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A Novel Method for Measurement of Ankle Joint Reaction Force and Response to Syndesmotic Injury

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Introduction/Purpose: Increasing evidence has suggested that alterations in joint mechanics results in articular pathology. Previous studies demonstrated noninvasive measurements of joint reactive forces (JRF) can be performed reliably without destruction of the peri-articular soft tissue in medium and small size joints of the upper extremity. This study presents a novel, noninvasive measurement of the JRF to investigate the normal and the effects of a syndesmotic injury. The JRF of the tibiotalar joint was also evaluated following anatomic reduction with fixation and malreduction of the syndesmosis.

Methods: Eight fresh-frozen human cadaveric lower extremity limbs were obtained disarticulated above the knee. A distraction force was applied across the tibio-talar joint to determine the baseline (normal) ankle force displacement curve. Next, a syndesmotic injury was created by releasing the interosseous syndesmotic ligaments, the transverse tibiofibular ligament and the anterior and posterior tibiofibular ligaments. Prior to sectioning, two drill holes were placed across the joint and tapped to ensure anatomic reduction. JRF were measured using a quadricortical technique with a single or double screw configuration. The syndesmosis was malreduced by anteriorly displacing the fibula 5mm. After each step, the resultant JRFs were determined using a distraction force across the tibiotalar joint.

Results: Force displacement curves obtained from multiple measurements from each specimen with a mean ankle JRF of 31.4 + 2.6 N. Syndesmotic injury resulted in a 35% decrease in tibiotalar JRF (20.3 + 3.0 N, p=0.002). Fixation of the injury using one syndesmotic screw resulted in significant increase in JRF compared to injury JRF (28.7 + 1.4 N, p=0.02). Syndesmotic fixation with 2 screws also demonstrated a trend towards restoration of tibiotalar JRF (28.3 + 2.2 N, p=0.06). There was no
statistical difference between fixation of one versus two syndesmotic screws. The JRF for the malreduced syndesmosis was $31.5 \pm 1.8 \text{ N (p=0.03,)}$ resulting in increased forces approaching the baseline JRF.

**Conclusion:** This study demonstrates a non-destructive model by which to measure joint reactive forces (JRF) across the tibiotalar joint and that these forces are diminished as a result of a syndesmotic injury, suggesting joint instability. Surgical stabilization with either 1 or 2 screws creates JRF that are similar to the normal JRF. Even with a malreduced syndesmosis, there appeared to be a JRF similar to baseline tibiotalar joint forces. However malreduction of the syndesmosis may alter the joint dynamics of the ankle in ways that were not measured in this study.