INTRODUCTION:
Traumatic injury or chronic inflammatory conditions and attenuation of distal radioulnar joint (DRUJ) stabilizers can lead to symptomatic DRUJ instability. Numerous treatment options for DRUJ instability reflect the complex and poorly understood anatomy and biomechanics. The ligamentous and osseous structures have all been shown to contribute to DRUJ instability. The relative importance of each structure for stability; however, remains controversial. This is in part due to the use of biomechanical models in which specimens had been disarticulated at the wrist and subjected to static loading.

The purpose of this study was to utilize a novel joint simulator to examine the role of the various soft-tissue stabilizers on the kinematics of the DRUJ during active simulated motion. A better understanding of the roles of these stabilizers will be important in the design of future reconstruction and rehabilitation techniques for the DRUJ.

METHODS:
Twelve fresh-frozen cadaveric upper extremities were tested (73 ± 13 years) with a novel forearm motion simulator. Pronation was achieved by applying load to the pronator teres and pronator quadratus. Supination was achieved by applying load to the bicipital and supinator. Specimens were randomly assigned to section sequence I or II. Sequence I involved sectioning DRUJ stabilizers from distal to proximal: the dorsal and palmar radioulnar ligaments (RULs) including the dorsal and palmar portions of the TFC respectively, the dorsal and palmar capsule, the ECU subsheath, the ulnocarpal ligaments (UCL), the PQ and the IOM.

Sequence II, was essentially the reverse; the PQ was sectioned, which allowed access to section the IOM, followed by sequential sectioning of the ECU, UCL, dorsal and palmar capsule, and dorsal and palmar RULs).

Data was collected simultaneously from an electromagnetic tracking device. Kinematic data was evaluated using a planar analysis to quantify distal radioulnar joint stability. Two kinematic variables were utilized to compare the intact and destabilized DRUJ. The first was the radioulnar ratio (RUR), which quantified the dorsal and palmar translations of the radius relative to the ulna. The second was the radioulnar distance (RUD), a quantification of radioulnar convergence or diastasis (Figure 1). Radioulnar ratio and radioulnar distance were compared for all sectioning at five angles of forearm rotation using one- and two-way repeated measures ANOVAs with post-hoc Student-Newman-Keuls tests (α = 0.05).

RESULTS:
Sequence I (n = 6), distal to proximal sectioning, demonstrated no significant differences in active joint kinematics following division of the radioulnar (dorsal and palmar) ligaments or capsule. During active supination there was a trend to increased instability following sectioning of the UCL and ECU subsheath, however, significant instability was not identified until sectioning of the IOM. This instability was demonstrated by a significant increase in radioulnar convergence (p < 0.05) and palmar translation of the radius (p < 0.05). With active pronation, there was a trend to increased instability following IOM sectioning with increased radioulnar convergence and dorsal translation of the radius, but this was not significant (p > 0.05).

Sequence II (n = 6), sectioning from proximal to distal, demonstrated no significant supination instability until the final cut, sectioning of the radioulnar ligaments and TFC. Instability was observed with radioulnar convergence (p < 0.05) and palmar translation of the radius (p < 0.05). Active pronation demonstrated a trend to radioulnar convergence and dorsal translation of the radius following sectioning of the radioulnar ligaments and TFC, but this was not significant (p > 0.05).

DISCUSSION:
Sectioning of known DRUJ soft tissue stabilizers produces significant instability with simulated active motion. Our findings suggest that while the IOM is an important stabilizer when all others have been compromised, soft tissue stabilizers at the level of the DRUJ may play a greater role in stability. The proximal to distal cutting sequence (i.e. Sequence II) demonstrates that the radioulnar ligaments and triangular fibrocartilage in isolation can maintain stability of the DRUJ during active forearm rotation, suggesting primary repair or reconstruction in patients with symptomatic instability should be considered. However, loss of the dorsal and palmar RULs and TFC does not cause abnormal active rotational kinematics if other soft tissue stabilizers remain intact (i.e. Sequence I). This suggests that when required, resection of larger portions of the TFCC may not be detrimental to joint kinematics and stability if secondary DRUJ stabilizers are preserved. However, as DRUJ injuries are not isolated to one ligamentous structure, a cautious approach to excision of the TFCC seems prudent. Preservation of the dorsal and palmar portions of the TFC and the radioulnar ligaments should be considered where possible.

REFERENCES: