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The Role of Calcaneofibular Ligament (CFL) Injury in Ankle Instability: Implications for Surgical Management

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Summary:
Injury to the Calcaneofibular ligament (CFL) leads to lower stiffness and torque, increased inversion of the calcaneus and talus, and significant shifting the center of pressure after CFL injury compared to the uninjured ankle. Repair of CFL should be considered during lateral ligament reconstruction to avoid the intermediate and long-term consequences of a loose or incompetent CFL.

Abstract:
Introduction
Acute inversion ankle sprains are among the most common musculoskeletal injuries. Higher grade sprains, which include anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) injury, can be particularly problematic. The precise impact of CFL injury in ankle instability is unclear. We aimed to evaluate the impact of CFL injury on ankle and subtalar joint stability and biomechanics. We hypothesized that CFL injury will result in decreased stiffness and torque, and alteration of ankle contact mechanics compared to the uninjured ankle in a cadaveric model.

Methods
Twenty matched cadaveric ankles dissected of skin and subcutaneous tissue were mounted to an Instron with 20° of ankle plantar flexion and 15° of internal rotation. Intact specimens were axially loaded to body weight, then underwent inversion stress along the anatomic axis of the ankle from 0 to 20° (simulating inversion injury) for three cycles. ATFL and CFL were sequentially sectioned, and inversion testing repeated for each condition. Stiffness was calculated and change in torque was recorded using an Instron. Pressure and contact area were recorded using a calibrated Tekscan sensor system. Inversion angle of the talus and calcaneus relative to the ankle mortise were recorded using a three-dimensional motion capture system. Paired t tests were performed to determine significance.

Results
Stiffness (0.67) and torque (16.0 N/m) did not significantly decrease after sectioning of the ATFL (0.615 and 15.5 N/m, respectively), but decreased significantly (by 37% to 0.49 and 12.2 N/m) after sectioning of the CFL. Peak pressures in the tibiotalar joint decreased significantly following CFL release compared to both the uninjured ankle and ATFL-only release. Mean contact area significantly increased following CFL release compared to both the uninjured ankle and ATFL-only release. There was a concentration of force in the anteromedial ankle joint during weight-bearing inversion. After ATFL release, the center of force (COF) shifted 0.83 mm further anteromedially compared to the uninjured ankle, approaching the medial shoulder of the talar dome. The COF shifted 1.22 mm posteromedially after CFL release relative to an intact ankle. Motion capture showed a significant, sequential increase in inversion angle of both the calcaneus and talus. There was significantly more inversion in the subtalar joint than the tibiotalar joint with weight-bearing inversion.

Conclusion

We found that with weight-bearing inversion of the ankle joint complex, there was significantly lower stiffness and torque following injury to both the ATFL and CFL, and sequentially greater inversion of the talus and calcaneus with progressive ligament injury. This corresponds to a shift in the COF in the tibiotalar joint and a reduction of peak pressure. The CFL contributes considerably to lateral ankle stability, and higher-grade sprains that include CFL injury appear to result in substantial alteration of contact mechanics at the ankle joint. Thus, repair of the CFL should be considered during lateral ligament reconstruction, and there may be a role for early repair in high grade injuries to avoid the intermediate and long-term consequences (e.g., articular damage or tendon injury) of a loose or incompetent CFL.