Microneurographic Evaluation of Afferent Deficits in the Unstable Ankle during Anterior Loading and Inversion Stress

Needle AR, Swanik CB, Farquhar WB, Thomas SJ, Kaminski TW: Athletic Training Research Laboratory, University of Delaware, Newark, DE

Context: Ankle sprains are very common in athletics, accounting for nearly 15% of all injuries. A debilitating condition, ankle instability, develops in 30 to 80 percent of persons suffering ankle sprains, and is associated with repeated, unanticipated episodes of “giving way” or “rolling.” The presupposed relationship between mechanical laxity and ankle instability has been inconclusive suggesting the cause for instability may not be structural, but insufficient sensorimotor function and dynamic restraint. An alternate theory for the development of ankle instability involves deafferentation of the peripheral mechanoreceptors, resulting in decreased afferent traffic and loss of sensation. However, direct evidence confirming isolated peripheral sensory deficits has been elusive because previous research relied upon subjective perceptions of ankle proprioception or kinesthesia. Objective: The purpose of this study was to explore the relationship between mechanical laxity, instability, and sensation by simultaneously measuring peripheral afferent nerve traffic, joint loading and motion in a comparison between healthy ankles and those with reported instability. Setting: Human Performance Laboratory. Participants: Recordings were obtained on 29 subjects stratified into a healthy control group (C, 19 subjects, 21±2.3yrs, 172.8±9.4cm, 75.4±13.1kg) or ankle instability group (AI, 10 subjects, 20.6±2.1yrs, 173.7±8.1cm, 72.7±12.3kg) based on scores of the Cumberland Ankle Instability Tool (C: 29.4±8, AI 17.4±5.5). Interventions: The independent variables were group, and levels of force, torque, displacement and rotation. Sensory traffic from muscle spindle afferents in the peroneal nerve was recorded using microneurography while anterior translation (AP) and inversion rotation (IE) stress was applied to the ligamentous structures utilizing a customized instrumented ankle arthrometer. Main Outcome Measures: The dependent variables were amplitude of afferent traffic (%) and mechanical laxity (mm or deg) determined at 0, 30, 60, 90, and 125 N of AP force; and 0, 1, 2, 3, and 4 Nm of IE torque. Two-factor repeated-measure analyses of variance were used to compare laxity and afferent amplitude at the predetermined levels of force and torque between HA and AI groups. Results: No differences in mechanical laxity were seen between healthy and unstable ankles (C: 8.3±2.4mm, AI: 7.2±2.0mm, p>.05). Afferent traffic increased significantly with increased force, torque, translation and rotation (p<.001). The AI group displayed a decrease in afferent activity at 30 N of anterior force compared to the control group (C: 30.2±9.9%, AI: 17.1±16.1, p<.05). Conclusions: The amplitude of peripheral afferent traffic does increase simultaneously with greater ankle motion and loading, supporting the integrated sensory role of capsuloligamentous and musculotendinous mechanoreceptors in maintaining joint stability. However, unstable ankles had diminished afferent traffic at low levels of force suggesting that the early detection of joint loading may be compromised. This impairment may delay or modify the appropriate sensorimotor responses necessary for dynamic stability and alter cognitive appreciation of an impending “rollover” event. Word Count: 449