INTRODUCTION:

Total Elbow Arthroplasty (TEA) is frequently employed for patients with distal humeral fractures, primary and post-traumatic osteoarthritis, and rheumatoid arthritis. It is rational to postulate that the ideal implant for TEA would be designed such that it closely reproduces the motion characteristics of the original articulation. There is, however, limited information regarding the anthropometric characteristics of the elbow (1). In particular, we were interested in the relationship between the flexion-extension axis of rotation of the ulnohumeral articulation with the axis of the distal medullary canal, as this has important implications with regard to implant design and placement. Thus we undertook an anthropometric study to determine relationships between the flexion-extension axis of the elbow and the medullary canal of the humerus.

METHODS:

CT scans of forty distal humeri with axial scan spacing of 1.25mm were obtained. Contours were generated for the diaphysis and distal humerus using thresholding and exported into IGES format for analysis. The anatomic axis was defined by a line connecting the centers of the capitellum and the trochlear sulcus (2). The center of the capitellum could be determined using a least squares sphere fit in a custom LabVIEW (National Instruments, USA) program. Similarly, the center of the trochlear sulcus was determined using a least squares circle fit. The centers of the approximated capitellum (C) and trochlear sulcus (T) were connected and the resultant line used as the flexion-extension axis (FEA), as illustrated in Figure 1.

To determine the medullary canal axis (MCA), six cross-sections of the humeral diaphysis were analyzed: 42.6 ± 4.6mm (M₀), 52.6 ± 4.7mm, 62.6 ± 4.8mm, 72.6 ± 4.9mm, 82.8 ± 4.9mm and 93.9 ± 5.0mm proximal to the FEA. The cross-sections were selected to ensure that the most distal cross-section that contained a continuous medullary section was defined as the distal boundary of the medullary canal.

RESULTS:

Offsets and cubital angles for the different MCA lengths considered are shown in Table 1. The offset was proportional to the length of the MCA (P << 0.001). (Figure 2) Cubital angle was independent of the length of MCA considered (P=0.7)

DISCUSSION:

The importance of implant alignment with regard to kinematics and load transfer at the elbow has been well established (4,5). Failure to replicate normal muscle moment arms may result in increased loading and stresses at the ulnohumeral joint and an alteration in joint tracking. Due to these differences in technique, we consider the smaller cubital angle measured in this study to be incompatible to previous reports. The use of internal rather than external geometry should be considered when designing a humeral component of an elbow arthroplasty. Differences between cubital angles in this study may be due to the use of the internal canal instead of the external geometry. With a 50mm segment, a difference between the internal center and external center positions of 3mm would create an angular change of 3°. There is no data currently reported that correlates internal and external geometry of the distal humerus. Similar studies examining the cubital angle have used the external geometry approximated as a circle, which is in contention with observations made in this study showing the external geometry to more closely approximate an ellipse for distal regions of the humerus. Due to these differences in technique, we consider the smaller cubital angle measured in this study to be incompatible to previous reports. The use of internal rather than external geometry should be considered when designing a humeral component of an elbow arthroplasty.

This data has implications with regard to elbow implant design. The findings suggest that an adjustable articulation would be efficacious from the viewpoint of correctly positioning the FEA with respect to the anterior-posterior offset. It would appear that longer stemmed implants should be curved or have a greater anterior offset in the articulation.

REFERENCES: