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Long-term analysis of revision reverse shoulder arthroplasty using cemented long stems

Birgit S. Werner, MD[a,*], Ayman F. Abdelkawi, MD[a], Dorota Boehm, MD[b], Robert Hudek, MD[a], Piet Plumhoff, MD[c], Klaus J. Burkhart, MD[a], Frank Gohlke, MD[a]

[a]*Clinic for Shoulder and Elbow Surgery, Bad Neustadt/Saale, Germany*
[b]*Center for Orthopedic Surgery, Würzburg, Germany*
[c]*Department of Orthopedic Surgery, Koenig-Ludwig-Haus, University of Würzburg, Würzburg, Germany*

Background: Revision of failed shoulder arthroplasty is often associated with poor results and a high rate of complications. Significant humeral bone loss after removal of long stems poses a considerable surgical challenge. Therefore, the aim of our study was the evaluation of the clinical and radiologic outcome of cemented long-stem humeral components in revision reverse shoulder arthroplasty with a minimum 5 years' follow-up.

Methods: Between June 2001 and June 2009, revision reverse shoulder arthroplasty using long-stem cemented humeral components was performed in 124 patients. Mean age at time of surgery was 69.6 years (range, 42-87 years). Complete clinical and radiographic data were available in 50 patients at a mean of 7 years (range, 5-11.6 years). Postoperative radiographs were evaluated for radiolucent lines, implant migration, fracture, and glenoid notching.

Results: The mean Constant score improved from 11.1 points (range, 0-27 points) to 39.5 points (range, 14-73 points) at the latest follow-up. Progressive humeral radiolucency was present in 24 patients, including 6 patients demonstrating complete loosening or progressive distal migration of the humeral stem. We noted an overall of 12 additional complications in 8 patients, necessitating revision surgery in 16.

Conclusion: The use of long-stem humeral components is a beneficial treatment in revision reverse shoulder arthroplasty. Nevertheless, the high percentage of patients with humeral loosening is concerning. Modular cementless revision stems that are adapted to the distal humeral medullary canal and additional distal screw and cable fixation might enhance durable distal fixation in case of advanced bone loss.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Revision arthroplasty; reverse shoulder arthroplasty; long-stem humeral component; implant loosening; bone loss; complication

Since the first report on revision shoulder arthroplasty using the reverse prosthesis by De Wilde et al,[6] expanding indications have increased the complication and revision rates.[1,2,8,14,21] Early revision within 1 to 3 years postoperatively is most likely related to infection or loosening.[11,14] In addition, deterioration in functional outcome has been observed at more than 5 years' follow-up in primary reverse shoulder

Institutional Review Board approval was not required because all clinical and radiographic interventions in this study followed routine assessment, were in line with consistent practice, and the investigation conformed to ethical principles of research. The clinical and radiographic data were enrolled in the National Shoulder Arthroplasty Register (IRB No.: FEKI 013/1042.)

*Reprint requests: Birgit S. Werner, MD, Clinic for Shoulder and Elbow Surgery, Salzburger Leite 1, D-97616 Bad Neustadt/Saale, Germany.

E-mail address: birgitwerner@hotmail.com (B.S. Werner).

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arthroplasty.[10,14,19] The reason for this observation is not yet sufficiently understood. Because age has been excluded after survival analysis, radiologic findings are assumed to be the key factors for failure.[10,14] That glenoid notching or polyethylene wear could be related to this break has been suggested.[10,14] Recent literature has focused on the failure modes of the glenoid component; however, a potential link between the appearance of scapular notching and decreased range of motion has not yet been confirmed.[16,19,22]

Significant humeral bone loss poses considerable surgical challenges in revision shoulder arthroplasty.[12] Underestimation of proximal humeral bone loss has been demonstrated to be related to postoperative instability due to the possibility of postoperative humeral shortening.[1] In addition, humeral bone loss might be a reason for stem loosening because of increased rotational forces in the implant-to-cement and the bone-to-cement interface in the diaphysis or within the implant itself.[5] Recent studies indicate that radiologic changes around the humeral shaft are more frequently observed in reverse shoulder arthroplasty than in anatomic prosthesis.[9,18]

The primary objective of this study was the evaluation of midterm to long-term clinical and radiologic outcomes in cemented long-stem revision reverse shoulder arthroplasty. Secondly, we assessed postoperative complications related to the humerus and potential strategies for revision. We hypothesized that deterioration in strength and active range of motion at long-term follow-up is associated with humeral stem loosening.

Materials and methods

Revision reverse shoulder arthroplasty using long-stemmed cemented humeral components was performed in 124 patients between June 2001 and June 2009 by the senior author (F.G.). Mean age at the time of surgery was 69.6 years (range, 42-87 years). Data were collected prospectively in the National Shoulder Arthroplasty Register. Informed consent was obtained from all patients. Indication for revision surgery was failed anatomic shoulder arthroplasty in 75 patients, infection in 25, aseptic stem loosening in 8, periprosthetic fracture in 7, and other causes in 9. All patients were prospectively monitored at 3, 6, and 12 months and at 2, 5, and 10 years. At a minimum 5-year follow-up, 33 patients were excluded due to incomplete data collection, 12 patients were unavailable for clinical evaluation, and 29 patients had died of an unrelated cause, leaving 50 patients (37 women, 13 men) for analysis. Mean follow-up was 7 years (range, 5-11.6 years).

Clinical and radiologic analysis

Preoperative and postoperative clinical analysis included the Constant score and active range of motion in forward flexion and external rotation with the elbow at side. Radiographic examination involved preoperative and postoperative radiographs in true anteroposterior, lateral, and axillary views with a digital caliper. Radiographic evaluation emphasized humeral radiolucent lines according to a modified Gruen classification,[13] implant migration, periprosthetic fracture, and scapular notching according to Sirveaux et al.[19] Two shoulder surgeons (B.W. and F.G.) independently assessed the clinical and radiologic data.

Surgical technique

Surgery was performed using the deltopectoral approach. After a meticulous soft tissue release and dislocation of the prosthesis, the humeral stem and remaining cement mantle were removed. To avoid intraoperative fractures, a pectoralis major pediculated humeral window was created to preserve humeral blood supply and the stabilizing function of the muscle according to a technique previously described (Fig. 1).[11] A cemented humeral revision stem of 180 mm to 210 mm in length (Aequalis Reversed; Tornier, Monbonnot, France) was implanted in all shoulders to achieve a sufficient anchorage length exceeding 80 mm in the distal humerus. After pulsatile lavage of the medullary canal and application of a resorbable cement stopper, a hand-driven syringe was used to introduce a hand-mixed high-viscosity cement into the distal humerus. Refixation of the bony window was performed with 1.5-mm cerclage wires.

Postoperative rehabilitation followed a standardized protocol. In all patients with symptoms suggestive of an infection, a two-staged procedure was performed using an articulating antibiotic-loaded humeral cement spacer and reimplantation after 8 to 12 weeks.

Statistical analysis

The paired *t* test was used to compare the preoperative and postoperative Constant scores and ranges of motion. Analysis of variance was used for comparison among complications, radiologic findings, and functional outcome. Statistical significance was set at $P < .05$.

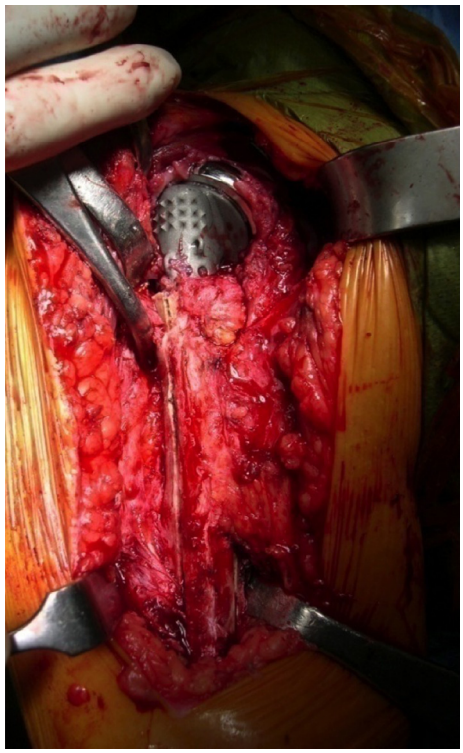

Figure 1 The pectoralis major pediculated bone window is performed using an oscillating saw, in consideration of the minimal length of the humeral window to extract the prosthesis as well as preservation of a sufficient anchorage length in the distal humerus. Refixation is accomplished with 1.5-mm cerclage wires.