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ORIGINAL ARTICLE

Is radiographic measurement of acromiohumeral distance on anteroposterior view after reverse shoulder arthroplasty reliable?

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Background: Reverse shoulder arthroplasty leads to arm lengthening. Different techniques have been described to determine postoperative lengthening. The purpose of this study was to evaluate the reliability of the acromiohumeral distance (AHD) in determining arm lengthening after reverse shoulder arthroplasty.
Methods: At 2 centers, 44 patients who had received an onlay design reverse shoulder arthroplasty were observed for a minimum of 6 months. Examination followed a standardized protocol including preoperative and postoperative radiographs on anteroposterior view in neutral rotation. Two orthopedic surgeons independently performed the measurements in random order.
Results: Mean arm lengthening averaged 2.5 cm (range, 0.3-3.9 cm) according to AHD measurement. Significant differences in interobserver and intraobserver variability for postoperative AHD measurements were found ($P < .01$). The mean intrapatient difference was 0.5 cm (range, 0.02-1.5 cm).
Conclusion: According to our study, the AHD is not a reliable measurement technique to determine arm lengthening after reverse shoulder arthroplasty.
Level of evidence: Level IV; Diagnostic Study

Keywords: Shoulder; reverse arthroplasty; lengthening; acromiohumeral distance; radiograph; measurement

Reverse shoulder arthroplasty provides excellent midterm and long-term results for irreparable rotator cuff–deficient shoulders.[2,15] However, complications occur in 19% to 68% of cases, including instability, infection, neurologic lesions, and acromial fractures as well as scapular notching.[19] The reverse shoulder arthroplasty improves the biomechanical environment in cuff deficiency by retensioning of the deltoid muscle.[2] The correct amount of deltoid tension is crucial to restore mobility and to avoid complications.[11] Recent literature indicates that deltoid tension is related to the extent of arm and humeral length. Different techniques have been described for radiographic evaluation of lengthening, including the distance from the inferolateral tip of the acromion to the midpoint of the deltoid tuberosity,[7] as initially described by De Wilde et al,[3] and bilateral scaled radiographs of the entire humerus,[12] with a mean arm lengthening of 1.5 to 2.7 cm using the Grammont-type prosthesis.[9] More recently developed onlay design systems to allow convertibility influence both arm lengthening and humeral offset.[8] The amount of arm

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lengthening has been demonstrated to correlate with postoperative forward flexion.[11] The humeral offset has been shown to affect abduction and external rotation with the elbow at the side.[6,8] In a preliminary study, bilateral radiographs corrected for magnification have been shown to be an effective tool in almost 80% of cases to determine lengthening.[17] However, it has not been possible yet to state a threshold value for lengthening, indicating the need for a validated radiographic measurement technique.

Standard radiographs are routinely performed in orthopedic practice. Evaluation of the acromiohumeral distance (AHD) on the anteroposterior view in neutral rotation is a widely accepted tool to determine narrowing of the subacromial space in rotator cuff diseases.[16,18] We therefore sought to quantify distalization of the humerus after reverse shoulder arthroplasty by measuring the AHD. The aim of this study was to evaluate the reliability of this new radiographic measurement technique for lengthening in reverse shoulder arthroplasty as well as lateral humeral offset (LHO) in an onlay design prosthesis.

Materials and methods

We performed a retrospective study of patients operated on with an Aequalis Ascend Flex Reverse Shoulder Arthroplasty (Tornier, Inc, Bloomington, MN, USA) between November 2012 and May 2014. The operation was performed at 2 shoulder centers by 1 of the senior authors (D.M. and G.W.). All data were gathered prospectively and analyzed in random order by 2 independent orthopedic surgeons (B.W. and A.J.). Intraoperative data and the occurrence of complications were extracted from the medical records. Imaging analysis included preoperative and postoperative radiographs and computed tomography scans. Patients were excluded in case of incomplete documentation, a clinical and radiologic follow-up of <6 months, and indications other than primary osteoarthritis, massive rotator cuff tear, and cuff tear arthroplasty, leaving 44 patients (10 men and 34 women) for evaluation. The average age was 75 years (range, 61-87 years). Mean follow-up averaged 11.1 months (range, 6-17 months).

Radiographic analysis

Radiographic measurements were performed on a standard true anteroposterior view with double obliquity under fluoroscopic control in a standing position. The arm was placed in neutral rotation with the elbow at the side. The radiographs were scaled with a caliper to compensate for magnification. Radiographic evaluation included the AHD as well as the LHO (Fig. 1). The AHD was defined as distance between the most lateral part of the undersurface of the acromion perpendicular to a line parallel to the top of the greater tuberosity. The increase of the AHD was calculated to determine lengthening. The distance from the AHD line perpendicular to the most lateral portion of the greater tuberosity determined the LHO. Both AHD and LHO were calculated preoperatively; on the initial postoperative radiographs; and at 3, 6, and 12 months.

Surgical technique

The operation was performed in a standardized technique. Positioning of the glenoid baseplate aimed at being flush with the inferior aspect of the glenoid. In all cases, a cementless stem with an inclination angle of 132.5° and a 6-mm polyethylene insert with a 12.5° angle were implanted. The humeral tray was positioned at the level of the greater tuberosity.

Statistics

Reliability of AHD and LHO measurements at repeated examination times and agreement between the raters were assessed using

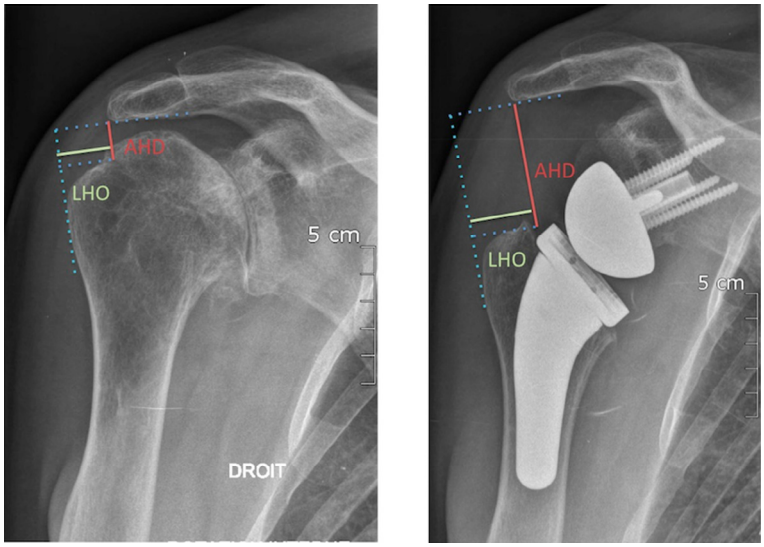

Figure 1 Radiographic evaluation was performed on a standard true anteroposterior view. The patient was positioned with the arm in neutral rotation and the elbow at the side. The acromiohumeral distance (*AHD*) was calculated from the most lateral part of the undersurface of the acromion perpendicular to a line parallel to the top of the greater tuberosity. The distance from the AHD line perpendicular to the most lateral portion of the greater tuberosity determined the lateral humeral offset (*LHO*).