, range of motion, anterior SEBT reach, posteriolateral SEBT reach, and normalized eversion, inversion, or plantar flexion strength.

Outcome Measure Category	AUC	Cut-off Score	Likelihood Ratios (95% Confidence Intervals)	
			Positive	Negative
FAAM	0.93	99%	5.05 (2.92 to 10.36)	0.05 (0.01 to 0.21)
FAAM-S	0.90	88%	31.00 (4.42 to 217.67)	0.33 (0.22 to 0.51)
Posteromedial SEBT Reach	0.79	89%	2.53 (1.77 to 3.79)	0.06 (0.02 to 0.27)

DISCUSSION: The results of this investigation indicate that perceptual (FAAM, FAAM-S) and some sensorimotor outcomes (posteromedial SEBT reach distance) can discriminate between copers and those with CAI. We hypothesize that these outcome measures represent part of the mechanism that 1) allows copers to function as if uninjured and 2) is absent in individuals who develop CAI. The current results, using clinical outcome measures, support previous findings that have illustrated perceptual and sensorimotor deficits using research and/or laboratory based outcomes. Further, because a variety of the current outcomes (perceptual and sensorimotor) successfully discriminated between copers and those with CAI, groups, the current findings support the theory that the causal mechanism of CAI is multi-factorial in nature. However, the most important finding of the current investigation is that the perceptual outcomes demonstrated the greatest ability to discriminate between copers and those with CAI with accuracy point estimates ranging from 0.90-0.93. Indeed, the perceptual outcomes (as a whole) demonstrated higher AUC estimates and positive likelihood ratios, as well as lower negative likelihood ratios compared with the sensorimotor outcomes (as a whole). This finding, which supports previous results, indicates that perceptual outcomes have the greatest ability to accurately predict those who became copers after initial lateral ankle sprain. Given the magnitude of the positive and negative likelihood ratios, we believe that perception based outcomes, such as the FAAM and FAAM-S, should be used in future longitudinal research investigations designed to determine if

and when, post-injury, these outcomes can predict who will develop CAI after an initial lateral ankle sprain.