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Tuberosity position correlates with fatty infiltration of the rotator cuff after hemiarthroplasty for proximal humeral fractures

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Hypothesis: This study investigates the correlation between tuberosity positioning, fatty infiltration of the rotator cuff, and clinical outcome after hemiarthroplasty for proximal humeral fracture.

Materials and methods: Twenty patients with a mean age of 70.8 ± 9.9 years were evaluated at a mean of 19.8 ± 9.4 months. Evaluation included assessment of the Constant score (CS); Disabilities of the Arm, Shoulder and Hand (DASH) score; radiographic evaluation; and computed tomography to classify healing of the tuberosities and changes in the rotator cuff. Fatty degeneration of the cuff was classified according to the Goutallier classification as stage 0 to 4. Tuberosity positioning was classified as mal-positioning of less than 0.5 cm., 0.5 to 1 cm., >1.0 cm., or not healed.

Results: The mean Constant Score (CS) of patients with greater tuberosity displacement of <0.5 cm was significantly higher than the CS of patients with ≥0.5 cm displacement and non-united greater tuberosities. The CS of patients with greater tuberosity displacement of 0.5 to 1 cm was significantly higher than that in patients with non-united greater tuberosities. For the lesser tuberosity, patients with displacement of <0.5 cm showed significantly higher outcome scores than patients with displacement of >1 cm and non-united lesser tuberosities. There was a significant correlation between fatty infiltration of the supraspinatus and infraspinatus muscles and greater tuberosity malposition and between fatty infiltration of the subscapularis and lesser tuberosity malposition.

Conclusion: Fatty infiltration of the cuff was significantly associated with lower clinical scores. Tuberosity positioning and healing are critical for improved clinical outcomes after hemiarthroplasty for proximal humeral fractures.

Level of evidence: Level 3; Retrospective cohort study.

Keywords: Hemiarthroplasty; fatty degeneration; tuberosity healing; proximal humeral fractures

Treatment of complex proximal humeral fractures remains challenging, and hemiarthroplasty is an option, especially in patients with fracture-dislocations, 3- and 4-part fractures, head-splitting fractures, or destruction of the articular surface of the humeral head after joint dislocation.[5,9,13,15,20,21] So far, published clinical outcomes

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remain inconsistent. Although adequate pain relief has been consistently demonstrated, motion and strength are less predictable. Prosthetic design has not been shown to be of influence for clinical outcome.[12,19] Poor functional results have often been attributed to malpositioning of tuberosities, loss of tuberosity reduction, or tuberosity resorption and malpositioning of the shaft.[1,4,9,14] All of these patterns result in poor function of the rotator cuff and, consequently, in limited range of active motion. However, even if the outcome is dependent on correct fracture analysis and appropriate techniques to restore anatomy and function, biologic problems, such as fatty degeneration of the rotator cuff, may be of clinical relevance. Gerber et al[6] reported that lesser tuberosity osteotomy for primary shoulder arthroplasty showed a significant increase in fatty infiltration of the subscapularis muscle after the operation, although anatomic healing of the osteotomy site could be established. The cause of this, however, remains unclear. Whether this observation can be transferred to the fracture situation and which factors are relevant for degenerative changes of the cuff are of clinical importance. We are not aware of any study that has evaluated the amount of tuberosity malpositioning and degenerative changes of the cuff after prosthetic replacement for proximal humeral fractures.

The purpose of this study was to evaluate rotator cuff quality, tuberosity positioning, and clinical outcome after hemiarthroplasty for complex proximal humeral fractures to gain more information about the influence of tuberosity positioning and fatty degeneration of the cuff on clinical results.

Materials and methods

Between February 2002 and May 2006, 43 patients with 3- and 4-part displaced proximal humeral fractures underwent hemiarthroplasty. Four patients died of causes unrelated to the sustained operation, and seven could not be re-examined because of poor medical condition or had moved. One sustained a periprosthetic fracture of the operative humerus and was excluded from the study. This left a total of 31 patients. Inclusion criteria were 3- and 4-part fractures and intraoperatively documented intact rotator cuffs without visible degenerative changes.

Because of unsatisfactory clinical results and to gain more information about tuberosity healing and positioning for possible revision surgery, postoperative computed tomography (CT) scans were performed in 20 patients (64.5%) at a mean of 19.8 ± 9.4 months postoperatively. Their mean age was 70.8 ± 9.9 years (range, 55-84 years). Data from patients in whom CT scan analysis was performed were evaluated retrospectively, and patients were contacted for clinical follow-up. Fractures were classified by the Neer classification system for proximal humeral fractures.[16] The classification was established from the preoperative radiographs by use of true anteroposterior (AP), axillary, and scapular lateral views and the documented intraoperative findings (Table I). In 2 cases, osteosynthesis had been attempted with early secondary loss of reduction immediately preceding arthroplasty.

Table I Fracture classification according to Neer system

Type of fracture according to Neer system	No.	Total
3 Part		8
Classical (greater tuberosity)	6	
Anterior fracture-dislocation	1	
Posterior fracture-dislocation	1	
4 Part		11
Classical	7	
Anterior fracture-dislocation	4	
Posterior fracture-dislocation	0	
Head split	1	1
Total		20

This study did not undergo Institutional Review Board approval.

Surgical technique

A standard deltopectoral approach was used. The greater and lesser tuberosities and their bone-tendon junction were identified. Strong nonabsorbable sutures were used for mobilization of the tuberosity and later fixation (Ethibond No. 6 [Ethicon, Somerville, NJ] or FiberWire No. 5 [Arthrex, Naples, FL]). The prosthetic head was chosen by use of the head fragment as a reference.

The prosthesis was cemented in all cases. Tuberosity positioning was performed by use of published techniques with the use of the nonabsorbable sutures to attach the fragments to the prosthesis, to the shaft, and to each other to gain stable fixation and anatomic positioning.[2,17] The sutures were placed at the bone-tendon junction of the tuberosities; one suture was placed around the medial prosthetic neck and around the tuberosities through the bone-tendon junction, and one suture was placed through drill holes in the shaft and in a figure of 8 through the bone-tendon junction of the greater tuberosity and the supraspinatus tendon. Rehabilitation started on the first postoperative day with passive exercises. After 6 to 8 weeks, active rehabilitation was started.

Patients were evaluated clinically and radiographically at a mean of 19.8 ± 9.4 months. For functional evaluation, the Constant-Murley score was used.[3] Muscular strength was measured with the Nottingham Mecmesin Myometer (Mecmesin Co., Nottingham, UK). Patient satisfaction and function were evaluated with the Disabilities of the Arm, Shoulder and Hand score.[7] Radiographic evaluation at follow-up included true AP and axillary radiographs of the operative shoulder.

Nonparametric statistical analysis was performed with SPSS software (version 13.0; SPSS, Chicago, IL) to determine relationships between variables. Spearman rank correlation tests were used for quantitative data analysis, and the Kruskal-Wallis test and the Mann-Whitney U test were used for qualitative data analysis. The significance level was set at $P = .05$. The variables analyzed to look for statistical correlations included the postoperative Constant score (CS), displacement of the greater and lesser tuberosities, and fatty infiltration of the cuff.

The quality of the humeral reconstruction was analyzed at the last review by evaluation of the position of both tuberosities and the prosthesis on AP and axillary views.