INTRODUCTION:
Lunato-triquetral (LT) ligament injuries may produce volar intercalated segment instability (VISI) patterns and are extremely difficult to treat. Although arthrodesis of the LT joint has been advocated for this ligamentous injury, the data shows that solid bony fusion is difficult to achieve at this joint with a pseudoarthrosis rate as high as 57%.(1) Recent biomechanical data has detailed that significant motion occurs at the LT joint after ligamentous injury, particularly after disruption of the proximal and palmar portion of the LT ligament. (2) It has been suggested that this increased motion between the two carpal bones is responsible for the increased failure rates with this procedure.(2) As additional methods of treatment are necessary for this injury pattern, it has been suggested that an ulnar shortening procedure be performed as an adjunct to a lunato-triquetral arthrodesis.(3) The purpose of this study was to evaluate the effects of progressive ulnar shortening on motion between the lunate and triquetrum through forearm rotation.

MATERIALS AND METHODS:
Six fresh-frozen cadaveric upper extremities were transected just below the deltoid tuberosity. All specimens were examined by x-ray and physical inspection and determined to be free from gross pathology. The average ulnar variance for the tested specimens was 0.2mm (+, 725) All skin and muscles were removed saving only the pronator teres, pronator quadratus, brachioradialis, supinator, and extensor carpi ulnaris (ECU). The proximal radioulnar joint, distal radioulnar joint (DRUJ) and intersosseous membrane were left intact. The hand was disarticulated just proximal to the metacarpal-phalangeal joint with a custom external fixator to maintain precise axial alignment of the ulna and radius using anatomic landmarks as a guide. The humerus was potted in plaster of paris and rigidly fixed to a custom jig. The elbow was fixed at 90 degrees with a custom external fixator. With the forearm in neutral rotation as judged by aligning the tip of the radial styloid with the midpoint of the width of the humeral shaft, the hand was potted in plaster of paris just distal to the insertion of the ECU. This setup permitted application of supination and pronation forces through loading of the specified muscles in their anatomic directions. In addition a custom external fixator was built to simulate ulnar shortening in a precise manner. (Figure 1) A specific osteotomy and ulnar shortening protocol was developed with respect to its neutral position to measure the laxity of the joint when supination and pronation forces through loading of the specified muscles in their anatomic directions. In addition a custom external fixator was built to simulate ulnar shortening in a precise manner. (Figure 1) A specific osteotomy and ulnar shortening protocol was developed with respect to the custom external fixator to maintain precise axial alignment of the ulnar. Throughout the remainder of the trial, the hand was maintained in its neutral position to measure the laxity of the joint when supination and pronation forces were applied. A standardized loading protocol was followed and digitizing markers were measured for each loading condition using the Microscribe 3DLX (Immersion Corporation). These measurements were repeated for the intact condition and 2mm, 4mm and 6mm of ulnar shortening. A constant time for tissue deformation was allowed and specimens were preconditioned before measurements were taken. ANOVA with p<0.05 was used for statistical analysis.

RESULTS:
A three dimensional coordinate system was created with each specimen. The results showed that strain increased in both the ulno-triquetral (UT) (p<0.001) and ulno-lunato (UL) (p<0.04 for all except neutral/2mm shortening) ligaments with progressive levels of ulnar shortening during both forearm pronation and supination. (Figure 2) Translation motion of the lunate and triquetrum decreased the greatest after 2mm of ulnar shortening with forearm rotation. Increased levels of ulnar shortening created a gradual increase in motion at different points in the DRUJ. (Figure 3)

DISCUSSION:
Injury of the lunato-triquetral interosseous ligament complex is a particularly vexing problem with limited successful therapeutic options. This study provides data to support the concept of performing an ulnar shortening procedure as an adjunct to limited intercarpal arthrodesis as an therapeutic option. This study provides biomechanical data that supports performing an ulnar shortening osteotomy of 2-4mm to reduce both DRUJ motion and lunato-triquetral translation. As such, it may be possible to reduce the rate of pseudoarthrosis after LT arthrodesis by performing an ulnar shortening procedure in ulnar positive patients as an adjunct.

REFERENCES:

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Figure 1. Photograph showing the DRUJ translation testing system and custom external fixator for ulnar shortening.

Figure 2. Histograms showing UT and UL strain with respect to supination and pronation.

Figure 3. Histograms showing motion of the DRUJ from neutral to max supination and pronation.

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