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ORIGINAL ARTICLE

Revision shoulder arthroplasty for failed surface replacement hemiarthroplasty

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Abstract

Purpose The aim of this study was to assess the reasons of failure of shoulder surface replacement hemiarthroplasty (SRH) and to evaluate the outcome of revision surgery.

Method The study group included 25 patients (26 shoulders) with failed SRHs. The mean time to revision surgery was 3.6 years. Their functional outcome was evaluated using adjusted Constant–Murley score at mean follow-up of 5.2 years (range 2–16 years).

Result Most common cause of failure was glenoid erosion (42%) and progressive failure of rotator cuff (31%). Median adjusted Constant–Murley score at mean follow-up of 5.2 years was 51.6. Median adjusted Constant–Murley score in patients who had primary diagnosis of osteoarthritis and had revision performed to anatomic TSA (14 shoulders) was 85 (range 40–100) at mean follow-up of 5 years compared to 36.3 (range 20–66.3) in the remaining patients at 5.4 years, $p = 0.00008$.

Conclusion Revision surgery for failed SRH can be technically challenging with variable results. Most common mode of failure was glenoid erosion. Functional outcomes are better in those with revision performed to anatomic TSA.

Keywords Surface replacement hemiarthroplasty · Shoulder resurfacing · Revision

Introduction

Copeland surface replacement was introduced for clinical use for management of the shoulder arthritis in 1986 [1]. In 1993 Mark-3 design was introduced with hydroxyapatite coating [1]. Levy et al. were the first reporting midterm outcomes of the shoulder resurfacing in 2001. In this series 94% patients felt that their shoulder was improved after the surgery. The authors reported that rate of revision surgery was comparable with the published literature on stemmed hemiarthroplasty (SH). They recorded ease of revision surgery with regard to removal of the component and preservation of the bone stock [2].

In subsequent studies from the same center, the authors reported similar results of the total and surface replacement hemiarthroplasty (SRH). Glenoid resurfacing was indicated with significant posterior erosion or biconcave glenoid with intact cuff [3]. There are few studies in the published literature reporting good midterm functional results from inventor's institution as well as independent centers [2–8]. Survivorship has been reported ranging from 98.2% at 5 years to 98% at 10 years [1, 6]. Overall, a revision rate of different modifications of Copeland SRH over 20 years was 6.87%. This improved to 2.6% after introduction of hydroxyapatite coating in Mark-3 prosthesis [1]. However, data from the Norwegian and Danish arthroplasty register showed no difference in revision rates between SRH and SH [9, 10].

Potential advantages of resurfacing are minimal bone resection, no need to address head–shaft angle, short operative time, lower prevalence of peri-prosthetic fractures and ease of revision to the total shoulder replacement [11]. Although ease of revision surgery has been perceived as one of the advantages of resurfacing, there has been only one study in the literature, which has reported variable 1-year functional outcomes of revision surgery.

The aim of our study was (1) to analyze reasons of failure of SRH and (2) to report functional outcome after revision surgery.

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Methods

This is a retrospective case series approved by the hospital's ethics committee. Between 1995 and 2009, one hundred and thirty-one patients (148 shoulders) with glenohumeral arthritis were managed with SRHs using Copeland Mark-3 prosthesis (Biomet Merck, Swindon, UK). Twenty-six shoulders have been revised in 25 patients (Table 1). There were seven males and 18 females. Mean age at the time of revision was 69 years (range 45–84 years). Mean interval from SRH to revision surgery was 3.6 years (range 6 weeks–8.9 years). The primary diagnosis was osteoarthritis in 15 (58%), rotator cuff arthropathy in five, secondary osteoarthritis in three and rheumatoid arthritis in two cases (Table 1).

The decision on the need for the glenohumeral joint revision surgery was made by the senior authors (SH and CPK) based on the signs and symptoms of glenohumeral joint pain. Where there was doubt about the nature of pain, selective bursal and glenohumeral joint injections were performed to confirm the glenohumeral joint symptoms. Inflammatory markers were done to rule out infection, and if there was a suspicion of infection, the shoulder was aspirated for culture and sensitivity. Ultrasound scan was performed to assess rotator cuff if there was clinical suspicion of rotator cuff tear. CT scan was performed to assess glenoid bone stock if there was concern on plain radiographs. Five patients had a CT scan, and glenoid was of Walch type B1 in three and type B2 in two cases [13]. Revision surgery was performed using a deltopectoral approach with (three) or without clavicular osteotomy (23). Multiple intraoperative samples were sent for culture and histology to exclude infection. Sixteen (61%) cases had anatomic total shoulder arthroplasty (TSA), of which nine had Affinis (four short stem) (Mathys European Orthopedics, Bettlach, Switzerland), four had Nottingham TSA (Biomet, Bridgend, UK), two had Global TSA (DePuy, Leeds, UK), and one had Copeland total resurfacing (Biomet Merck, Swindon, UK). Seven (27%) cases were revised to a reverse shoulder replacement for rotator cuff failure, out of which four had Delta 3 reverse shoulder replacement (DePuy, Leeds, UK), two had Affinis (Mathys European Orthopedics, Bettlach, Switzerland), and one had Biomet reverse shoulder replacement (Biomet, Bridgend, UK). In addition, one (11%) each had Nottingham bipolar hemiarthroplasty (Biomet, Bridgend, UK), Affinis hemiarthroplasty (Mathys European Orthopedics, Bettlach, Switzerland) and EPOCA reconstruction glenoid (Argomedical USA Inc., Redondo Beach, CA).

Patients were followed up in the clinic and assessed with Constant–Murley score [12]. Constant–Murley scores were adjusted for age and gender [14]. Data were prospectively collected on all the patients and recorded in the shoulder database. Radiographs were taken at each visit to assess for loosening and wear of the components. To delineate the importance of intact rotator cuff, outcomes of patients who had primary diagnosis of osteoarthritis and had revision performed to an anatomic TSA (group 1) were compared with the rest of the patients (group 2).

Statistical analysis

Descriptive statistics are reported as mean (range) for the continuous variable and median (range) for the ordinal variables. Postoperative outcome scores were regarded as ordinal variable. The Constant–Murley score between two groups of patients (group 1: primary osteoarthritis with intact rotator cuff and group 2: patients with failed rotator cuff) was compared using Mann–Whitney test. IBM SPSS statistical software 20.0 (SPSS Inc., Chicago, IL) was used for statistical analysis, and p value ≤ 0.05 was considered significant.

Results

Twenty-six shoulders in 25 patients underwent revision surgery. The reasons of failure are explained in Table 2.

Glenoid erosion was the most common reason for revision (42%) (Table 2) (Figs. 1, 2). It was peripheral in all cases except one patient in which exact location was not recorded. It was antero-superior in two patients in which it was associated with the thinning of the rotator cuff. In seven shoulders glenoid erosion was posterior. One shoulder had antero-inferior glenoid erosion. Majority (10) were revised to anatomic TSA. Eccentric reaming was sufficient to correct glenoid version in cases with glenoid erosion. Bone grafting was not required in any patient. One patient (case 26) was revised to hemiarthroplasty because of the inability to expose glenoid during surgery (Table 1).

Eight shoulders (31%) were revised for failure of the rotator cuff. Primary diagnosis in five of these was rotator cuff arthropathy, two had rheumatoid arthritis, and one patient had arthritis secondary to Paget's disease. Seven of these underwent reverse total shoulder replacement, and one had constrained glenoid (Table 1).

Four shoulders (15%) were revised for pain to an anatomic TSA.

Two shoulders (8%) were revised for infection, one of which (case 14) developed acute postoperative infection and underwent two-stage revision with a successful outcome. Another shoulder (case 15) presented with infection 5 months after the surgery and underwent single-stage revision to total surface replacement (Table 1).

Table 1 Details of all the cases with survival of primary SRH, follow-up (years) of revision surgery and outcome scores at most recent follow-up

Case no.	Age (years)	Survival	Primary diagnosis	Reason revised	Revision prosthesis	Approach	Follow-up (years)	Pre-op adjusted Constant score	Post-op adjusted Constant score
1	76	3.7	OA	Glenoid erosion	Nottingham TSA	DP	8.2	NA	83.6
2	52	2.7	OA	Glenoid erosion	Mathys Affinis TSA	DP	4.0	55.2	44.3
3	61	5	OA	Glenoid erosion	Mathys Affinis (short stem) TSA	DP	4.3	33	97.6
4	69	3	OA	Glenoid erosion	Mathys Affinis TSA	DP	3.5	54.4	98.4
5	61	1.9	OA	Glenoid erosion	Global TSA	DP + clavicular osteotomy	9.6	NA	84.2
6	72	3	OA	Glenoid erosion	Mathys Affinis (short stem) TSA	DP	4.9	28.2	40.8
7	74	6.9	OA	Glenoid erosion	Global TSA	DP	2.7	40.6	76.6
8	80	3.8	OA	Glenoid erosion	Mathys Affinis TSA	DP	4.5	NA	96.9
9	74	4.7	OA	Glenoid erosion	Mathys TSA	DP	2.7	40.6	89
10	79	5	OA	Pain	Mathys Affinis (short stem) TSA	DP	2	78	100
11	91	2.5	OA	Pain	Mathys Affinis (short stem) TSA	DP	3.9	NA	100
12	67	3.2	OA	Pain	Nottingham TSA	DP	10.5	17.1	42.2
13	67	1.8	OA	Pain	Mathys TSA	DP + clavicular osteotomy	2.1	21.7	56.7
14	72	0.1	OA	Infection	Two-stage revision Nottingham TSA	DP	6.4	NA	85.9
15	46	0.5	Ochronosis	Infection	Copeland TSA	DP	16.2	NA	30
16	84	8.5	Paget's	Pain	Delta 3 reverse	DP	5.4	21.3	27.9
17	66	1.4	Cuff tear arthropathy	Migration of humeral head	Delta 3 reverse	DP + clavicular osteotomy	7.9	24.1	54.9
18	79	0.6	Cuff tear arthropathy	Migration of humeral head	Delta 3 reverse	Superolateral	2.6	NA	39
19	61	2.9	Cuff tear arthropathy	Migration of humeral head	Delta 3 reverse	DP	5.1	NA	20
20	68	5.2	Cuff tear arthropathy	Rotator cuff failure	Mathys reverse	DP	2	22.9	66.3
21	59	3	Cuff tear arthropathy	Rotator cuff failure	Biomet reverse	DP	2	11.3	35.2
22	45	3.6	RA	Glenoid erosion	Nottingham TSA	DP	8.2	11.8	37.3
23	61	4	RA	Rotator cuff failure	Mathys reverse	DP	2.8	NA	35.7
24	70	5.9	OA	Pain	Mathys, EPOCA	DP	7	65.7	33.8

Table 1 (continued)

Case no.	Age (years)	Survival	Primary diagnosis	Reason revised	Revision prosthesis	Approach	Follow-up (years)	Pre-op adjusted Constant score	Post-op adjusted Constant score
25	79	1.5	OA	Aseptic loosening	Nottingham bipolar	DP	2.1	NA	40
26	80	8.9	OA	Glenoid erosion	Mathys hemiarthroplasty	DP	4.1	NA	35.6

OA Osteoarthritis, *RA* rheumatoid arthritis, *DP* deltopectoral, *TSA* total shoulder arthroplasty

Table 2 Reasons for revision of surface replacement hemiarthroplasty with mean time to revision in years

Reason for revision	Number (percentage)	Mean time to revision (years)
Glenoid erosion	11 (42)	4.3
Rotator cuff failure	8 (31)	3.9
Pain from glenohumeral joint	4 (15)	3.1
Prosthetic infection	2 (8)	0.3
Aseptic loosening	1 (4)	1.5

One shoulder (4%) (case 25) was revised to a bipolar prosthesis for aseptic loosening (Table 1).

Complications

Eight patients had further complications, which are summarized in Table 3.

Functional outcome

At the mean follow-up of 5.2 years (range 2–16 years), median Constant–Murley score was 40.5 (range 14–81). Median postoperative adjusted Constant–Murley score was 51.6 (range 20–100).

To delineate the importance of intact rotator cuff, outcomes of patients who had primary diagnosis of osteoarthritis and had revision performed to an anatomic TSA were compared with the rest of the patients. These two groups had similar preoperative demographics, $p = 0.33$. Median adjusted postoperative Constant–Murley score in patients who had primary diagnosis of osteoarthritis and had revision performed to anatomic TSA (14 shoulders) was 85 (range 40–100) at mean follow-up of 5 years compared to 36.3 (range 20–66.3) in the rest of the group at 5.4 years, $p = 0.00008$.

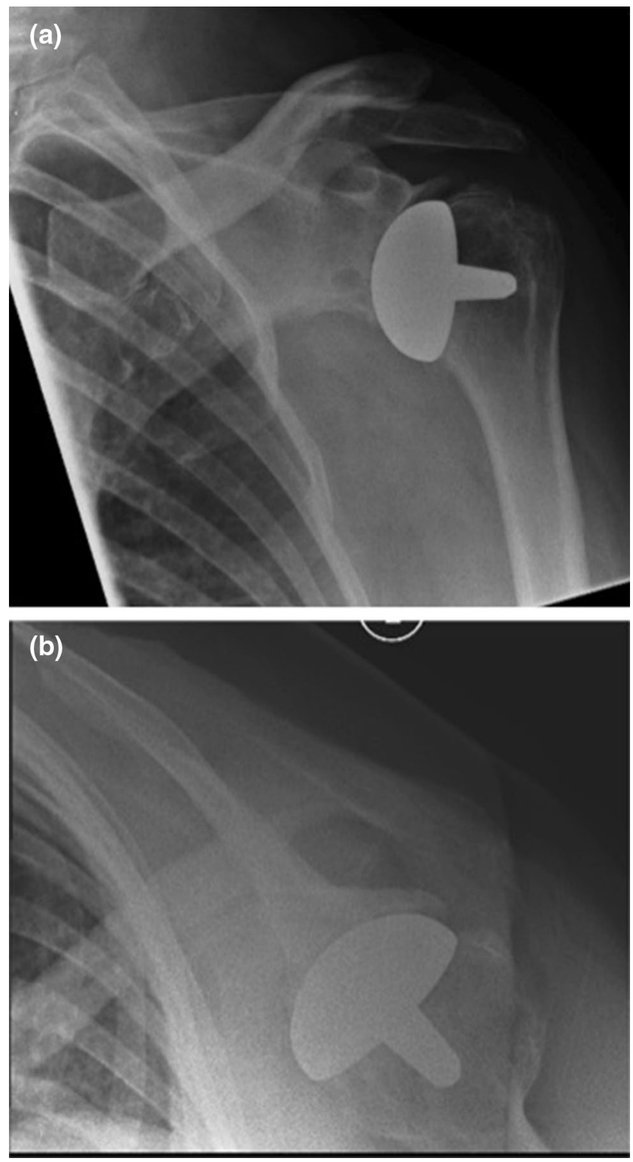

Fig. 1 Five-year post-primary SRH radiograph of case 9 showing antero-inferior erosion: **a** AP view and **b** axillary view

Fig. 2 Follow-up radiograph at 2.7 years after revision to anatomic TSA showing well-fixed prosthesis: **a** AP view and **b** axillary view

Discussion

The main finding of our study was that glenoid erosion was the most common cause of failure of SRHs, followed by failure of rotator cuff. There are few studies published in the literature looking at the outcome of Copeland SRH. However, most of the early series published are small and report low failure [2–6, 8].

However, longer follow-up data from Danish arthroplasty register showed cumulative revision rate of 13% in 1210 SRH at 8 years in patients with primary diagnosis of osteoarthritis. Glenoid erosion (27%) followed by rotator cuff dysfunction (22%) were the two most common reasons for revision surgery [15].

The latest annual report from the National Joint Replacement Registry in Australia recorded 10% 7-year cumulative rate of revision of 517 Copeland SRH which was similar to SH. Most common mode of failure was pain and glenoid erosions (24.2% each) followed by rotator cuff tear (15.6%) [16].

Sperling, Carroll and Rispoli also cite glenoid erosion as the most common mode of failure of the SH [17–19]. One of the reasons for the asymmetric glenoid wear is humeral head subluxation. Carroll has suggested contracture of anterior capsule and subscapularis along with attenuation of posterior capsule can lead to posterior–superior glenoid erosion [16]. In fact, any imbalance in the functioning of rotator cuff can lead to loss of concentric articulation of humeral head and glenoid and can lead to asymmetric erosion.

Overstuffing of humeral head can lead to glenoid erosion and pain postoperatively [8]. Recent studies have used standardized radiographs and CT scan to measure change in the humeral offset after SRH. Mechlenburg et al. used preoperative and 6-month postoperative standardized radiographs. They reported a significant increase in the lateral glenohumeral offset on the postoperative radiographs. In this study, over 5-year period five of the 13 revisions were done because of pain due to overstuffing of the joint [20]. A CT scan-based study showed a significant increase in the medial humeral offset, but no significant change in the lateral glenohumeral offset at mean follow-up of 18 months (2.6–57 months). Glenoid wear can result in stabilization of the lateral glenohumeral offset despite an increase in the medial glenohumeral offset. Follow-up in this study was too short to assess this possibility, although most of the glenoid showed concentric wear at the last follow-up [21]. Soudy et al. in their CT scan-based study reported an increase in medial humeral offset as well as lateral glenohumeral offset and glenoid wear at a longer mean follow-up of 56 months. They concluded that excessive lateral glenohumeral offset led to an increase in rotator cuff stress and glenoid wear [22]. Due to the lack of standardized radiographs we were not able to measure change in the offset in our study.

There is only one study in the literature, which has reported functional outcomes after revision of failed SRH. Rasmussen et al. reported 1-year outcome after revision of failed SRH in patients with osteoarthritis, from Danish joint registry. Out of 107 revisions, 80 completed 1-year Western Ontario Osteoarthritis of the Shoulder (WOOS) index. Median WOOS was 62 points. Thirty-three (41%) of these patients had an unacceptable outcome with a WOOS of ≤ 50

Table 3 Complication following revision of surface replacement hemiarthroplasty. Follow-up in months after revision surgery, when the complication was detected

Case no.	Complication	Follow-up since revision surgery (months)	Outcome
2	Aseptic glenoid loosening	36	No intervention due to patient developing unrelated malignancy
6	Subscapularis failure	12	Reconstruction of subscapularis tendon using graft jacket, subsequent failure. Patient declined further intervention
12	Subacromial impingement	84	Subacromial decompression with resolution of symptoms
15	Aseptic loosening, both components	120	Patient declined further intervention
16	Dislocation of reverse TSR	1	Closed reduction
17	Aseptic glenoid loosening	96	Patient declined further intervention
24	Aseptic loosening, both components	84	Patient declined further intervention
25	Rotator cuff tear and glenoid erosion	24	Patient declined further intervention

points at such a short follow-up. Eleven shoulders (10%) required further revision surgical procedures. Revision to SH (39) and anatomic TSA (31) had significantly worse outcome than primary SH and anatomic TSA. According to authors this may be related to surgeons' experience in performing primary and revision procedures [15].

Integrity of rotator cuff has implication on ultimate success of the revision surgery. Rhee et al. noted significantly less improvement in range of motion after conversion of the SH to total shoulder arthroplasty, in patients requiring complex soft tissue repair of rotator cuff and greater tuberosity [23]. Sassoon et al. reported 38 unsatisfactory results out of 68 revision total shoulder arthroplasty performed for painful glenoid arthrosis. Although there was no statistical significant difference in outcomes between simple vs complex soft tissue reconstruction, authors concluded that soft tissue had substantial contribution to complication of instability. They recommended that reverse shoulder replacement should be considered as a revision option for patients with preoperative instability due to a large or massive rotator cuff tear or thinning with stretching of the anterior shoulder capsule and subscapularis [24, 25].

In our series, patients with the primary diagnosis of osteoarthritis and functioning rotator cuff, who underwent revision to an anatomic TSA, had mean Constant score of 54.8 (range 30–81) which is comparable to mean Constant score of 50.6 (range 33–69) in 16 patients who underwent revision TSA for painful SH [26]. Function in this group was significantly better with median adjusted postoperative Constant–Murley score of 85 compared to 36.3 in the rest of the group, underlining the importance of soft tissues.

One of the arguments in favor of SRH versus SH is the ease of revision. These procedures in our view were technically challenging. Although the removal of prosthesis was easy, adequate exposure and soft tissue release required an extensile approach in the form of clavicular osteotomy in three cases. In the presence of glenoid erosion careful eccentric reaming was performed to correct the glenoid version. Levy et al. reported problems regarding exposure during surgery for revision in the patients with total shoulder resurfacing. In three out of four total shoulder resurfacings requiring glenoid revision, the humeral prosthesis had to be removed in spite of being well fixed to gain access to the glenoid [2]. Primary SRH is technically easier surgery than stemmed hemiarthroplasty. Although the removal of the humeral surface replacement at revision is easy to perform, other aspects of surgery like exposure, glenoid erosion, soft tissue contracture and integrity of rotator cuff are challenging problems, which potentially adversely affect the outcome of revision surgery. Rasmussen et al. concluded that, functional outcomes after revision of failed SRH are variable and, in many cases, disappointing. When SRH is used in the treatment of osteoarthritis, revision cannot be counted upon as a fallback [15].

There are some limitations to our study. Firstly, this is a case series with small numbers and we did not have a control group to compare our results. However, all the data were prospectively collected minimizing selection bias. Secondly, different implants were utilized for revision surgery. However, the senior author (CPK) was involved in all cases of revision, thus limiting bias in variables like operative technique and rehabilitation protocol. Thirdly, preoperative outcome scores were not available for all the patients, so the evaluation of magnitude of change in function was not possible in every patient.

Conclusion

This is the first study reporting midterm functional outcome of revision surgery for failed SRH. The glenoid erosion was the most common mode of failure. Outcomes of revision surgery are unpredictable, but patients with diagnosis of primary OA and intact rotator cuff had statistically better outcomes than patients with failed rotator cuff.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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