INTRODUCTION:
Arthroplasty of the distal ulna is a common treatment for disorders of the distal radioulnar joint, including osteoarthritis, rheumatoid arthritis, and instability due to injury and post-traumatic malunion. However, there are a number of reports of implant failure in the literature. For this reason, a new implant has been proposed, based upon anthropometric data. This design incorporates a new concept of removing only the damaged articular portion of the ulnar head, leaving soft-tissue attachments that stabilize the distal ulna intact. The purpose of this study was to compare the kinematics of the intact forearm to that of a partial implant, a full ulnar head replacement, a full ulnar head replacement including a soft-tissue repair, and a Darrach or ulnar head excision.

METHODS:
An implant prototype system incorporating a range of sizes and allowing all three stages of ulnar head replacement outlined above was designed. Six fresh-frozen cadaveric upper extremities (of mean age 73.5±14.3, range 48-85 years) were tested using a custom loading apparatus designed to simulate unconstrained forearm rotation with the elbow maintained in 90° of flexion (Figure 1). Specimens were radiographed prior to testing to verify the absence of any DRUJ disorders and to determine the proper implant size. Cables were sutured to 7 forearm muscles and tendons – the biceps, supinator, pronator teres, pronator quadratus, triceps and 4 wrist flexors and extensors. These structures were loaded under motion and load control via pneumatic actuators to induce pronation and supination based on cross-sectional area and EMG data; and to stabilize the wrist joint. An electromagnetic tracking device recorded the internal-external (IE) rotation, flexion-extension (FE) angle and varus-valgus (VV) angle of the radius relative to the ulna.

A six-stage protocol was followed, that involved first testing the intact specimen, then performing a capsular cut and repair to allow exposure of the distal ulna. Following capsular repair, a partial ulnar head excision was performed and the partial implant was cemented in place. This was followed by insertion of the full ulnar head implant, and testing was conducted with and without a soft-tissue repair of the triangular fibrocartilage complex to the implant. The implant was removed and testing was performed on a complete ulnar head excision or Darrach. Kinematics were recorded following each surgical stage. FE and VV angle of the radius relative to the ulna were analyzed at every 20° of pro supination. The statistical analysis used one-way and two-way repeated measures ANOVAs and post-hoc SNK tests (α = 0.05).

RESULTS:
Significant differences in FE angle during supination, as well as FE and VV angle during pronation, were found between the Darrach and all other procedures (p<0.05)(Figure 2). There were no significant differences in kinematics between intact, capsule repair, partial implant, full implant or full implant with a soft-tissue repair in either pronation or supination. During pronation, the FE angle was smaller following the Darrach compared to the intact state (p=0.003) and the VV angle was increased in valgus orientation (p=0.016). During supination, the FE angle was higher compared to the intact case (p=0.004).

DISCUSSION & CONCLUSIONS:
The lack of differences measured between the intact DRUJ and following the capsule cut and repair indicates that the surgical approach does not affect the outcome kinematics. There were also no differences among all stages of implant surgeries, indicating that there is no effect on kinematics following ulnar head replacement, and that the proposed implant should replicate normal forearm rotation pathways clinically. From the viewpoint of joint kinematics, this implant would be a successful treatment option. However, the Darrach procedure did result in altered forearm kinematics. This suggests that ulnar head arthroplasty may be a preferred alternative to ulnar head excision. Further studies are needed to evaluate DRUJ stability following ulnar head arthroplasty.