MORPHOLOGIC ANALYSIS OF THE PROXIMAL ULNA WITH SPECIAL INTEREST IN ELBOW IMPLANT SIZING AND ALIGNMENT

INTRODUCTION:
Total elbow replacement is frequently employed for arthritic and traumatic conditions. Some studies have focused on the design of the humeral implant (1,2); however investigations have been limited with respect to the ulnar side (3). In order to develop an implant system that aims to replicate the motion characteristics of the native joint, an understanding of the key morphological features is important. There is, however, limited information regarding the anthropometric characteristics of the proximal ulna (4,5). In particular, it is important to establish the relationship between the medullary canal that accepts the stem, and the flexion-extension axis of the articulation.

Therefore, this CT-based morphological study was conducted to determine the anatomical parameters that define the optimal size and shape of the ulnar component for total elbow arthroplasty.

METHODS:
CT scans of 25 proximal ulnae with axial spacing of 0.625 mm were obtained. Surface contours were generated for the medullary canal of the proximal ulna after thresholding to remove cancellous bone from the CT images (Mimics, Materialise Medical, USA). These surface contours were then loaded into a surface modeling application (Rhinoceros 3D, Robert McNeel & Associates, USA) for analysis.

To characterize the endosteal morphology of the medullary canal, a minimum of 10 cross-sections of the proximal ulnar canal were analyzed beginning at approximately 50 mm distally from the centre of the trochlear ridge, and spaced 5 mm axially until the proximal limit of the canal. Then, cross sections were analyzed at every 10 mm from the 50 mm distal point until the distal limit of the available ulna was reached. More measurements were analyzed proximally because the morphology changed more rapidly proximally than distally. The centre of each cross-section was determined using an ellipse fit method (6).

A local coordinate system was also established using landmarks from the proximal ulna. The origin (O) of the coordinate system was defined as the centre of the trochlear ridge, which was determined using a least squares fit of the cross-section centers greater than 50 mm distal to the origin (7). The plane of the greater sigmoid notch was determined as the plane through the origin to become the proximal-distal (PD) axis. From which the orientation of the plane of the greater sigmoid notch, from which the local coordinate system was determined.

The long axis of the ulna was the eigenvector determined using a least squares fit of cross-section centers greater than 50 mm distal to the origin. This vector was projected onto the plane of the greater sigmoid notch through the origin to become the proximal-distal (PD) axis. Finally, the anterior-posterior (AP) axis was determined as a vector perpendicular to both the ML and PD axes.

Offset of the centers of the canal cross-sections were determined in the AP and ML directions with respect to the PD axis. The ellipse minor diameter was determined. The varus-valgus angle of the long axis relative to the plane of the greater sigmoid notch was also determined.

RESULTS:
An illustration of canal diameter (D) and offsets for different axial cross-sections are shown in Figures 1 and 2, respectively. The varus-valgus angle of the long axis with respect to the plane of the greater sigmoid notch was 7.8° ± 3.8°. There was no correlation between diameter and canal offset (p=0.7).

REFERENCES: