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Rigid Syndesmotic Fixation Alters Joint Contact Mechanics and Talar Kinematics

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Introduction/Purpose: The variety of methods available for performing syndesmotic fixation have led to significant controversy about the optimal method of surgical fixation, and the effects of syndesmotic fixation on the biomechanics of the ankle remain poorly understood. The purpose of the present study was to use a cadaveric model to evaluate the effects of progressively increasing syndesmotic fixation on talar motion and contact stress on the talar dome and in the medial and lateral gutters.

Methods: Twelve fresh-frozen cadaveric specimens were dissected to expose the ankle joint while leaving ligaments, syndesmosis, and interosseus membrane intact, simulating a best-case fibular reduction. Rigid clusters of reflective markers were attached to the tibia, the distal fibula, and the talus for tracking with a motion capture system. A Tekscan pressure sensor was inserted into the tibiotalar joint (n=6) or into both gutters (n=6) for measuring contact stress. A 600N axial load was applied in a custom-built ankle simulator which permitted free internal/external rotation and inversion/eversion while holding either 20°plantar flexion, 10° plantar flexion, neutral, or 10° dorsiflexion. Specimens were tested without fixation, with one 3.5mm screw, and with two 3.5mm screws. Motion data were rotated into an anatomic reference frame and a fixed center of rotation (CoR) of the talus was calculated in the sagittal plane. Tekscan data were analyzed for changes in peak contact stress and changes in contact area.

Results: Antero-posterior translation of the talus was variable with increasing fixation and specimen dependent. A single 3.5mm screw shifted the average CoR posteriorly 0.4 mm, and two 3.5mm screws shifted the average talar CoR anteriorly 1.6mm. Five specimens shifted posteriorly with fixation, while the other specimens moved anteriorly, resulting in extremely large standard deviations of AP movement. Peak contact stress on the talar dome decreased 10%-20% with the addition of syndesmotic fixation. Contact area on the talar dome decreased with increased syndesmotic fixation. Conversely, peak contact stress in the medial and lateral gutters increased with the addition of syndesmotic screws, although the magnitude was substantially lower than peak stresses in the talar dome. Contact areas in both gutters tended to increase with each syndesmotic screw.

Conclusion: Fixation of the distal tibiofibular syndesmosis altered the biomechanical behavior of the ankle, generally shifting the talus slightly anteriorly, decreasing the load on the tibiotalar articulation, and increasing medial and lateral gutter contact stress. The specimen-to-specimen variability was noteworthy. While the variability lead to large standard deviations and prevented some mechanical trends from achieving statistical significance, it became very apparent that there are certain individuals who would suffer grossly abnormal ankle mechanics after rigid syndesmotic fixation, and a more aggressive fixation would amplify the mechanical abnormalities.

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