Primary reverse shoulder arthroplasty for acute proximal humerus fractures: A 5-year long term retrospective study of elderly patients

Pierfrancesco Luciani[a,*], L. Farinelli[a], R. Procaccini[a], C. Verducci[b], A. Gigante[a]

[a] Clinical Orthopaedics, Department of Clinical and Molecular Sciences, Università Politecnica delle Marche, Ancona, Italy
[b] Department of Orthopedics and Traumatology, Civitanova Marche, Italy

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ABSTRACT

Background: Reverse shoulder arthroplasty (RSA) in complex shoulder fractures is ever more frequently. This study compares clinical and radiologic results of patients with comminuted proximal humeral fractures (PHFs) treated with RSA, with and without tuberosities grafting.

Methods: Between January 2009 and June 2014, 55 patients aged ≥65 years with 3- and 4-part PHFs were treated surgically. Patients' files and the hospital's digital database were reviewed retrospectively with at least 5-year of follow up. We constituted three groups according to the tuberosity consolidation: patients in whom the tuberosities showed anatomic consolidation (Group I) and patients either with secondary displacement of the tuberosities (Group II) or without tuberosity repair (Group III).

Results: The 74% of the repaired tuberosities consolidated in anatomic position. Among range of motion (ROM), we reported that forward elevation, abduction and external rotation were significantly better in Group I than those in Group II-III. Furthermore, quick Dash score and Constant score showed more satisfied results in Group I. Regarding complications, not infection or instability were found in group I. On the other hand, in group II, we reported one patient with deep infection, leading to two steps surgery. In group III, we recorded two patients with instability required implant revision and one with deep infection treated by revision.

Conclusion: RSA showed satisfied results even at 5 year follow up. Preservation of the tuberosities in anatomic position improves active forward elevation and external rotation as well as patient satisfaction with less complications.

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Introduction

Proximal humerus fractures (PHFs) are the third most commonly encountered fracture in elderly [1]. Reverse shoulder arthroplasty (RSA) was initially recommended to restore a pain-free function and strength of the shoulder of elderly patients with rotator cuff pathology [2]. Moreover, the use of RSA is becoming increasingly popular for the treatment of complex three- and four-part proximal humerus fractures in the elderly. Indeed, poor outcomes have been gained follow treatment of proximal humerus fractures with hemiarthroplasty or osteosynthesis due to migration, malunion, nonunion or resorption of the tuberosities [3]. The mean advantage of the RSA is that, even in the absence of tuberosity grafting, the patient remains able to elevate and abduct the arm. After the promising and encouraging results of clinical reports, to date, two major issues continue to limit the use of RSA in traumatology: the high rate of scapular notching and the abolition of rotation [4]. Nowadays, it has been well established that at short term, shoulder rotational ability is improved by systematically repairing the tuberosities around the implant of RSA, when an anatomic consolidation is obtained [5,6]. However, the rates of tuberosity healing vary from 40% to 84% in elderly patient [7]. As a consequence, malunion, nonunion or resorption of the tuberosities remain a challenge for RSA. Despite the increasing numbers of RSA procedures, the long-term results have been rarely reported. The purpose of this retrospective study was to assess the clinical results at minimum 5 year of follow up in a cohort of patients aged ≥65 years with complex proximal humeral fractures treated with RSA. Especially, we reported the clinical results based on tuberosity healing. We hypothesized that patients with anatomic consolidation of tuberosities showed more satisfied results that those with secondary displacement or without tuberosities grafting.

Patients and methods

Between January 2009 and June 2014, 55 patients aged ≥65 years underwent RSA for 3- and 4-part PHFs in Clinical Orthopaedics, Ancona and Department of Orthopedics and

Traumatology, Civitanova Marche Hospital. The mean age of the patients at the time of trauma was 77 years (range, 65–85 years). All patients have been operated within the first 10 days of the initial trauma. Over the follow-up period, 8 patients died, 3 were lost to follow-up, and the general health status of 2 did not allow radiologic/clinical examination. The dominant side was affected in 74% of patients. The mechanism of fracture was a simple fall in all patients. At January 2019, patients' files and the hospital's digital database were reviewed retrospectively. In total, 42 patients (37 women and 5 men) observed for at least five years after the surgery, were included in the study. According to Neer's system, PHFs in 12 patients were classified as type 3 and those in 30 patients were classified as type 4. We excluded patients with neurological disorders, rheumatic diseases, previous shoulder surgeries, bifocal or neoplastic pathological fractures.

Surgical technique

After a careful collection of patient's past medical history and preoperative assessment by the use of plain radiographs and computed tomography scans with 3-D reconstruction, reverse shoulder arthroplasty was indicated based on: type of fractures, bone stock quality, rotator cuff tear arthropathy, glenohumeral osteoarthritis and function of deltoid. An upper-limb specialist operated all patients. All patients underwent surgery on a standard operative table in the beach chair position under sedation and peripheral nerve blocks anesthesia. Each fracture was approached through a deltopectoral incision, and the humeral head was resected between the tuberosities. The glenoid and humerus were reamed and prepared for implant fixation (Lima Corporate, San Benedetto Del Friuli, Italy) using appropriate surgical instruments. The glenoid component with 10° of inferior tilt was fixed to the scapula with two screws as recommend by Gutierrez et al [8]. The humeral component of the appropriate size was fixed through press-fit mechanism with about 0° retroversion. Tuberosity repair was systematically performed by the use of No. 2 Ethibond suture (Ethicon, Somerville, NJ, USA) respecting their anatomical position. Tuberosity osteosynthesis was realized through horizontal sutures around the stem of the prosthesis and vertical ring in each tuberosities [9]. It was impossible to fix tuberosities in 10 cases due to the poor bone stock and the excessive bone fragmentation.

Post-operative rehabilitation

After the RSA surgery, each patient required a sling immobilization in abduction of 15-30° for 2 weeks, passive ROM of the shoulder and pendulum exercises with active elbow movements were allowed from the first day after surgery. After 2 weeks, progression to active assisted shoulder movements were initiated avoiding internal and external rotation until 40 days after surgery.

Clinical assessment

Patients were clinically and radiographically evaluated postoperatively at 3, 6, 12, and 24 months and then yearly. All patients included in the study underwent clinical examination and radiological exams by our unit after about 5 year from the surgery. The mean follow-up was 65 months (range 60–68 months). It has been evaluated joint active range of motion in anterior elevation, abduction, elbow- to-body external rotation, hand-in-back internal rotation (Fig. 1), and the Constant-Murley score. X-rays were performed in three projections (true AP view, Y-view and axillary-view). The patients' subjective assessment was recorded in terms of satisfaction and quality of life according to the Disabilities of the Arm, Shoulder and Hand (DASH) score. Subsequently, we constituted three groups according to the tuberosity consolidation: patients in whom the tuberosities showed anatomic consolidation (Group I) and patients either with secondary tuberosities displacement (Group II) or without tuberosity repair (Group III). Greater tuberosity was considered to heal in anatomic position when visible in the AP view with the arm in neutral position, the top of the greater tuberosity at the level of the insert of the humeral component, or the top of the greater tuberosity at the level of the epiphyseal part of the prostheses [1,10]. In addition, it is mandatory the visualization of the greater and lesser tuberosities on the lateral views according to the hemiarthroplasty criteria of Boileau et al [9].There were 9 cases of secondary tuberosities displacement (7 mal-union, 2 non-union).

Statistical analysis

Data were collected and organized using Excel (Microsoft, Redmond, WA, USA). Categorical variabilities were expressed in numbers and percentages. Continuous variabilities were expressed by averages and standard deviation (DS). Data from three groups were compared using Mann-Whitney test, *t*-test and Fisher exact test when appropriated. Statistical analyses were made using SPSS (version 21.0; IBM, Armonk, NY, USA). A $p < 0.05$ was considered as significant.

Results

Patient demographics and clinical results are reviewed in Table 1. The mean postoperative hospital stay was 5 days (range
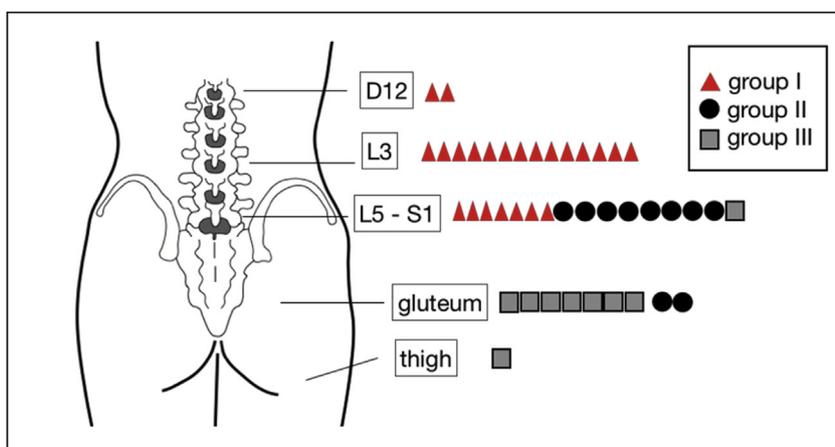

Fig. 1. Schematic illustration of grade of internal rotation after RSA.

Table 1
Patient characteristics and clinical results.

			Tuberosities graft		No tuberosities graft
			Group I	Group II	Group III
Age (SD) year			76.68 (4.5)	76.1 (4.42)	77.3 (5.02)
Sex	Female		20	7	6
	Male		3	1	1
Follow – up (SD) months			63.8 (1.97)	63.4 (1.41)	63.7 (1.58)
Range of motion					
		Forward elevation (SD)°	135 (12.7)	117 (12.8)	108 (10)
		Abduction (SD)°	119 (12.8)	104 (14)	91(7.2)
		External rotation (Elbow-to-body) (SD)°	28 (6.8)	12.1 (3.1)	5.7 (1.2)
Quick DASH score (SD)			16.8 (5.02)	27 (7.8)	37.4 (7.0)
Constant score (SD)			72.5 (3.82)	59.6 (9.0)	52.2 (6.4)

3–7 days). The mean ages of patients, the postoperative hospital stay and the follow up periods were similar with no significant difference between groups (P > 0.05). Anatomic consolidation of the tuberosities was obtained in 23 patients (74%). Among shoulder ROM measures, the forward elevation, abduction, and external rotation were significantly higher in group I than in group III (P < 0.05). The same statistical differences were reported comparing the group I and group II (P < 0.05). Similarly, regarding internal rotation, we reported more satisfied results in group I. The modes observed were L3, L5-S1 and gluteum respectively for group I, II and III. The mean quick DASH scores were significantly higher in group III than in group I (P = .003). Conversely, mean Constant scores was significantly higher in group I than group III (P = .001). The mean quick DASH scores were significantly higher in group II than in group I (P = .004). Furthermore, mean Constant scores was significantly higher in group I than group II (P = .001). Interestingly, comparing the group II and III, we reported that all sectors of motion were significantly better in the group in which the tuberosities were characterized by secondary tuberosities displacement than those without tuberosities grafting (P < 0.05). In addition, quick Dash score and Constant score showed more satisfied results in group II than group III albeit without statistical significance (P>0.05). Regarding complications, in group II, we reported one patient with deep infection, leading to two steps surgery. In group III, we recorded two patients with instability required implant revision and one with deep infection treated by revision. No infection or instability were found in group I. Furthermore, we reported no radiographic signs of loosening either on the baseplate or on the stem. There was scapular notching in 12 patients (29%). On the basis of the Sirveaux classification [11], they were grade 1 in 75% and grade 2 in 25%.

Discussion

Complex proximal humeral fractures in elderly are characterized by several challenges in view of poor bone quality, tuberosity comminution, technical failure and difficult postoperative care. In aging patient, the main goal of the treatment of PHFs with RSA, is to obtain a functional joint range of motion necessary to comfortably and effectively perform activities of daily living (ADL) (i.e. toileting activities). Namdari et al. demonstrated that shoulder requires approximately 120° of forward elevation, and 130° of abduction to complete a series of exercises comparable of ADL. At the same time, the same authors stated that subjects require a minimum of 57% and a maximum of 76% of full shoulder motion to be retained satisfied [12]. In our series, all patients reached at least 90° of forward elevation and approximately 90° of abduction. For these reasons, in concordance with the literature published, we stated the RSA as a valid long-term option for the treatment of PHFs. The

Grammont prothesis is characterized by the medialization of center of rotation with a placement of the glenosphere more inferiorly on the glenoid. RSA system was developed to work without rotator cuff by the increase of the deltoid moment arm. For these reasons, surgeons did not routinely reattach tuberosities in the early reports of RSA use for acute PHFs [13]. In addition, several researches reported no differences in terms of range of motion and satisfaction of the patient between healed and nonhealed tuberosities in RSA group [14–17]. In our experience, we clearly reported that all sectors of motion, Constant and quick Dash scores were significantly better in the group in which the tuberosities were repaired and in particular in which the tuberosities showed anatomic consolidation after at least 5-year of follow up. Our study confirmed the results reported by Gallinet et al. and Anakwenze et al. in which anatomic fixation of the tuberosities over the prosthesis significantly improved rotational functions [5,18]. Indeed, even though supraspinatus is not necessary for elevation in RSA, the absence of infraspinatus and teres minor implies lack of active external rotation [19]. We need to consider that reconstructing the tuberosities around the implant represent a true technical challenge. Numerous studies report tuberosity healing rates after RSA for fracture, around 70.5% [20]. In our series, we reported a rate of anatomic healing around 74%. It has been well established that comorbidities, poor bone stock and a scant post-operative rehabilitation negatively influenced the healing of the tuberosities [21]. Furthermore, exact and accurate positioning of the implant, with regard to both height and retroversion, appears to be an essential step for a successful osteosynthesis of the tuberosities. In addition, accurate tuberosity positioning and suture fixation, in both horizontal and vertical planes are important technical factors that surgeons should control [9,22]. For these reasons, in the last years the use of biologic (autografts) and nonbiologic (patient-specific implants and trabecular metals) materials has been suggested to increase th e tuberosity union rate [20]. Hence, Formaini and colleagues reported an 88% of tuberosity healing utilizing the "black and tan" method [10]. It consists of a hybrid cementation-impaction grafting technique that uses autogenous cancellous bone graft to create an interface between the proximal cement mantle and the area of tuberosity repair. An additional advantage of successful tuberosity healing is related to a lower rate of complications after RSA [7]. Indeed, based on our results, we reported main complications as infection and instability only in patients without tuberosity repair or malunion. In according to Boileau and colleagues [7], we believed that anatomic consolidation of tuberosities might represent a bone and soft tissues envelope around RSA capable of reduce the risk of infection and instability. Based on our own results, we firmly believe that the reattachment of tuberosities when using RSA should be warranted. Indeed, it is worth mentioning that patients enrolled in group II

showed better clinical results respect those in group III. The limitations of this study are the inclusion of a small number of patients for each group and the retrospective study design.

Conclusion

RSA is being increasingly used for complex, displaced fractures of the proximal humerus in older patients. It showed satisfied results even at 5 year follow up. Preservation of the tuberosities in anatomic position improves all sectors of motion as well as patient satisfaction with less complications. Techniques to improve tuberosity osteosynthesis should be warranted in order to get healing tuberosities even in the most challenging cases.

Declaration of Competing Interest

The authors declare that there are no conflicts of interest.

Acknowledgement

None.

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