

Clinical and radiographic mid-term outcomes after shoulder resurfacing in patients aged 50 years old or younger

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Abstract

Purpose Humeral resurfacing is a treatment option to conventional shoulder arthroplasty, conferring the advantages to preserve the bone stock and the normal joint geometry. Aim of the current study was to report clinical and radiographic mid-term outcomes in a population of 60 patients, aged 50 years or younger, who underwent shoulder resurfacing in osteoarthritis.

Methods The mean age was 48 ± 8.4 , 36 were male and 24 female, dominant arm in 43 cases. Glenoid arthritis was treated in 36 cases (60 %) using a meniscus allograft in 22 cases, biologic patch in 4 cases and microfractures in 10 cases. Clinical and radiographic assessment was performed with Constant-Murley score and standard X-ray.

Results At an average follow-up of 44 months, the mean values of the constant score increased of 30 points ($p < 0.05$), the pain decreased of 4.56 points ($p < 0.05$) and the Simple Shoulder Test increased of 4.3 points ($p < 0.05$). We found lower scores ($p > 0.05$) in 9 patients (15 %) treated for glenoid arthritis using homologous meniscus (7 cases) and biologic patch (2 cases). A significant narrowing of joint space (5.92 mm postoperative versus 1.65 mm at 37 months) ($p < 0.05$) was found in the

22 cases treated with meniscus interposition. In 4 cases with type A2 preoperative glenoid morphology and in 9 cases type B1, we registered significantly lower scores compared with the overall study population ($p < 0.01$). Five unsatisfied patients (7 %), underwent to meniscus removal and glenoid reaming in 3 cases and conversion in total shoulder arthroplasty in 2 cases.

Conclusions Resurfacing arthroplasty is an effective device in young patients with advanced glenohumeral arthropathy; however, the high rate of postoperative glenoid erosion and the failure of biologic allograft lead us to consider glenoid replacement as the best option to improve clinical outcomes.

Keywords Shoulder · Resurfacing · Young patients · Glenoid erosion

Introduction

Shoulder osteoarthritis is a common source of pain and disability affecting middle age and older subjects with a prevalence of 17 % [1]. Shoulder replacement guarantee satisfactory results through the restoring of shoulder congruity that induces marked improvement in proprioception [2].

Resurfacing was originally designed in 1970 [3] as a treatment option to conventional shoulder arthroplasty, conferring the advantages to preserve the bone stock and the normal joint geometry [4]. These first implants, made of stainless steel, had non-central stem and were fixed to the proximal aspect of the humerus with methylmetacrylate cement [3]. Later, in 1979, Copeland developed a cementless surface replacement that consisted of a central pegged humeral prostheses secured by a screw to the lateral cortex

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combined with an all polyethylene glenoid component [5]. Modern resurfacing hemiarthroplasty have variables shapes, diameters and lengths of the central humeral stem and a hydroxyapatite coating to encourage the bone ingrowth [6]. Severe bone loss with no surface to replace, acute four-part fractures or non-union represent a limitation for shoulder resurfacing and require a stemmed prostheses [7].

Aim of this study was to report the clinical and radiographic mid-term outcomes in a population of 60 patients aged 50 years or younger who underwent shoulder resurfacing in osteoarthritis.

Materials and methods

Study population and prosthetic design

All the patients gave informed consent prior being included in the study. The study was authorized by the local ethical committee and was performed in accordance with the Ethical Standards of the 1964 Declaration of Helsinki as revised in 2000. Among 984 shoulder arthroplasty performed from January 2005 to March 2011, we enrolled 60 patients treated with humeral head replacement for shoulder osteoarthritis. The mean follow-up was 44 months (range 24–62). We used 25 Mark II Copeland CSRA (Biomet, Swindon, UK), 3 Mark III Copeland CSRA (Biomet Merck, Swindon, UK), 28 SMR resurfacing (LIMA, San Daniele del Friuli—Italy), 3 Global C.A.P.[®] (DePuy, Warsaw, IN, USA) and 1 HemiCAPTM (Arthro-surface, Franklin, MA, USA). Demographic data of the study population are described in the Table 1. Overall patients' medical records were reviewed to search for the size of the prostheses that were implanted.

Clinical investigation

Clinical assessment was performed with the scale of Constant-Murley (CS) [8] and Simple Shoulder Test (SST) [9]. Subjective pain was recorded using VAS score, including overall pain, pain at night, pain with activity and

pain without activity, rated on a scale ranging from 1 (no pain) to 10 (severe pain).

Radiographic analysis

Standard X-ray (AP Grahey view and axillary view) were preoperatively performed to grade the stage of osteoarthritis according to Samilson-Prieto [10]. An additional CT scan or MRI was performed in all patients to evaluate glenoid morphology using the criteria reported by Walch et al. [11]. The following radiologic features were depicted on the postoperative Grashey view radiograms: prostheses height, acromiohumeral interval and cervico-diaphyseal angle. Lucency lines around the implant were classified on their thickness (<1, 1–2, >2 mm) and locations.

Glenohumeral joint space, glenoid wear and prostheses stability were assessed on standard axillary view [12].

Surgical technique

All procedures were performed by a single operator (G.P). We used a standard delto-pectoral approach with the patient in beach-chair position under general anesthesia in combination with an interscalene block. We identified the delto-pectoral interval checking for the cephalic that was retracted laterally. We assessed the anatomic integrity of the rotator cuff, we marked the subscapularis with a suture and we performed a lesser tuberosity osteotomy. The capsule was completely excised to expose the joint with a Fukuda retractor. When the subscapularis and the capsule were released, the humeral head was dislocated by external rotation, adduction and extension of the humerus (Fig. 1). We located the center of the head using a k wire as guide (Fig. 2), and we reamed with fully cannulated instruments system to restore humeral head shape and contour to allow a close fit of the final implant (Fig. 3). We drilled the central hole for the tapering docking peg (Fig. 4), we placed the trial head to choose the size and we fixed the resurfacing head having a Ti and plasma spray HA coating on their under side to aid fast osteointegration and resulting stability (Fig. 5). Glenoid arthritis was treated in 36 cases (60 %) performing the following associated procedures: biologic resurfacing with homologous meniscus in 22 cases (37 %) (Fig. 6), biological patch (Hyalofast[®], Fidia Advanced Biopolymers S.r.l. Abano Terme—PD, Italy) in 4 cases (6 %) and microfractures in 10 cases (16 %). At the end of the procedure, we assessed joint motion and we performed the drawer test to evaluate the prostheses stability. A compressive bandage was applied and the limb was placed in a sling. Assisted passive mobilization in the scapular plane begun the day after surgery. Active mobilization, including internal and external rotation, were allowed after 35 days. Strengthening exercises with elastic resistance begun after 2 months.

Table 1 Demographic data of the study population

Variable	Data
N ^o	60
Age (years) (mean ± SD)	48 ± 8.4
Sex (M/F) (%)	36 (60)/24 (40)
Dominant shoulder (N ^o)(%)	43 (72)
Preoperative diagnosis (N ^o) (%)	Primary arthritis (46) (77) Posttraumatic arthritis (14) (23)
Mean FU (months)	44



Fig. 1 Shoulder exposure through a delto-pectoral approach shows flattening of the humeral head and the osteophytes all around



Fig. 4 All osteophytes are removed before drilling the central hole for the tapering peg

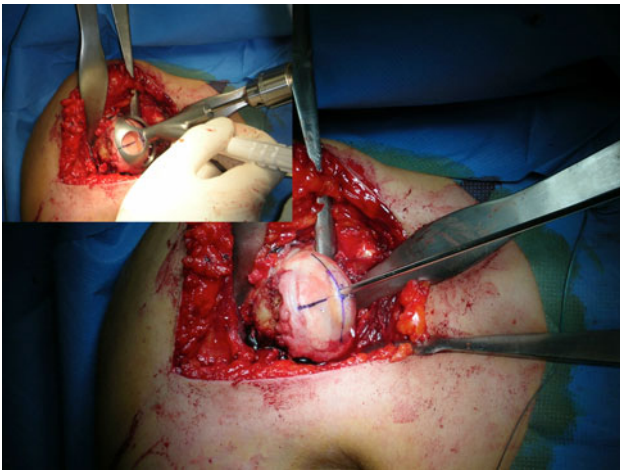


Fig. 2 A k wire is placed in the center of the humeral head to guide the reaming

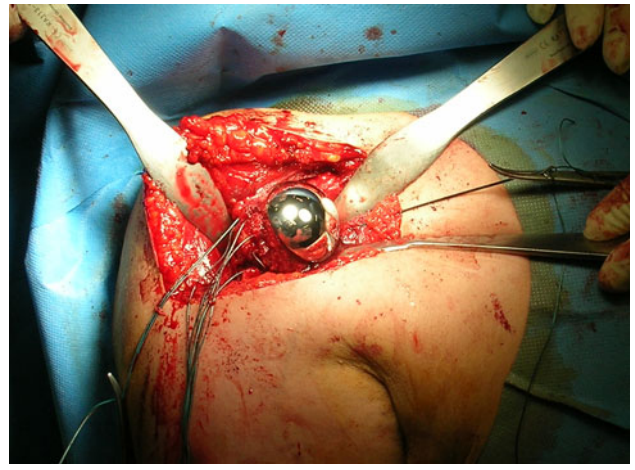


Fig. 5 We fix the head prosthesis and we test the intrinsic stability. Note the bone suture for subscapularis reattachment

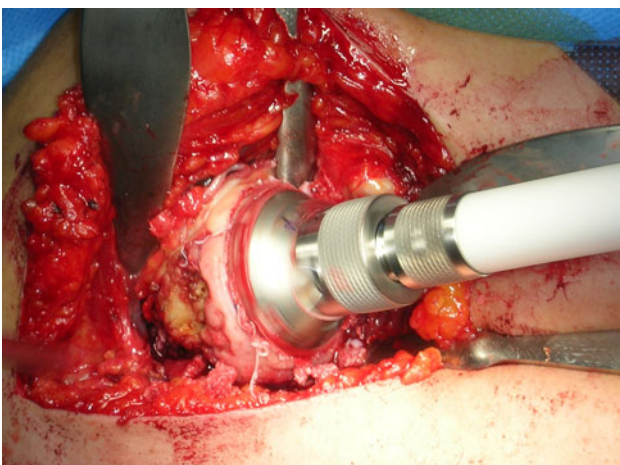


Fig. 3 Humeral head is reamed to restore the anatomic head shape

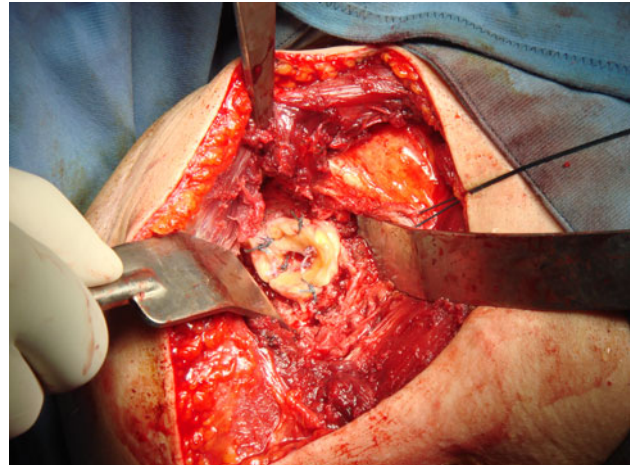


Fig. 6 Glenoid resurfacing with lateral meniscus allograft

Results

Clinical assessment

Results of the analysis of clinical records showed that the average prostheses size was 45.5 mm (range 42–50 mm). Preoperative versus postoperative values of CS score are reported in the Fig. 7. The mean values increased from 36.15 ± 7.4 to 66.4 ± 10.7 ($p < 0.05$). A significant increase of active range of motion (ROM) was registered ($p < 0.05$):

Forward elevation: 135° (range 110° – 145°) versus preoperative 90° (range 70° – 100°)

External rotation: 50° (range 30° – 60°) versus preoperative 10° (range 0° – 30°)

Internal rotation: 45° (range 30° – 50°) versus preoperative 15° (range 10° – 20°)

The mean “yes” response at SST passed from 3.9 ± 2.4 preoperatively to 8.2 ± 1.9 postoperatively ($p < 0.05$). Pain score and relative subscores significantly decreased ($p < 0.05$) (Table 2). When the results of CS were stratified, we found lower scores (min 41 max 54) in 9 patients (15 %) who had meniscus allograft (7 cases) and biologic patch (2 cases) to treat the glenoid arthritis. The subgroup with preoperative posttraumatic osteoarthritis had lower clinical scores (56.2 ± 9.8) but were not statistically significant ($p > 0.05$).

Five unsatisfied patients (8.3 %), complaining for pain and severe stiffness, underwent meniscus removal and glenoid reaming in 3 cases and conversion in total shoulder arthroplasty (TSA) in 2 cases.

Radiographic assessment

Among the 34 cases with primary osteoarthritis, 22 were classified as Samilson II (68 %) and 12 as Samilson III (32 %). The CT assessment of glenoid morphology showed

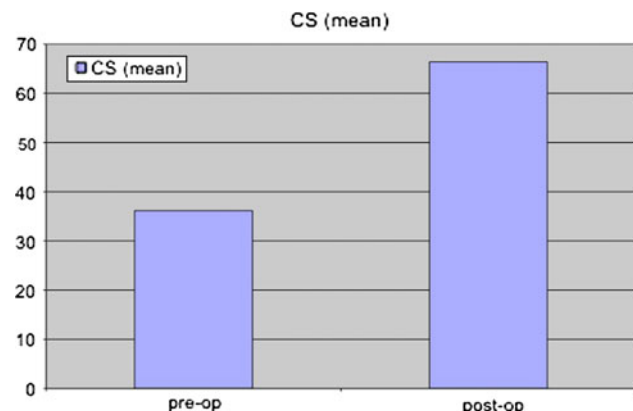


Fig. 7 Preoperative and postoperative constant score

Table 2 Comparison of preoperative and postoperative pain score

	Preoperative	SD	Postoperative	SD	p value
Pain overall	8.16	1.55	2.4	1.92	0.0093
Pain without activity	7.96	1.12	3.4	1.67	0.0098
Pain with activity	8.45	1.63	4.9	1.47	0.0297
Pain at night	8.34	1.2	4.2	1.37	0.0194

Data refer to mean values

p values refer to operative versus postoperative

SD standard deviation

a type A1 glenoid in 40 cases (78 %), type A2 in 11 cases (22 %) and a type B1 in 9 cases (15 %).

The average prosthetic height was 42.1 mm (range 2.92–5.41 mm), the implant inclination 129.8° (range 112° – 138°), the prosthetic height 0.8 mm (range 0–2.1 mm) and the acromiohumeral interval 6.8 mm (range 5.9–7.2 mm). Two cases of humeral head resurfacing in primary and posttraumatic osteoarthritis are reported in the Figs. 8 and 9.

Radiolucent lines <1 mm were found in 4 patients and were located beneath the inferior third of the implant. The average glenohumeral joint space registered at last follow-up in the overall population was 3.21 mm ($p > 0.05$) (Fig. 10), while a significant narrowing (5.92 mm postoperative vs. 1.65 mm at 37 months) ($p < 0.05$) was found in



Fig. 8 Postoperative X-ray (AP Grahey view) of the right humeral head resurfacing in primary osteoarthritis. The glenoid was not treated



Fig. 9 Postoperative X-ray (AP Grashey view) of the left humeral head resurfacing in posttraumatic osteoarthritis. The glenoid was treated with microfractures

the 22 cases treated with meniscus interposition; in additional 7 cases who had not had meniscus resurfacing of the glenoid (2 treated with Hyalofast membrane and 2 with microperforations), we found a concentric glenoid erosion (Fig. 11).

In 4 cases with type A2 preoperative glenoid morphology and in the 9 cases type B1, we registered significantly lower scores compared with the overall study population ($p < 0.01$).



Fig. 10 Postoperative X-ray in axillary view of the left humeral head resurfacing

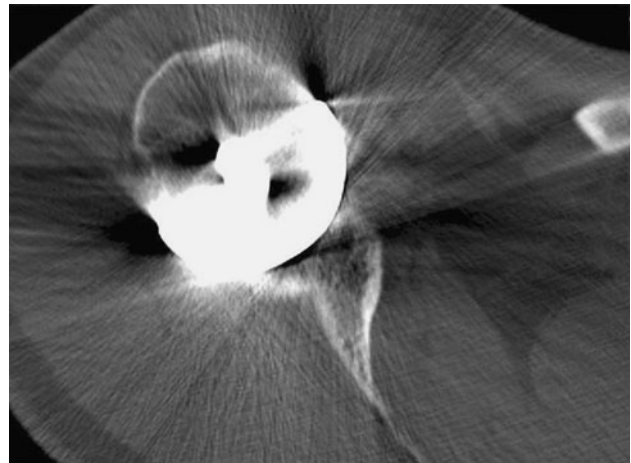


Fig. 11 CT axial scan of a painful right humeral head resurfacing before revision with total shoulder arthroplasty (case n.12). Note the concentric glenoid erosion

The analysis of the remaining radiographic parameters showed no significant correlations with clinical outcomes ($p > 0.05$).

Discussion

Resurfacing is indicated to relieve pain and increase shoulder function in patients with arthrosis [13], inflammatory arthritis [14] and osteonecrosis [15]. Surface replacement is advantageous for minimal bone resection and primary bone-ingrowth fixation; furthermore, it is an alternative method to treat cases with deformities of the proximal humerus for whom the placement of a conventional prostheses could be technically difficult to achieve [5]. In fact, during humeral head resurfacing, the native head-shaft angle remains intact because the humeral neck and more than 50 % of the humeral head are retained with beneficial effects to restore the normal shoulder joint anatomy [16, 17]. Several studies have demonstrated functional results after humeral head replacement almost comparable to stemmed hemiarthroplasty (HA) and total shoulder replacement (TSR) [7, 13, 18–21]. In our study, we found a good pain relief, with a significant decrease of 5,76 points for pain overall and 4,56 points for pain during work or sports activity. CS increased of 30 points ranging from a minimum of 41 points to a maximum of 79 points and similarly, the SST increased significantly of 4,3 points. Similar results are described by Levy and Copeland [7] who had a CS of 75 points in 68 TSA and 35 HA using the Mark II prostheses, at an average follow-up of 6.8 years. In their study, the authors began preferentially implanting a glenoid component when an adequate fixation could be achieved, but they changed to perform an HA toward the end [7]. Al-Hadithy et al. [22] in a study with a follow-up

of 4.2 years reported a mean age-adjusted CS of 75.1 % with MARK III Copeland prostheses that resulted to be not as higher than those described in the prostheses designer's institution [7] and they assumed that the difference may reflect selection and measurement bias that they tried to minimize by including patients with an intact rotator cuff (RC) and glenohumeral osteoarthritis. Good clinical outcomes were reported by Thomas et al. [18] at 2.8 years and by Giannotti et al. [23] at 33 months who concluded that the good functional results were attributed to the reduction in implant-placement error, as a result of the resurfacing procedure and from the normal RC function. The revision rate reported with humeral head resurfacing ranged from 2 to 8 % [7, 22]; however, considering the failure as a condition with pain and satisfaction scores worse than preoperative condition [24], the rate of unsatisfactory results rise up to 10 % at 5 years [22]. The main concern after humeral head resurfacing is the glenoid erosion that is found in about 12 % of the shoulder [7, 18, 22]. Oversized humeral component, loss of humeral head center of rotation and RC deficiency are the main factors which have been implicated in the glenoid wear after shoulder cup hemiarthroplasty [7, 13, 18, 22]. In our study, we had 12 % of the shoulder with glenoid erosion with a rate of unsatisfied patients of 15 %. Radiographic analysis of our research showed a good prostheses position with preserved bone stock beneath the implant, in contrast with the glenoid that showed arthrosis and erosion in 7 cases, and the biologic resurfacing with homologous meniscus underwent resorption as confirmed by the progressive narrowing of the glenohumeral joint space in all the 22 cases treated. Seven out of 9 unsatisfied patients had meniscus interposition and 4 of them were treated with removal of the meniscus and conversion in HA or TSR. None of the patients with lower scores had clinical sign of RC deficiency nor the intraoperative findings of the cases revised showed rotator cuff tears.

Overall assessment of correlations between clinical scores and radiographic outcomes showed that the main factor affecting clinical outcomes was the presence of glenoid erosion. In order to reduce the risk of postoperative glenoid erosion, we support two speculative hypothesis. First, the size should be reduced, favouring small prosthesis covering about 80 % of the head surface and having a head height not exceeding 1.5 mm; second, in those cases with preoperative glenoid, arthritis could be reasonable to place the prostheses more valgus to limit the concentric loading of the head prostheses on the glenoid surface which helps to increase the risk of central glenoid erosion.

The results we found in the patients who underwent glenoid resurfacing with meniscus allograft are consistent with our previous study [25], but not with recent research findings [26]; in our opinion, the short follow-up reported by Nicholson et al. [26] may be the main factor that would

explain the difference we found. However, the sample size of this study could not be large enough to affirm that glenoid resurfacing with meniscus is certainly ineffective, but these data have discouraged us to continue the use of meniscal allograft as a "socket perspective." The current research has some limitations: (1) the patients were retrospectively revised, (2) there is no comparison with stemmed prostheses, (3) clinical assessment was performed by a unique rater and (4) the follow-up is not long enough to give information on the survivorship of the humeral implant. Despite these limitations, we think that this study offers good information about the mid-term efficacy of humeral resurfacing in young patients, highlighting the limits of the biologic resurfacing to treat the glenoid arthritis and the risk of postoperative glenoid erosion that can negatively affects the results.

Conclusions

Humeral head replacement in patients aged 50 years or younger is advantageous for minimal bone resection and primary bone-ingrowth fixation. Our results are consistent with previous research findings for pain relief and recovery of shoulder function; however, the high rate of glenoid erosion and the failure of biologic allograft found in this study lead us to consider glenoid replacement as the best option to improve clinical outcomes and patient satisfaction.

Conflict of interest None.

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