

Comparison of Reverse Shoulder Arthroplasty and Hemiarthroplasty for Proximal Humeral Fractures: What about Functional Outcome?

Reverse versus Hemiarthroplasty in Shoulder Fractures

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Abstract

Purpose: Shoulder replacement becomes more indicated in complex fractures of the humeral head. Indications depend on some factors especially age and fracture's pattern. The aim of our study is to compare the functional results of both reverse shoulder arthroplasty (RSA) and hemiarthroplasty (HA) in complex proximal humerus fractures. **Materials and Methods:** Fifty-two shoulder arthroplasties (20 reverse shoulder arthroplasties, 38 hemiarthroplasties), were reviewed retrospectively, between January 2010, and December, 2015. Preoperative, operative, and postoperative evaluations were achieved based on medical observations. At last follow-up, functional outcomes were established according Constant-Murley Score and American Shoulder and Elbow Surgeons (ASES) score. Complications rates were well-defined and compared between the study groups. **Results:** The mean of follow-up was 41.5 months. Comparing the study groups, reverse shoulder arthroplasties were significantly older (mean age: 76.3 versus 66). These fractures occur more in women (70% versus 57%). At last follow-up, functional outcomes were better in reverse shoulder arthroplasty group (Constant-Murley Score 76 versus 59; ASES score 56 versus 41). The mean anterior elevation and external rotation were better in reverse shoulder arthroplasty respectively (110° versus 88°; 28° versus 19°). Revision was more required in hemiarthroplasty group than reverse shoulder arthroplasty group. **Conclusion:** Reverse shoulder arthroplasty seems to improve functional outcome at intermediate and long-term of follow-up of proximal complex humeral fractures on comparison to hemiarthroplasty.

Keywords

Shoulder, Fracture, Reverse, Hemiarthroplasty, Comparison

1. Introduction

Complex fractures of the proximal humerus become more frequent in daily practice, explained by the increasing rate of osteoporosis in actual aging populations [1]. These injuries are considered to be the third fracture of person aged more than 65 year-old [2] [3]. Treatment is still controversial and various options have been described in the literature: none operatively treatment may be used in case of undisplaced or minimally displaced fractures however, surgery is compulsory in displaced fractures [4] [5]. Indications depend on some factors such as: age, arm dominance, patient activity level, presence of other injuries, osteoporosis and fracture's pattern [6]. Shoulder arthroplasty is an option for complex fractures coming in older people with osteoporosis, fracture-dislocations, head-splitting fractures, and fractures involving more than the half of the articular surface [7]. Through the literature, several series were found evaluating functional outcome after both hemiarthroplasty and reverse shoulder arthroplasty but with few comparative studies [8] [9] [10] [11]. The aim of our study was to compare the functional outcome of reverse versus hemiarthroplasty shoulder replacement in complex proximal humeral fractures.

2. Materials and Methods

2.1. Patients

We have reviewed retrospectively all cases of complex fractures of the humeral head treated with shoulder arthroplasty. All patients were collected between January 1, 2010, to December 31, 2015 in orthopedics department of Sahloul University Hospital. Selection criteria were: complex fractures of the humeral head, no associated injuries of the upper limb and absence of shoulder arthritis. The mean of follow-up was 41.5 months (range: 24 - 96). Two groups had been established based on the type of arthroplasty indicated in each case (group 1: fractures treated with hemiarthroplasty and group 2 treated with reverse shoulder arthroplasty).

2.2. Assessment

A comparison of both these groups concerning preoperative characteristics (age, sex, fracture's pattern), operative characteristics (surgical approach, prostheses used), and postoperative outcomes, including Constant-Murley scores and American Shoulder and Elbow Surgeons (ASES) scores were achieved [12] [13]. Post operative elevation, abduction and external rotation were evaluated separately. Complications such as stiffness, nonunion, malunion of tuberosities, infection and the revision rate were revealed and compared between the two

groups. Baseline demographic, operative and post operative measures were compared between the groups using Fisher exact tests, independent t tests, and Mann-Whitney U tests, as appropriate. A general linear model was used to compare Constant score and ASES score between groups in a multivariate analysis that included age, sex, surgical approach, functional outcome. Complication's rates were compared using Fisher exact tests, and log-rank tests were used to compare revision rates during the entire follow-up period. A two-tailed $p < 0.05$ was taken to indicate statistical significance.

3. Results

3.1. Demographic Characteristics

After reviewing our results, the mean age in reverse shoulder arthroplasty group was significantly higher than the hemiarthroplasty group (76.3 years versus 66; $p = 0.002$). Women were more concerned by the reverse shoulder arthroplasty than hemiarthroplasty with a significant difference (70% versus 57%; $p = 0.042$).

3.2. Preoperative and Operative Data

Concerning the fracture's classification, there was no significant difference between the two groups: three-part fracture (40% versus 47%; $p = 0.8$) and four-part (60% versus 53%; $p = 0.9$) (**Table 1**). The choice of the surgical approach has never affected the results since there was no significant difference between the deltopectoral and superolateral approaches in both groups (RSA: 40% versus 60%; $p = 0.7$, HA: 57% versus 43% $p = 0.6$). The reconstruction of tuberosities has been established by the same surgical procedure in all cases of both two groups.

3.3. Functional Outcomes

Reviewing the functional outcomes at last follow-up, reverse shoulder arthroplasty was better and effective than the hemiarthroplasty in term of decreasing the pain (ASES score was better in reverse shoulder arthroplasty than the hemiarthroplasty: 56 versus 41; $p = 0.51$). Moreover, the Constant score was better in reverse shoulder arthroplasty group than in hemiarthroplasty group but this difference was not statistically significant (76 points versus 56 points; $p = 0.052$).

Table 1. Preoperative demographic features of RSA and HA groups.

	RSA (%)	HA (%)
Number	20	38
Male	6 (30%)	16 (42%)
Female	14 (70%)	22 (58%)
Age (year)	76.3	66
Three-part fracture	8 (40%)	18 (47%)
Four-part fracture	12(60%)	20 (53%)

Evaluation of postoperative range of motion has revealed a better results in reverse shoulder arthroplasty than in hemiarthroplasty: the mean active anterior elevation in reverse shoulder arthroplasty group was 111° compared to 88° in hemiarthroplasty group; $p = 0.003$. Furthermore, external rotation was little better in reverse shoulder arthroplasty group but without a significant difference (28° versus 19°; $p = 0.6$) however, the mean abduction in reverse shoulder arthroplasty was worse than the hemiarthroplasty group without a statistical significant difference (90° versus 100°; $p = 0.7$) (**Table 2**).

3.4. Complications

Reviewing the tuberosities evolution, we have found that resorption of tuberosities has affected the final outcome especially in terms of external rotation and it was with a statistically significant difference between the two groups: external rotation was more decreased in hemiarthroplasty group explained by the resorption of tuberosities. At the time of follow-up, all complications were revealed: Stiffness was the most reported complication with a difference statistically significant between the two groups (RSA: 15% versus HA: 18%; $p = 0.047$). Infection rates were similar in two groups without a statistical significant difference between groups ($p = 0.53$). Resorption of tuberosities has been found more frequent in hemiarthroplasty group with a significant statistical difference (18% versus 10%; $p = 0.03$) (**Table 3**). Finally, some especial complications for reverse shoulder arthroplasty such as scapular notching, was found in only three cases (15%): 100% were grade I. Specific complications of the hemiarthroplasty were well mentioned in (**Figure 1**).

4. Discussion

Management of complex proximal humerus fracture is until now controversial especially in elderly [14]. Several published series have reported the functional outcomes for each type of arthroplasty at short, intermediate and long-term of follow up with a disparity of results [15] [16] [17]. However, the early evaluation of functional outcome has not revealed any difference between ship the two types of shoulder arthroplasty especially before six months postoperatively [18] [19]. In addition, functional outcomes, at intermediate follow-up, in patients treated with hemiarthroplasty had never found a difference to those treaded

Table 2. Functional outcomes of both RSA and HA.

Outcome	RSA	HA	p-value
ASES pain score (Points)	56	41	0.51
Constant –Murley (Points)	76	59	0.048
Active abduction(°)	90	100	0.7
Active anterior elevation (°)	111	88	0.003
External rotation with arm by side(°)	28	19	0.6

Table 3. Complication rates of both RSA and HA.

Complications	Number (%) of	Number (%) of	p-value
	complications RSA	complications HA	
Infection	1 (5)	2 (5)	0.53
Hematoma	2 (10)	3 (7)	0.63
Resorption	2 (10)	7 (18)	0.03
Non union	2 (10)	5 (13)	0.04
Mal union	1 (5)	3 (7)	0.52
Dislocation	0 (0)	3 (7)	0.003
Nerve palsy	1 (5)	2 (5)	0.043
Stiffness	3 (15)	7 (18)	0.047
Periprosthetic fracture	0 (0)	0 (0)	0



Figure 1. (a) Anteroposterior radiograph indicating glenoid wear after failed hemiarthroplasty; (b) Anteroposterior radiograph indicating non-union of tuberosities; (c) Anteroposterior radiograph indicating a resorption of tuberosities after hemiarthroplasty.

even conservatively or with others devices such as nail or plates a part from fractures morphology, demographic characteristics and surgical approaches. However, the functional results at long-term follow-up were found to be better in reverse shoulder arthroplasty than in hemiarthroplasty group [20] [21] [22]. The authors felt that the good functional outcome seen in their series supported the use of reverse shoulder arthroplasty as a treatment option for elderly patients with complex acute proximal humeral fractures [8]-[23]. Comparative series studying functional results in both hemiarthroplasty and reverse shoulder arthroplasty are rare [24] [25]. The most reported results agreed that functional outcomes at intermediate and long-term follow-up are better than the fractures treated with hemiarthroplasty [26] [27]. In fact, reviewing the literature, the first fractures were treated by hemiarthroplasty: this option needs to respect some obligations such as, tuberosities reconstruction, conservation of the humeral length and ideal retroversion [28] [29]. Whereas, it is so difficult to respect all these details that can lead to an early failure of the surgery [29]. Displacement

and non-union of tuberosities are the most reported complications after hemiarthroplasty and functional outcomes may be affected by these complications [30]. Through the literature, functional outcomes of hemiarthroplasty, indicated for complex proximal humerus fractures, have been found to be various but several conclusions have been established concerning the relationship between the outcomes and this options: it is well known that the functional outcome depends on the quality of tuberosities reconstruction and the surgical recommendations at the time of hemiarthroplasty procedure: malposition may lead to non union and inferior functional results [30] [31] [32]. Some authors have published superior outcomes after reverse shoulder arthroplasty as compared with hemiarthroplasty; most reports have presented Level-III evidence [9] [30] [31] [32] [33] [34] [35] (Table 4). Obviously, in case of reverse shoulder arthroplasty, functional results were not affected by malunion or nonunion of the tuberosities as much as in case of hemiarthroplasty, in addition, the recovery is obtained quickly without careful mobilization during rehabilitation [33] [34]. As a matter of fact, reverse shoulder arthroplasty represents an excellent solution for elderly patients with cuff tear arthropathy, degenerative arthritis and proximal humeral malunion [31] [32] [35]. Moreover, it is considered as a solution for several problems associated in preoperatively to acute fractures or occurring in post-operatively after hemiarthroplasty as complications [33] [34] [35]. Until now, no prospective randomized trials comparing reverse shoulder arthroplasty with hemiarthroplasty has been published. Some systematic reviews have found that reverse shoulder arthroplasty improves range of motion and functional outcome scores (ASES, Constant-Murley, and Oxford scores), with no difference in the rate of complications comparing to hemiarthroplasty group [34] [35]. On the basis of the current literature, reverse shoulder arthroplasty in acute complex fractures of the humeral head seems to provide satisfied functional outcomes especially at intermediate and long-term follow-up.

Our study has several limitations. Firstly, the patient groups were not equivalent at baseline because they differed with respect to age, sex, and demographic characteristics. Multivariate analyses were performed to adjust the Constant comparison for these potential confounding variables, however, and this had no effect on the significance of the differences between the two patient groups. Secondly, preoperative Constant score was not assessed, which would have assisted interpretation of postoperative function. However, because the patients in our study were all admitted and managed acutely after shoulder trauma, the validity of pre-morbid shoulder functional assessment is questionable. Thirdly, we don't have preoperative or postoperative radiographic assessment, assessment of associated soft tissue injury, or the specific indications for RSA or hemiarthroplasty in each case, restricting result stratification with respect to fracture severity, soft tissue damage, tuberosities healing, and treatment algorithm. Tuberosities healing are of particular importance, because near-anatomic tuberosities healing in hemiarthroplasty patients has been shown to significantly positively affect

Table 4. Comparative functional outcomes in both RSA and HA through the literature.

Author, Year	Level of Evidence	No. of Patients	Age (year)	Duration of Follow-up (mo)	Outcome	Forward Elevation (°)	External Rotation (°)	Complications
Gallinet ⁹ , 2009								
RSA	IV	16	74 (58 to 84)	12 (4 to 18)	Constant, 53 (34 to 76) DASH, 37 (12 to 65)	98 (20 to 150)	9 (0 to 80)	scapular notching (15) Infection (2), CRPS (1),
Hemi		17	74 (49 to 95)	16 (6 to 55)	Constant, 39 (19 to 61) DASH, 41 (18 to 60)	54 (30 to 100)	14 (0 to 30)	tuberosity malunion (3) Neurologic (1), CRPS (2), infection (1),
Young ³⁰ , 2010								
RSA	IV	10	77	22 (16 to 37)	ASES, 65 (40 to 88) Oxford, 28.7 (15 to 56)	115 (45 to 140)	49 (5 to 105)	Scapular notching (2; 20%), tuberosity nonunion (1)
Hemi		10	76	44 (24 to 56)	ASES, 67 (26 to 100) Oxford, 22 (12 to 34)	108 (50 to 180)	48 (10 to 90)	Tuberosity malunion (2; 20%), infection (1), persistent pain requiring revision (1)
Garrigues ³¹ , 2012								
RSA	IV	10	80 (67 to 97)	3.6 yr (1.3 to 3.8 yr)	Penn, 82 (73 to 99) ASES, 81 (75 to 88) SANE, 85 (70 to 95)	121 (90 to 145)	34 (10 to 45)	Scapular notching (1)
Hemi		9	69 (57 to 87)	3.6 yr (1.3 to 3.8 yr)	Penn, 53 (29 to 86) ASES, 47 (30 to 81) SANE, 39 (0 to 90)	91 (30 to 140)	31 (5 to 60)	Tuberosity nonunion (2), neurologic (2)
Cuff ³³ , 2013								
RSA	II	27	74.8 (70 to 86)	29 (24 to 36)	ASES, 77 (67 to 82) SST, 7.4 (6 to 9)	139 (102 to 172)	24 (8 to 42)	Transient ulnar paresthesia (1), periprosthetic fracture (1)
Hemi		26	74.1 (70 to 88)	39 (36 to 48)	ASES, 62 (28 to 84) SST, 5.8 (1 to 9)	100 (30 to 170)	25 (0 to 48)	Tuberosity nonunion (3), Hematoma (1), pneumothorax from intrascapular nerve block (1)
Boyle ³² , 2013								
RSA	III	55	79.6 (57 to 90)	60	Oxford, 41.5			Revision rate, 1.7%
Hemi		313	71.9 (27 to 96)	60	Oxford, 32.3			Revision rate, 1.1%
Sebastiá ³⁴ 2014								
RSA	III	31		28.5	Constant 56.1	120.3		Notching (1)
HA		31			Constant 40.0	79.8		56.6% of tuberosities healed and 30% resorbed Infection (1)
Ferrel ³⁵ 2015								
RSA	IV			12	Constant score 54.6 ASES 64.7	118	20	
HA						Constant score 58 ASES 63.0	108	30

patient outcomes [5]. Fourthly, functional evaluation was restricted to the Constant score, which is purely a subjective scoring system. Objective functional evaluation, with assessment of range of motion and power, would have significantly strengthened our group comparisons.

5. Conclusion

Management of acute complex proximal humerus fractures is until now controversial especially in elderly. Shoulder arthroplasty has been considered as a successful option for these injuries. Series comparing the functional outcomes in both reverse shoulder arthroplasty and hemiarthroplasty are rare. The reported results in literature showed a better pain relief, range of motion and Constant score in reverse shoulder arthroplasty than hemiarthroplasty with a similar complication rates. Our results support reverse shoulder arthroplasty as a successful surgical option for patients with acute proximal humeral fractures requiring prosthetic replacement of the humeral head.

Disclaim

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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