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ORIGINAL ARTICLE

Midterm outcomes of bone grafting in glenoid defects treated with reverse shoulder arthroplasty

Yaiza Lopiz, MD, PhD[a,b,*], Carlos García-Fernández, MD[a], Alvaro Arriaza, MD[a], Belen Rizo, MD[a], Hector Marcelo, MD[a], Fernando Marco, MD, PhD[a,b]

[a]*Shoulder and Elbow Unit, Department of Orthopaedic Surgery and Traumatology, Clínico San Carlos Hospital, Madrid, Spain*

[b]*Departamento de Cirugía, Complutense University, Madrid, Spain*

Background: Large glenoid defects are a difficult reconstructive problem for shoulder surgeons. The purpose of this study was to determine the complications, rate of healing, and functional results of glenoid bone grafting in primary or revision surgery with reverse shoulder arthroplasty.

Methods: We retrospectively reviewed 23 patients with glenoid bone loss who underwent primary or revision surgery using a glenoid bone graft with a minimum follow-up of 2 years. Range of motion and the Constant, American Shoulder and Elbow Surgeons, and visual analog scale scores were obtained from preoperative assessment and the latest follow-up visit. Radiographic evaluation included analysis of plain radiographs as well as preoperative and follow-up computed tomography.

Results: Three patients were excluded from the study. Allografts were used in 13 cases and autografts in 7 cases. The mean Constant score improved from 30.7 ± 9.4 to 51.3 ± 13.4 ($P < .001$). At a mean follow-up of 26 months, computed tomography imaging revealed that the glenoid bone graft was fully incorporated in 95% of cases. No statistically significant differences were found on analysis of the clinical and radiographic outcomes related to the graft source. There was a 20% postoperative complication rate: 1 case of aseptic glenoid component loosening, 1 surgical wound hematoma, 1 acromial fracture, and a symptomatic grade 3 scapular notching.

Conclusions: The use of bone grafts in glenoid defects is a useful technique by which, in the majority of cases, single-stage reconstruction surgery may be performed, even in the presence of severe bone loss. Incorporation rates are high, with satisfactory clinical outcome.

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

Keywords: Glenoid loosening; glenoid bone loss; glenoid reconstruction; bone auto graft; bone allograft; reverse shoulder arthroplasty

The use of reverse shoulder arthroplasty (RSA) in glenoids with major uncorrected defects may have extremely negative consequences, such as inappropriate positioning of the baseplate that predisposes to its early failure, insufficient fixation, dislocation episodes, greater development of scapular

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*Reprint requests: Yaiza Lopiz, MD, PhD, C/Cotoblanco 11, 3° A. Majadahonda, E-28222 Madrid, Spain.

E-mail address: yaizalopiz@gmail.com (Y. Lopiz).

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notching, or joint kinematic disturbance with lower uptake of deltoid fibers.[24] Several existing procedures may be used to confront the challenge of these defects, depending primarily on the available bone stock[10]: glenoid grafting without reimplantation, eccentric glenoid reaming, 2-stage revision with grafting, and augmented baseplates. With the development of RSA, surgeons appear more motivated to use grafts than with previous implants; this is because this prosthesis seems to provide an ideal mechanical setting for its use.[26]

Few studies have shown the clinical outcome and radiographic evolution of these "reverse glenoid-prosthesis bone graft" constructs.[2,12,15,17,20,31] The purpose of this study was to review the outcomes associated with glenoid bone grafting in the setting of primary or revision RSA. Specifically, we aimed to determine the functional outcomes, graft healing, and complication rates.

Materials and methods

This is a retrospective case series study of 23 patients who underwent revision or primary RSA and a reconstructed glenoid with bone graft between January 2011 and December 2014. Three patients were lost to follow-up and were excluded from clinical or radiographic analysis. Therefore, 20 of 23 patients were followed up for a minimum of 2 years; 90% were female, and the mean age at time of surgery was 75.3 years (range, 48-85 years).

Preoperatively, the patients underwent a functional evaluation according to the presurgical protocol established using the Constant score, American Shoulder and Elbow Surgeons (ASES) score, and visual analog scale (VAS). In addition, active abduction, forward flexion, and active and passive external rotation with the arm at the side were measured with a goniometer. Radiographic studies included anteroposterior, trans-scapular, and axillary views, which provide a useful initial 2-dimensional assessment of glenoid bone stock, and computed tomography (CT), which provides more detailed 3-dimensional information with regard to bone loss, version, and vault anatomy. The authors' preferred method of measuring glenoid version has been described previously by Friedman et al,[9] using an axial slice at the level of the coracoid tip. The version is equal to the angle subtended by a line drawn between the scapular axis (from the medial tip of the scapula to the midpoint of the glenoid) and the glenoid face (between the anterior and posterior margins of the glenoid face). The maximum depth of the horizontal plane bone defect can be measured on CT by the method adapted from Hill and Norris.[11]

At a mean follow-up of 38 months (range, 26-51 months), patients were clinically and radiologically evaluated by 2 independent trained examiners who had not participated in the surgical procedure according to the same preoperative protocol (Constant score, ASES score, and VAS and range of motion). Postoperative radiographic evaluation included an anteroposterior, trans-scapular, and axillary view (if motion was not impeded) and also a CT scan. When differences in assessments of image studies were noted, the 2 observers reached a consensus.

The last postoperative radiographs were analyzed for the presence or absence of baseplate loosening (radiolucency around the screws or the central peg, classified as grade 0 when there is no radiolucent line, grade 1 when a line is <1 mm wide and incomplete, grade 2 when a line is 1 mm wide and complete, grade 3 when a line is 1.5 mm wide and incomplete, grade 4 when a line is 1.5 mm wide and complete, or grade 5 when a line is 2 mm wide and complete),[7,28] scapular notching classified according to the system described by Sirveaux et al,[27] any evidence of hardware failure, and humeral stem loosening. The CT scan was performed to determine the bone graft incorporation rate more accurately. The allograft was assumed to be fully incorporated when osseous trabeculae had completely bridged the space between the host glenoid and the graft in all the CT coronal and axial slices. An estimation of graft percentage of incorporation was made according to the amount of graft remaining at the 3-dimensional CT reconstruction. This was rated as fully incorporated (>75% of initial bone graft), partially incorporated (25%-75%), or not incorporated (<25%), as described previously.[6]

Complications were documented and categorized postoperatively and at follow-up visits. Only those events that modified the clinical evolution or affected the final outcome have been considered complications.

The glenoid graft was used in primary arthroplasty in 9 cases (45%) and in 11 revision cases (55%). All grafts were used to correct glenoid deficiencies, not only to lateralize the center of rotation. The original diagnosis of the primary cases was rotator cuff arthropathy in 4 patients (44%), osteoarthritis in 3 patients (33%), and fracture-dislocation in 2 patients (22%). Revision surgery was performed for aseptic loosening of the glenoid component in 7 cases (64%), instability in 2 cases (18%), and failed humeral hemiarthroplasty in 2 cases (18%).

Surgical technique

All surgical procedures were performed by a single surgeon (F.M.). The deltopectoral approach was used in all patients. In cases of primary surgery, if the bone obtained was viable, the humeral head was used as the bone graft (35%). In revision and primary surgery in which the humeral head was not suitable to be used as the bone graft, we used a frozen allograft of the femur or tibia (65%; 11 revision and 2 primary surgeries). We prefer to use the hospital's allografts, from its bone bank, because of their accessibility, rather than adding greater comorbidity to the patient's donor sites. Moreover, as may be seen in our series, our patients were of advanced age. The choice of the graft (tibial plateau or proximal femur) depended on the availability at the institutional bone bank at the time of surgery. The authors usually used tibial plateau allograft (11 cases) as described in Figure 1, but for 2 cases, this graft was not available; thus, a proximal femoral allograft was used as described previously.[2] A guidewire is inserted through the center point of the cut surface of the medial femoral neck allograft following the axis of the neck; subsequently, through the cannulated system, the proximal femoral allograft is reamed, the central peg is drilled, and the definitive baseplate is inserted. A similar defect is harvested from the allograft, with a fine micro-oscillator saw determining the correct thickness and final shape. Unlike the construct of Bateman and Donald,[2] autogenous impacted graft surrounding the central peg was not used in this study.

By preoperative CT, an estimation of the graft size is performed as explained previously. We prefer to slightly oversize the graft bone (by 2 or 3 mm) with respect to the initial measured defect compared with the implant. By doing this, a possible rupture is unlikely when the fixation screws are inserted.