Background
Unlinked elbow joint arthroplasty is a procedure that uniformly relieves pain, but varies widely regarding stability and long-term survival of the implants. Many unlinked 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 directly compare the intrinsic joint constraint of unlinked implants to that of the normal ulno-trochlear joint.

Materials and Methods
We tested 12 cadaveric normal ulno-trochlear joints with a custom-made multi-axis material testing machine, Figure 1. With compressive loads ranging 10N to 100N, the joints were moved in either valgus or varus prescribed motions, and angular displacements. Further analysis was conducted for the maximum torque (MAT) generated and the displacement at this torque. A constraint ratio was defined as MAT/displacement.

Results
The data was able to segregate the five implants into those that had normal elbow type behavior, and those that did not. In valgus displacement, the Kudo and Souter (Figure 2) implants increased MAT and concurrently decreased displacement with increasing compressive load, as did the normal elbow; whilst in varus displacement the Kudo, Sorbie, and Souter demonstrated this normal behavior (Figure 3). No implant replicated the constraint ratio of the normal ulno-trochlear joint (Figure 4). The Souter replicated the behavior but was stiffer in magnitude in both valgus and varus displacements. The Kudo more closely replicated the behavior in valgus displacement, but was stiffer in varus displacement.

Conclusion
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.

Figure 1: Multi-axis material testing equipment. A total elbow prosthesis is inserted in individual component fixtures and articulated at 90° of flexion.

Figure 2: Kinematic behaviour of the Souter prosthesis in internal and valgus rotation.

Figure 3: Averaged data, with standard deviation bars, with 50N axial compressive load, of maximum achieved torque (bar graphs) and rotational displacement (line graphs). VR = valgus rotation, IR = internal rotation.

Figure 4: Peak constraint ratio in valgus rotation (positive) and varus rotation (negative).