INTRODUCTION:
Disruption or laxity of wrist soft tissue restraints has been implicated with ulnar sided wrist pathology. There still remains much confusion as to how disruption of various soft tissue components alters distal radio-ulnar joint motion. The purpose of this study was to evaluate the altered Distal Radioulnar Joint (DRUJ) motion associated with a progressive, ulnar sided wrist injury.

MATERIALS AND METHODS:
Eight 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. All skin and muscles were removed saving only the pronator teres, pronator quadratus, biceps brachii, supinator, and extensor carpi ulnaris (ECU). The proximal radioulnar joint, DRUJ and interosseous membrane were left intact. The hand was disarticulated just proximal to the metacarpal-phalangeal joint with a hand held oscillating saw. The carpal bones were fixed to the metacarpals with Kirschner wires to eliminate carpo-metacarpal motion and ensure measurements were truly relative to the DRUJ. Digitizing markers were consistently placed on 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 (Figure 1). Throughout the remainder of the trial, the hand was maintained in this position to measure the laxity of the joint when supination and pronation forces were applied. This setup permitted application of supination and pronation forces through loading of the specified muscles in their anatomic directions. A specific loading protocol was followed and digitizing markers were measured for each loading condition using the Microscribe 3DLX (Immersion Corporation). These measurements were repeated after transecting the Triangular Fibrocartilage Complex (TFCC) according to each of the first three of Melone’s five stages of acute injury to the TFCC. (1) 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. As expected, there was increased motion of the radius relative to the ulna with progressive sectioning of the ligaments for the pronation force (p<0.05) (Figure 2). Under pronation force (79N pronator teres, 5N biceps and supinator, 21N ECU), the radial styloid translated 0.68mm±0.20 for stage 1 (p=0.01 compared to intact), 1.39mm±0.28 for stage 2 (p=0.002 compared to intact, p=0.002 compared to stage 1), and 1.74mm±0.41 for stage 3 (p=0.004 compared to stage 1, p=0.004 compared to stage 1). The ulnar styloid translated 0.41mm±0.11 for stage 1 (p=0.008 compared to intact), 1.43mm±0.33 for stage 2 (p=0.004 compared to intact, p=0.01 compared to stage 1), and 1.91mm±0.72 for stage 3 (p=0.03 compared to intact). The supination force showed similar findings (p<0.05). Analysis of the other markers showed significant translations were appreciated between intact and stage 1, intact and stage 2, intact and stage 3, stage 1 and 2, stage 1 and 3, but never between stages 2 and 3. Figure 3 illustrates the effects of TFCC transection on DRUJ kinematics. The increased motion, however, was not a simple increase in volar and dorsal translation. In addition, there was a substantial rotational component after release of the ECU sheath creating an increased separation between the radius and ulna distally (Figure 3).

DISCUSSION:
Motion at the DRUJ is more complex than previously reported. The soft tissue constraints limit not only dorsal/volar motion, but also separation of the radius and ulna. With a progressive injury to the DRUJ, disruption of the ECU sheath with or without disruption of the ulnocarpal ligaments is necessary to significantly increase distal radius and ulna separation. This study serves to improve our understanding of the complexity of DRUJ motion so that a better treatment plan of DRUJ stability may be pursued.