The Effect of Lateral Ligament Injury and Reconstruction on Contact Mechanics of the Ankle Joint and the Kinematics of the Hindfoot

Presenting:

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Summary:
Ankle joint contact mechanics and hindfoot kinematics are altered by lateral ankle ligament injury. Anatomic repairs and graft reconstruction affects the dynamic contact mechanics and primary/coupled hindfoot kinematics.

Abstract:

INTRODUCTION:
Surgery can address chronic lateral ankle ligament laxity. The effects of ligament injury on contact mechanics and hindfoot kinematics and characterizing the ability of reconstructive procedures to restore them is important to the health of articular cartilage. The aims of this study were to determine the effects of ligament injury and common ligament reconstructions on 1) contact mechanics at the ankle joint 2) primary and coupled hindfoot motion patterns.

METHODS:
8 cadaveric limbs were loaded using a Mitsubishi ZX165U robot. A 6-DOF load cell measured forces at the joint. The calcaneus was secured to a pedestal and the tibia/fibula complex was attached to the robot. Specimens were loaded to 4.5 Nm of inversion with 200N axial load at neutral and at 20° plantar-flexion. The motion path was obtained using force feedback with all ligaments intact, after sectioning both the ATFL and CFL, and after the Broström, the Broström-Gould, and tendon graft reconstruction. Primary motion and coupled rotation in inversion at the maximum applied moment was measured. The motion path was repeated while recording dynamic ankle pressures. Motion of the center of pressure (COP) from the neutral to the loaded position, and contact area (CA) in the loaded position were measured.

RESULTS:
In neutral, ligament sectioning increased inversion compared to intact while the Broström restored inversion. The Gould and graft limited inversion by 4.2° and 3.2° (P

In neutral, sectioning caused a medial shift in the COP with inversion and a decrease in CA. At 20°, sectioning caused a medial and anterior shift in COP. In neutral the Broström, Gould, and graft all improved the medial shift in the COP. The Broström and graft restored the medial shift in the COP at 20°. The Gould and graft also reduced the anterior displacement of the COP at 20°. The Gould caused an increase in CA above the sectioned and intact at neutral and 20°. At 20° this increase in CA was more than the graft. The graft more closely approached restoration of the CA at neutral and 20°.

DISCUSSION:
The Gould provided additional hindfoot support compared to the Broström alone, resulting in both constrained primary and coupled rotation patterns in inversion. Graft reconstruction also significantly limited coupled internal rotations with inversion. Lateral ligament injury significantly altered the contact mechanics
at the ankle joint. This alteration in contact behavior may contribute to the onset and progression of OA seen in patients suffering from ligament laxity. Both the Gould and graft reconstruction helped restore contact mechanics. However, the Gould tended to increase contact area more than the graft. These subtle differences in contact mechanics may be associated with onset and progression of OA.