A Biomechanical Cadaver Study of Subtalar Instability

Presenting:

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Summary:
Inversion trauma of the ankle can result in subtalar instability as an isolated disorder or as part of chronic functional lateral ankle instability. The exact etiology of subtalar instability remains unknown, providing an impetus for a comprehensive study of the function of the cervical, calcaneofibular, and interosseous ligaments. Changes in subtalar joint inversion/eversion, internal/external rotation, and translation in response to standardized externally applied torsional and drawer loads were measured after systematic sectioning of these ligaments.

Abstract

Background:
Because ankle inversion trauma can result in persistent isolated subtalar joint instability and can contribute to chronic lateral ankle instability, optimization of subtalar joint ligament injury diagnosis and treatment is essential. Previous biomechanical cadaver studies have provided limited information on the roles of subtalar joint ligaments, but a more extensive understanding of the etiology of subtalar instability is necessary. The investigation described here was designed to comprehensively evaluate the function of the cervical, calcaneofibular, and interosseous ligaments in resisting an array of controlled forces applied to the subtalar joint.

Methods:
12 fresh-frozen cadaver lower extremities were used. An arthrodesis was performed on each talocrural joint, and the plantar aspect of the calcaneus and the proximal tibia and fibula were embedded in cylinders to facilitate attachment to the testing apparatus. The testing device incorporated a cradle on which the sole of the foot rested and a combined linear and rotary bearing to which the cylinder containing the proximal tibia and fibula was attached. The cradle was a component of a gimbal system that allowed unrestricted inversion/eversion and anterior-posterior and medial-lateral translation of the subtalar joint in response to controlled force application. The bearing system to which the tibia/fibula were attached allowed unconstrained internal/external rotation and superior-inferior translation of those bones. 4 N-m inversion/eversion and internal/external rotational moments and translational forces of 67 N were applied through a system of levers, pulleys, cables, and dead weights, and the provoked subtalar joint rotations and translations were measured by integral transducers and dial indicators, respectively. All measurements were performed sequentially in neutral, 10° dorsiflexion and 20° plantarflexion, and were repeated as the cervical, calcaneofibular, and interosseous ligaments were consecutively sectioned in all possible different orders.

Results:
With an inversion load applied, in neutral position, inversion increased after sectioning of the cervical (3.7°), interosseous (0.8°), and calcaneofibular (1.9°) ligaments individually. Combined sectioning of all three ligaments showed an increase in inversion of 8.3°, 1.4° and 8.5° in the neutral, plantarflexed, and dorsiflexed positions, respectively, compared to the intact ankle. In dorsiflexion, an increase in inversion of 2.0° was documented after sectioning the cervical ligament in the otherwise intact ankle. With an external rotation load applied, external rotation also increased in neutral position after sectioning the
cervical ligament (2.0°). In dorsiflexion, external rotation increased after sectioning the cervical ligament (2.4°). Combined sectioning of all ligaments with an external rotation load showed an increase in external rotation of 3.6° and 5.4° for neutral and dorsiflexion, respectively. The largest change in anterior drawer displacement in neutral position was observed after sectioning of the interosseous ligament (1.0mm) and after sectioning all ligaments (1.9mm).

**Conclusion:**
The exact etiology of subtalar instability has not been well understood, providing an impetus for this comprehensive study of the function of the cervical, calcaneofibular, and interosseous ligaments. Clear consequences of sectioning each ligament were documented through the described multiplanar measures of stability, and this empirical information may be helpful to the surgeon in both diagnosing and planning treatment of problematic subtalar joint instability.