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Biomechanical evaluation of a Lisfranc ligament Injury: a novel cadaveric model using supination and pronation testing

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ABSTRACT

Introduction: Lisfranc joint injuries occur due to direct or indirect trauma, where a twisting or axial force is transmitted to the foot. Cadaveric models are a useful way to evaluate injury patterns and models of fixation, but a frequent limitation is the amount of joint displacement after injury. Our hypothesis was that applying pronation and supination motion combined with ankle plantar flexion to a cadaveric model would produce reliable and measurable joint displacements.

Methods: Twenty-four fresh frozen lower leg cadaveric specimens were utilized. The medial (C1) and intermediate (C2) cuneiforms and the first (M1) and second (M2) metatarsal bones were marked. A complete ligament injury was performed between C1-C2 and C1-M2 in 12 specimens (Group 1) and between C1-C2, C1-M2, C1-M1 and C2-M2 in 12 matched specimens (Group 2). Internal and external rotation was applied to the tibia with the ankle in 30 degrees of flexion, achieving pronation and supination motions, respectively, of the forefoot relative to the hindfoot. A 3D Digitizer was used to measure distances.

Results: Distance C1- C2 increased 3mm after ligament injury (23% increase) with supination motion. C1-M2 increased 4mm after ligament injury (21% increase) with pronation motion. Distances between C1-M1 and C2-M2 only changed in Group 2, increasing 3mm (14%) and 2mm (16%), respectively.

Conclusion: Pronation and supination motions of the forefoot relative to the hindfoot produce measurable joint displacements in a cadaveric Lisfranc injury model. Distances M1-M2 and C2-M1 are not reliable for the detection of injury in this model. The inclusion of axial rotation in Lisfranc injury models may allow better test repair or reconstruction techniques.

Keywords: Lisfranc Joint; Cadaveric model; Neoligamentoplasty.

