Orthopaedics & Traumatology: Surgery & Research xxx (2018) xxx–xxx

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EM|consulte
www.em-consulte.com/en

Original article

Reverse shoulder arthroplasty for proximal humerus fractures: Is the glenoid implant problematic?

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ARTICLE INFO

Article history:
Received 4 December 2017
Accepted 11 June 2018

Keywords:
Shoulder joint
Orthopedic Surgical Procedure
Traumatology
Joint Prosthesis

ABSTRACT

Introduction: Reverse shoulder arthroplasty (RSA) is a key tool in the orthopedic trauma surgeon's arsenal, especially when faced with a proximal humerus fracture in older patients. However, few studies have focused on the glenoid side of RSA in this indication as the implant is placed in a generally healthy scapula.
Hypothesis: Glenoid implants for RSA after trauma are well positioned and do not often cause complications.
Material and methods: Retrospective multicenter study of 513 patients who underwent RSA because of a proximal humerus fracture. The mean follow-up was 55 months. Radiographs were used to assess the height and tilt of the glenoid implant, along with the development of scapular notching or loosening. The clinical outcomes were determined based on the Constant score.
Results: At the last follow-up, 44% of shoulders had scapular notching, 7% of which were severe (stages 3–4). This notching was progressive, with two resulting in loosening. The rate of severe notching was higher in patients with a high glenoid implant (62.5% vs. 42.3%, $p = 0.03$) or glenosphere with superior tilt (58.3% vs. 37.8%, $p = 0.02$). Nine patients had confirmed loosening and 63 had potential loosening. This was more common in cases with superior tilt (9.3% vs. 0.4%, $p < 0.001$). Patients with a high glenoid implant had a lower Constant score (57 vs. 45, $p < 0.001$). There fewer cases of severe notching when a lateralized glenoid implant was used (0% vs. 7%, $p < 0.05$) and/or the humeral implant had a smaller neck-shaft angle (implants < 155°: 3% vs. implants at 155°: 8.5%, $p = 0.03$).
Discussion and conclusion: Glenoid loosening and severe scapular notching are related to poor positioning and/or incorrect orientation of the glenosphere. Implant selection is important, as there is little to no notching when less-angled humeral implants and lateralized glenoid implants are used.
Level of evidence: IV.

1. Introduction

Reverse shoulder arthroplasty (RSA) was developed by Grammont in the 1980s and became more popular after the introduction of the Delta implant in 1991 [1]. It is based on a biomechanical concept that shifts the center of rotation medially and increases the deltoid's moment arm. It also helps to maintain proper active range of motion and to partially compensate for rotator cuff deficiency. This implant, which was initially designed to treat glenohumeral osteoarthritis with rotator cuff tear, is now frequently used in the trauma context [2,3] for complex proximal humerus fractures in older adults.

The functional outcomes after hemiarthroplasty for displaced fractures of the proximal humerus in older adults are generally disappointing [4]. The main reasons for failure are lack of tuberosity healing and secondary lysis or malunion of the tuberosities. In other terms, this poor function is related to secondary insufficiency of the rotator cuff. In this indication, RSA provides better functional outcomes than hemiarthroplasty [5], and is now an integral part of the treatment arsenal of orthopedic trauma surgeons along with fracture fixation and hemiarthroplasty techniques [6,7].

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https://doi.org/10.1016/j.otsr.2018.06.008
1877-0568/

Nevertheless, RSA also has its complications [8,9]. The complication rate is around 12% for degenerative conditions, of which 6.5% affect the glenoid side [8]. Glenoid loosening requires surgical revision in 1.3% to 3.5% of RSA cases. This is a rare complication that is often due to an infection and sometimes to technical errors during implantation [9].

A specific complication of RSA [10] is notching of the lateral border of the scapula that occurs in 49% to 96% of cases and is due to the center of rotation being shifted medially [11–13]. This notching is the result of adduction impingement (and very likely rotation and extension) between the polyethylene humeral insert and the lateral border of the scapula. It can be associated with radiolucent lines under the implant or even complete loosening of the implant.

These potential complications mean that RSA in the context of proximal humerus fractures is a very specific indication. In fact, in this case, and contrary to hemiarthroplasty, performing RSA means the surgeon is replacing a mostly healthy glenoid with an artificial one. Placing a glenoid implant on a normal joint surface increases the risk of complications associated with RSA. No study had specifically focused on the glenoid side of RSA in the context of proximal humerus fractures.

The primary objective of our study was to evaluate glenoid complications and their clinical impact in a multicenter cohort of older patients who underwent RSA for a proximal humerus fracture. We hypothesized that the problems and complications associated with RSA for proximal humerus fracture are related to the positioning and orientation of the glenosphere.

2. Material and methods

This study was performed in the context of the 2016 SOFCOT symposium on "Outcomes of reverse shoulder arthroplasty in recent proximal humerus fractures" (principal investigators Boileau, Gallinet and Valenti). This was a retrospective multicenter study (14 hospitals in France) of patients operated between January 1, 1995 and May 31, 2015. Patients above 65 years of age who underwent RSA for a proximal humerus fracture within 1 month of the injury, with no fracture fixation and a minimum of 1 year of clinical and radiological follow-up were included. One observer reviewed the patients and radiographs at each participating hospital. The data were compiled in an electronic case report form with double verification (local and national). Patient consent was obtained and approval for data processing for the purpose of this study was requested from the French Advisory Committee for Data Processing in Health Research (CCTIRS, file No. 16-003). This was followed by a request for approval from the French data protection authority (CNIL) for processing of personal data for the purpose of medical research (Fig. 1).

For the portion of the study focused on the glenoid side of the implant, radiological and/or clinical data were available for the glenoid of 513 patients (Table 1).

According to the Neer classification of proximal humeral fractures [14], 70% were four-part fractures, 17.4% were three-part fractures and 2.4% were two-part fractures. The procedures were done using the superior deltoid splitting approach in 75% of cases and the deltopectoral approach in the other cases.

On the glenoid side, 63% of glenosphere implants were 36 mm in diameter, 27.3% were 38 mm in diameter, 5.8% were 42 mm in diameter and 2.2% were 40 mm in diameter. The glenosphere was lateralized thanks to its design in 2.9% of cases and the addition of a bone graft in 2.4% of cases.

On the humeral side, 30 different stem models were used. The main types were the AEQUALIS FRACTURE (Tornier) in 33.9% of cases, the UNIC (Evolution) in 25.3% and the AEQUALIS (Tornier) in 9%. The metaphysis neck-shaft angle was 155° (standard) in 67.8%

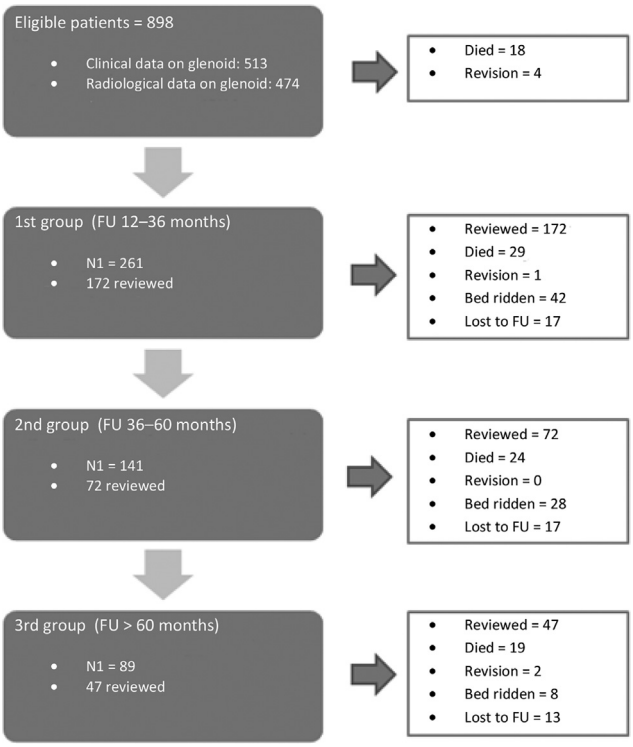

Fig. 1. Study flowchart. Only patients with more than 12 months of clinical and/or radiological follow-up (FU) were included in the study.

Table 1
Initial characteristics of the population.

Characteristics	
Sex	13.1%♂ 86.9%♀
Dominant side	7.8% left-handed 92.2% right-handed
Side of the fracture	42.8% left 57.2% right
BMI	26.2 (16–64)
Mean age at fracture	78 years (65–95)

of cases and less than 155° in 32.2% of cases. Most of the stems (60%) were considered "filling" stems. The tuberosities were reattached in 69% of cases.

The following radiological criteria were analyzed:

- immediate postoperative:
  - height defined as the distance between the inferior edge of the baseplate and the inferior edge of the bony glenoid, noted as adequate if there was an inferior overhang (A), high if the glenosphere grazed the inferior edge of the glenoid (B) and excessively high if it was beyond this (C),
  - tilt measured between a horizontal line (with the patient standing) and the medial edge of the baseplate, noted as inferior (I) if the resulting angle was less than 90°, neutral (N) if the angle was 90° and superior (S) if it was greater than 90° (Fig. 2);
- follow-up visits:
  - appearance of scapular notching (Fig. 3) according to the Sirveaux classification [15], appearance of scapular bone spurs (at the inferior portion of the native glenoid) and/or heterotopic ossification in the glenohumeral joint (any ossification in the space between the lateral border of the scapula and the humerus, Fig. 4), appearance of radiolucent lines under the baseplate (Fig. 5) and evidence of implant migration. We associated migration with confirmed loosening and stage 3/4

Please cite this article in press as: Lignel A, et al. Reverse shoulder arthroplasty for proximal humerus fractures: Is the glenoid implant problematic? Orthop Traumatol Surg Res (2018), https://doi.org/10.1016/j.otsr.2018.06.008