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The rotation of the humeral head does not alter radiographic evaluation of the head-shaft angle

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Background: The head-shaft angle is used to plan osteotomies and arthroplasties and to assess the radiographic outcomes of surgical treatment for proximal humerus fractures. There are no published data showing whether different degrees of arm rotation interfere with the evaluation of this angle.
Methods: Eighteen humeri from adult cadavers were used. Radiographs were taken with the specimens initially placed in a true anteroposterior position and then subsequently positioned with internal and external rotations of 10°, 20°, and 30°. All radiographs were evaluated by 3 shoulder and elbow surgeons at 2 different times 3 months apart. The head-shaft angle was measured using a picture archiving and communication system.
Results: For the humerus in the neutral position, the head-shaft angle was 137° ± 4°. With the anatomic specimen positioned with increasing external and internal rotations, there was a maximum difference of 2° compared with the value observed in the neutral position, which was not a significant difference ($P = .911$). Measurements of the head-shaft angle showed a good interobserver correlation coefficient, with a value of 0.788 (0.728-0.839) for all measurements. The intraobserver correlation coefficient ranged from moderate to excellent (0.536-0.938).
Conclusion: The head-shaft angle did not change significantly with varying degrees of humeral rotation. The interobserver correlation coefficient showed good reliability, and the intraobserver correlation was moderate to excellent.
Level of evidence: Basic Science Study, Anatomy, Imaging.

Keywords: Shoulder morphology; humeral head retroversion; humeral torsion; humerus morphology; shoulder arthroplasty; proximal humerus fracture

The head-shaft angle is a method described for evaluating the deviation in the coronal plane of the proximal humerus.[1,10] This angle is used to plan shoulder arthroplasties[11] and corrective osteotomies.[2,3] In fractures of the

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proximal humerus, the angle is useful to evaluate the radiographic results of surgical treatment.[4,7,8]

The angle, which is approximately 135°,[5] is measured on radiographs in true anteroposterior (AP) view.[4,8] However, joint pain or stiffness can make it impossible to correctly position the arm. In addition, variations between different image acquisition protocols, possible technical errors, and anatomic variations can impede the acquisition of standardized images in the true AP view. The humeral retroversion varies widely from −2° to 60°, averaging 26° ± 11°,[9] which can alter the radiographic appearance of the joint in true AP view. There are no published data showing whether different degrees of arm rotation interfere with the evaluation of the head-shaft angle.

The aim of this study was to evaluate, using dried humeri from human cadavers, the variability of head-shaft angles in varying degrees of rotation ranging from 30° internal rotation to 30° external rotation at 10° intervals. Secondary objectives included calculations of the intraobserver and interobserver reliability of the measurements and descriptions of the average retroversion and head-shaft angle of the samples evaluated.

Methods

Sample

Eighteen humeri from adult cadavers (11 male and 7 female) without ligament or muscle insertions were evaluated. Cadavers with skeletal immaturity, osteoarthritis of the proximal end, or signs of fracture or previous surgery were excluded. The study was approved by the local research Ethics Committee.

Radiographic examination

The radiographic images were acquired using a DuoDiagnostic system (Philips Medical Systems, Hamburg, Germany).

The specimens were positioned vertically and fixed to a device that provided rotational control (Fig. 1). The humerus was fixed with screws in the medial and lateral epicondyle, grips in the diaphyseal region, and a screw in the proximal region in line with its longitudinal axis.

To identify the true AP view of each specimen, a metal ring was placed around the anatomic neck. Initially, the humerus was positioned using visual control and was subsequently positioned using radioscopy. The proximal portion of the humerus was considered to be in true AP view when the full overlap of the front and rear portions of the ring was captured. At this point, the degree of humeral retroversion could be determined on the basis of the mold holding the humerus specimen, considered the difference between the biepicondylar axis and the true AP view (Fig. 2).

After removal of the metal ring, radiographs were taken at the initial position and at internal and external rotations of 10°, 20°, and 30° (Fig. 3).

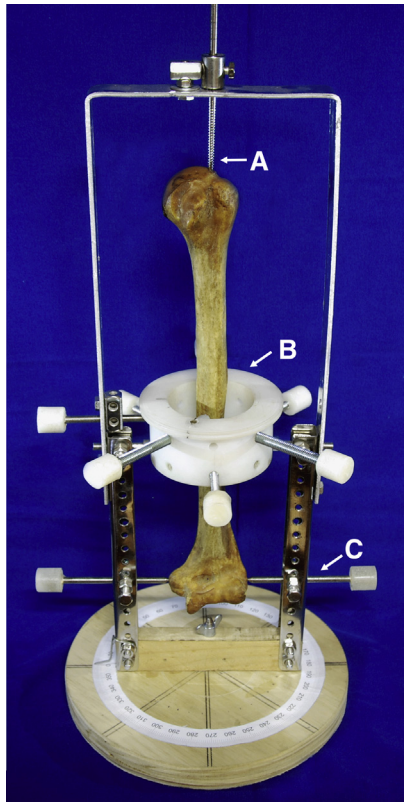

Figure 1 Device used to position the humerus: screw positioned in the longitudinal axis of the humerus (*A*), grips securing the shaft (*B*), and screws securing the medial and lateral epicondyle (*C*).

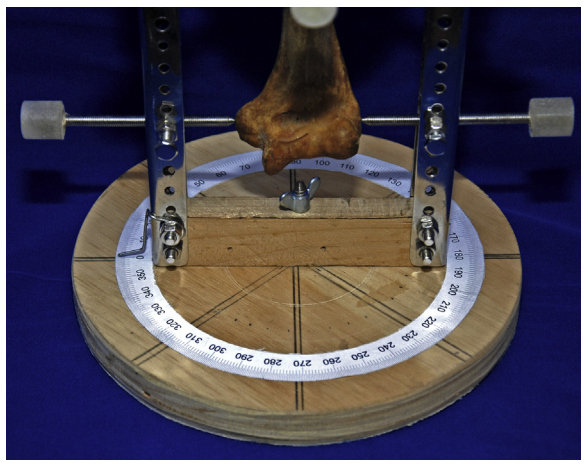

Figure 2 Disc with a degree scale, located in the base of the device. The degree of retroversion was determined from the biepicondylar axis after determining the true anteroposterior view of the proximal region.

Evaluators

Radiographs were assessed by 3 shoulder and elbow surgeons (E.A.M., J.H.A., and M.E.C.G.) with 8 to 10 years of experience who received educational material with details on how to evaluate