Dynamic Biomechanical Evaluation of the Dorsal InterCarpal Ligament Repair for Scapholunate Instability
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Introduction: Scapholunate dissociation is currently treated with multiple surgical techniques with limited success. Many procedures have been developed in the absence of any biomechanical testing. One of the soft tissue procedures used to treat scapholunate dissociation uses the dorsal intercarpal ligament (DIC) as described by Szabo et al. The purpose of this study was to evaluate this repair in a biomechanical model. The hypothesis of this study is that the soft tissue repair using the DIC will restore carpal kinematics following surgically created static scapholunate instability.

Materials and Methods: Eight fresh frozen cadaver upper extremities (average age of 61 years, range of 26 to 85; 5 male, 3 female) were prepared for testing in a wrist joint motion simulator. The sample size of 8 arms was based on a previous power study. Electromagnetic motion sensors were indirectly attached to the scaphoid, lunate and radius via carbon fiber rods and acrylic platforms and directly to the third metacarpal, to measure the angular and translational motion of these bones. The specimen was then placed in a wrist joint simulator and moved through repetitive cyclic wrist motions by pulling on the appropriate tendons with physiological forces. Each wrist was moved in sinusoidal cyclic motions of 30° extension to 50° flexion and cyclic wrist motions of 10° radial deviation to 20° ulnar deviation, while scaphoid, lunate, third metacarpal and distal radius kinematic data were collected. A static instability pattern was created by sectioning the entire scapholunate interossseous ligament (SLIL) and the dorsal radiocarpal ligament and by lifting the DIC off of its attachment to the scaphoid, trapezium and trapezoid. Kinematic data were collected from these cyclic movements. Immediately after the cyclic motion, the DIC repair was performed on one specimen. This repair restored carpal kinematics to the control group. These 3D models were animated using the previously recorded kinematic data. Using these models, the minimum distance between the scaphoid and lunate was calculated with the wrist at all flexion-extension and radioulnar deviation positions. Changes in carpal motion and changes in the minimum distance between the scaphoid and lunate caused by ligament sectioning were analyzed using a one-way repeated measures analysis of variance (Duncan’s method) at each degree of wrist motion at p<.05.

Results: Ligamentous sectioning resulted in static scapholunate dissociation. Statistical increases in scaphoid flexion (fig 1), scaphoid ulnar deviation, lunate extension (fig 2) and lunate radial deviation occurred during both wrist flexion-extension and radioulnar deviation. These increases were statistically significant throughout the entire range of motion except for the scaphoid radial deviation in extreme extension. In 7 of the 8 arms, these changes were seen as a gap between the scaphoid and lunate and as the scaphoid either subluxing or dislocating. Visually, the DIC repair initially reduced the gap and stabilized the scaphoid but within a few cycles of wrist flexion-extension there were statistically significant increases in scaphoid flexion, scaphoid ulnar deviation, lunate radial deviation and lunate extension compared to the intact motion. In 6 of the arms, the substance of the DIC repair stretched. In the other 2 arms, the repair stretched and also pulled out of the bone junction. After the 3 ligaments were sectioned, the minimum distance between the scaphoid and lunate statistically increased compared to the intact, as the wrist moved from 25° of flexion to maximum flexion and from maximum flexion to 5° of extension. Following the repair, the minimum distance was reduced, but was still statistically greater than the intact as the wrist moved from 35° of flexion to 19° of flexion.

Discussion: This study does not support the hypothesis that the DIC repair alone will stabilize the scaphoid and lunate following scapholunate instability. For the patient with scapholunate instability, the use of the DIC repair should be augmented with additional stabilization. This study does support the concept that the scapholunate ligament is the primary stabilizer of the joint. Sectioning the dorsal intercarpal ligament and the dorsal radiocarpal ligament produced additional instability, and allowed us to test our hypothesis.

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