Intrinsic Constraint of Unlinked Total Elbow Replacements - The Ulno-Trochlear Joint

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Background
Many unlinked total elbow replacement designs exist with radically differing articular geometries suggesting no optimal design. A feature inherent to the articular design is the intrinsic constraint afforded to the joint by the implant. Our aim was to compare the intrinsic constraints of unlinked implants to that of the normal ulno-trochlear joint.

Methods
We tested 12 cadaveric ulno-trochlear joints with a custom-made multi-axis material testing machine. With compressive loads ranging 10N to 100N, the joints were moved in either valgus or varus directions at 90° of flexion. The ulno-trochlear components from a single medium example of 5 unlinked elbow replacements were also tested; Ewald, Kudo, Pritchard ERS, Sorbie-Questor, and Souter-Strathclyde. Measurements recorded were the torques required for prescribed motions, angular displacements, axial displacement of the humerus relative to the ulna in relation to angular displacement and torque. Statistical analysis was performed with a one factor ANOVA and a post-hoc student t-test.

Results
In valgus displacement, the Kudo and Souter implants increased maximum torque and concurrently decreased displacement with increasing compressive load, as did the normal elbow. In varus displacement the Kudo, Sorbie, and Souter demonstrated this same pattern of behavior.

No implant replicated the constraint ratio (maximum torque/displacement) of the normal ulno-trochlear joint. The Souter and Kudo implant had the least parameters that were statistically different from the human elbow, with significance at p<0.05.

Conclusions
Whereas the best data of implant behavior is from long-term clinical results, an understanding of fundamental in-vitro behavior is important to improve results and understand failures. Implants designed to be anatomically correct do not necessarily replicate normal kinematics, and small geometrical design changes have a significant influence on behavior.

Clinical relevance
Prior to designing and implanting new prostheses a stage of implant testing should be undertaken, in which the implant should be shown to closely replicate human joint behavior. If the behavior is not optimized in the ideal setting of the laboratory, it is difficult to predict when implanted into a patient.

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