Original article

Stemmed hemiarthroplasty versus resurfacing in primary shoulder osteoarthritis: A single-center retrospective series of 78 patients

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ABSTRACT

Introduction: Resurfacing shoulder arthroplasty is proposed in primary osteoarthritis of the shoulder. The present study compared resurfacing versus 3rd generation stemmed hemiarthroplasty in terms of survival, functional results and implant positioning effects.

Materials and methods: Seventy eight patients underwent arthroplasty for primary osteoarthritis of the shoulder: 41 by resurfacing and 37 by stemmed hemiarthroplasty. The two populations were comparable on all baseline variables. Minimum follow-up was 2 years. The principal assessment criterion was survivorship with surgical revision as end-point. Secondary criteria were functional results on Constant, quick-DASH, Neer and SSV scores, and implant positioning effects assessed on radiology.

Results: At a mean 44 months’ follow-up (range, 24–118 months), there were no significant differences in functional scores. Radiologic analysis found greater varus positioning and lateral offset of the humeral head in resurfacing compared with stemmed hemiarthroplasty (128° vs 138°, P<0.01; 6.5±2 vs 4.6±1.6 mm, P<0.01). Survivorship without revision was significantly poorer in resurfacing, with 4 revision procedures for glenoid wear (9.8%), versus none in hemiarthroplasty (P=0.02). There was no correlation between humeral head size, positioning or lateral offset and revision.

Conclusion: Revision-free survival was significantly lower in resurfacing than in hemiarthroplasty.

Greater humeral head size may increase lateral offset, accelerating glenoid wear. Down-sizing the humeral head in resurfacing procedures might limit these complications.

Level of evidence: Level III: case-control study.

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1. Introduction

Shoulder resurfacing was recommended by Copeland in degenerative shoulder pathology, with the aim of restoring joint congruency while conserving proximal humeral bone stock. Clinical results were favorable, with recovery of pain-free motion [1–4]. Follow-up, however, found progressive joint-line narrowing, with frequent recurrence of pain [5,6]. A recent assessment of resurfacing in primary osteoarthritis of the shoulder reported well restored anatomy, increased lateral offset of the humeral head, a tendency towards varus implant positioning and a long-term trend towards glenoid wear [7]. In 2013, the Australian Orthopaedic Association Joint Registry likewise reported higher 5-year revision rates in shoulder resurfacing compared with anatomic stemmed implants [8].

The principal hypothesis of the present study was that survivorship is lower in resurfacing than in stemmed hemiarthroplasty for primary osteoarthritis of the shoulder. The secondary hypothesis was that implant positioning and size affect outcome.

2. Materials and method

2.1. Study design

A single-center retrospective non-randomized comparative study included all patients treated for primary shoulder osteoarthritis with intact rotator cuff, using resurfacing or anatomic stemmed hemiarthroplasty, between 1997 and 2010. Exclusion criteria were: management by total shoulder replacement, resurfacing or anatomic stemmed hemiarthroplasty for secondary osteoarthritis and follow-up of less than 2 years.

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2.2. Patients

Seventy eight patients were included and followed up for a mean 44 months (range, 24–118 months). There were 40 women and 38 men. Involvement was of the dominant side in 48 cases (61.5%). Two groups were compared: group I comprised of 41 patients managed by resurfacing (GlobalCap®, DePuy-Synthes), and group II 37 patients managed by anatomic stemmed hemiarthroplasty (Neer®, Smith & Nephew). Groups were broadly comparable for all baseline variables, although age at surgery was slightly lower in group I. Sex ratio was comparable in the two groups. Mean Constant score was higher in group I. Preoperative active motion was restricted in both groups. Glenoid wear was centered in most cases in both groups (Table 1).

2.3. Surgical technique

Identical surgical technique was used in both groups, by 4 surgeons. The approach was deltopectoral. Subscapularis tenotomy was performed 1 cm from the insertion onto the lesser tuberosity and reinserted at end of surgery, by simple tendon-to-tendon suture or transosseous suture. According to intraoperative findings, only 51% of patients in either group underwent tenodesis of the long head of the biceps. No glenoid resurfacing or rotator cuff repair were performed. Mean humeral head diameter was 49 ± 5 mm in group I and 45 ± 3 mm in group II (P<0.01). Resurfacing implants were non-cemented, whereas hemiarthroplasty stems were systematically fixed with Palacos-Genta® normal viscosity cement.

2.4. Postoperative course

The postoperative protocol was identical in the two groups. Elbow-to-body sling immobilization was maintained for 45 days. Self-rehabilitation pendulum exercises began on postoperative day 2. Passive rehabilitation was initiated at day 15, with external rotation protected for 1 month. At day 45, the sling was abandoned and active rehabilitation was initiated, aiming at full recovery of ranges of motion, including external rotation. Muscle reinforcement was initiated at the end of the third postoperative month.

2.5. Assessment

As the principal study objective was to assess survival between the two implants, the principal assessment criterion was surgical revision for whatever cause.

The secondary assessment criteria were:

- functional results at last follow-up, assessed on Constant score with a threshold of 75/100 for a satisfactory result [9], pain on visual analog scale, active motion (anterior elevation and internal and external rotation), Subjective Shoulder Value, Quick-Disability Arm, Shoulder and Hand score (DASH) [10] and Neer satisfaction score [11];
- radiologic prognostic factors: acromio-humeral distance (AHD), lateral offset (LO), cervico-diaphyseal angle (CDA), proximal migration of the humeral head (PM), medial offset (MO), distance between superior poles of the humeral head and of the greater tubercle (D), and glenoid depth (GD) were measured on AP shoulder view in neutral rotation (Figs. 1A and B).

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Table 1
Baseline patient data.

<table>
<thead>
<tr>
<th></th>
<th>Group I (Resurfacing)</th>
<th>Group II (Hemiarthroplasty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean follow-up (months)</td>
<td>40 months</td>
<td>48 months</td>
</tr>
<tr>
<td>Patients</td>
<td>41</td>
<td>37</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>61 (47–80)</td>
<td>63 (56–79)</td>
</tr>
<tr>
<td>Male/female</td>
<td>20/21</td>
<td>18/19</td>
</tr>
<tr>
<td>Absolute Constant score/100 (range)</td>
<td>31 (14–62)</td>
<td>24 (14–63)</td>
</tr>
<tr>
<td>Active motion (degrees)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior elevation</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>External rotation</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Glenoid wear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centered</td>
<td>27 (66%)</td>
<td>25 (68%)</td>
</tr>
<tr>
<td>Excentric</td>
<td>14 (34%)</td>
<td>12 (32%)</td>
</tr>
</tbody>
</table>

Fig. 1. Radiologic parameters in the 2 treatment groups. A: O: projection of the center of the humeral diaphysis; M: center of the humeral head; D: distance between the tangents of the implant summit and of the greater tubercle; CDA: cervico-diaphyseal angle; GD: glenoid depth; MO: medial offset; PM: proximal migration. B: LO: lateral offset; AHD: acromio-humeral distance.
2.6. Statistical analysis

Statistical analysis used R64-bit software. Survivorship was analyzed on Stata/SE v11.2 software. Qualitative variables were compared on Chi² test or, when necessary, Fisher exact test. Quantitative variables were compared on Student test when distribution was normal, and otherwise on Welsh test. For variables with non-normal distributions, only the median was assessed, on Wilcoxon ranks test. Revision-free survivorship was analyzed on the Kaplan-Meier method, with 95% confidence intervals.

3. Results

3.1. Complications

In group I, there were 10 complications (24%), 6 involving joint-line narrowing with glenoid thickening (Fig. 2), systematically associated with recurrence of pain and deterioration of function. Two patients presented pain with conserved function, attributed to supraspinatus tendinopathy without tearing, confirmed on ultrasonography. One patient presented rotator cuff tear, and another retractile capsulitis. In group II, there were 6 complications (16%), including one case of symptomatic glenohumeral joint-line narrowing, 2 rotator cuff tendinopathies without tearing, and 3 rotator cuff tears (Fig. 3).

3.2. Principal assessment criterion: revision-free survival

At a mean 44 months’ follow-up (range, 24–118 months), 4 cases required implant revision; all were in group I and all involved symptomatic joint-line narrowing; 3 were female and one male, of varying ages (49, 60, 72 and 73 years), without notable preoperative clinical or radiological signs. Two were treated by reverse total shoulder replacement due to age (> 70 years); one with rotator cuff tear and the other with fatty degeneration of the supraspinatus and subscapularis. In the youngest patient, the rotator cuff was intact, and the resurfacing implant was replaced by a pyroccarbon model (Inspyre®, Tornier). In the fourth patient, the rotator cuff was intact, and glenoid resurfacing was performed with a cemented polyethylene glenoid implant, despite the conservation of the resurfacing head. Revision was performed a mean of 46 months (range, 30–60 months) after primary arthroplasty. At 10 to 30 months’ follow-up, results were satisfactory in all 4 patients with, notably, resolution of pain.

Fig. 2. Radiological results for a resurfacing implant. Shoulder views: preoperative (A), immediate postoperative (B), at 2 years (C), and at 5 years (D). At 2 years, the shoulder was asymptomatic, with Constant score > 80; by 5 years, pain was severe (7/10 on visual analogic scale [VAS]; Constant score, 67). Revision used a pyrocarbon implant.
The principal assessment criterion was revision-free survival. Using percentage revision at the end of follow-up as assessment criterion, without taking the account of time, the revision rate was 9.8% in group I versus 0% in group II, and this difference was non-significant (P = 0.12). Taking time (primary arthroplasty to revision) into account as a factor in the survivorship curve, the survival rate was significantly lower in group I (P = 0.02): in group II, survivorship was 1 throughout follow-up, compared to 0.41 (range 0.01–0.84) at 5.5 years’ follow-up in group I (Fig. 4).

3.3. Secondary assessment criteria

3.3.1. Functional results

Table 2 presents the functional results. There were no significant inter-group differences on functional scores. Ninety-two percent of patients were satisfied or very satisfied with their result in group I, versus 82% in group II. Subjective Shoulder Value (SSV) was 80% in both groups.

3.3.2. Implant positioning

Postoperative results at 3 months’ follow-up: results are shown in Table 3. Positioning was in significantly greater varus in group I (P < 0.01). Lateral offset of the humeral head was likewise significantly greater in group I (P < 0.01) as was proximal migration. There were no significant differences on the other parameters.

At the end of follow-up: results at the longest follow-up were identical to those at 3 months (Table 3). The principal differences consisted in greater varus positioning, lateral offset and wear-related glenoid depth in group I.

3.4. Statistical analysis

Correlations were examined between implant positioning, functional results and onset of complications. Only the diameter of the resurfacing implant significantly influenced postoperative clinical results (P < 0.05), without an impact on complications.

4. Discussion

Copeland originally developed resurfacing implants, applied in degenerative shoulder pathology as a whole [1–4]. The aim was to reproduce humeral head anatomy, in terms of diameter and also of curvature radius and version automatically and as faithfully as possible, while restoring near-normal lateral offset. The intention was to compensate for humeral head wear, to restore optimal rotator cuff function while conserving humeral bone stock.

A radiologic analysis by Thomas et al. [12] demonstrated that the Copeland resurfacing implant restored near-normal anatomic landmarks. Radius of curvature of the humeral head was reduced by about 3.5%; lateral offset increased by about 5 mm (22%) over pre-operative values. The authors argue that the Copeland resurfacing implant provided 6-mm postoperative lateral offset, compensating for osteoarthritis-related wear. Subsequently, Hammond et al. [13] likewise reported that resurfacing prostheses reproduced the geometric center of the humeral head more precisely than 3rd generation hemiarthroplasty.

The surgical technique as described for resurfacing implants, however, is misleadingly simple: humeral head exposure can in fact be difficult. Deladerrière et al. [14] showed that positioning often shows excessive anteverision, probably due to underexposure. Correct implant size is fairly subjective, especially in case of humeral head deformity with a large osteophytic collar. Smith et al. [15] highlighted the fact that in their series, implant size was well-adapted in only 28 of the 50 implants assessed. Resurfacing implant positioning should be guided by precise landmarks: the anatomic neck and the superior rotator cuff insertion. In the series reported by Mansat et al. [7], however, implants were generally in
varus as compared with preoperative positioning. Reaming depth is hard to evaluate intraoperatively: insufficient depth will induce a tendency to excessive lateral offset of the head, whereas excessive reaming, down to the cancellous bone, may induce a lesion of the superior rotator cuff insertion and, in small patients, lead to contact between the tip of the resurfacing implant and the lateral humeral cortex. In contrast, more accurate instrumentation seems to make hemiarthroplasty easier to implant, with easier adaptation of humeral head size. In the present series, the cervicodiaphyseal angle was closer to normal in hemiarthroplasty than in resurfacing (138 ± 4 vs 127 ± 11; P = 0.01). Poorly adapted head size or insufficient rasping induces excessive lateralization of the humerus and excessive stress to the glenoid cavity and rotator cuff. Third generation hemiarthroplasty seems to avoid these errors. In the present study, mean lateralization was 10 ± 8 mm in resurfacing versus 3 ± 6 mm in hemiarthroplasty (P < 0.01). Numerous other series likewise reported excessive lateralization in resurfacing [5,15–17].

The literature reports satisfactory results with resurfacing implants for primary osteoarthritis of the shoulder [1,2,4,7,12,18]. Over time, however, progressive glenoid wear occurs, reported in various series as increased glenoid depth [7], Thomas et al. [12] also reported reduced lateral offset over time, indicating progressive glenoid wear; other studies reported similar evolution [5,6,15–19] implicating excessive humeral head size and stress to the glenoid cavity [5,15–17]. Type of preoperative glenoid wear also seems to be a factor for postoperative wear, which is greater in case of eccentric preoperative wear patterns [15]. This complication was also reported in hemiarthroplasty, especially in younger patients [20–22] and at long-term follow-up [23–25]. In the present series, it occurred only in resurfacing, and not in hemiarthroplasty; mean follow-up, however, was only 4 years. Resurfacing thus does not seem to resolve the problem of long-term glenoid wear encountered in hemiarthroplasty, which occurs earlier when resurfacing implant size and positioning are not well-adapted.

Shoulder resurfacing should reduce joint impingement and recurrence of pain. However, as the humeral head is not resected, glenoid exposure may be difficult. Biological interpositions in the glenoid cavity have been described for resurfacing, but this solution does not seem to be satisfactory in the long term [16,19,26]. A glenoid implant seems to be the best option to guarantee against pain and ensure recovery of functional motion, whether with resurfacing [27] or stemmed hemiarthroplasty [20–22,28]. Long-term results, however, are needed to validate this option in resurfacing.

The limitations of the present study are its retrospective design, small series, multiple surgeons and uneven follow-up ranging from 24 to 118 months. It is nevertheless a comparative study between 2 homogeneous groups, managed using a well-codified surgical technique in a single indication, comparing two implants. It can thus assess the working hypothesis, demonstrating a greater rate of surgical revision in resurfacing than 3rd generation hemiarthroplasty. It allowed us to improve our technique, by systematically resurfacing the glenoid along with the resurfacing implant in patients aged over 50 years, reaming the humeral head down to the cancellous bone, and down-sizing the humeral resurfacing implant.

5. Conclusion

In primary osteoarthritis of the shoulder, revision-free implant survival was significantly lower in resurfacing than in hemiarthroplasty, due to onset of symptomatic joint narrowing over time. Functional results, however, were similar with the two implants. Radiology found a tendency for varus positioning of resurfacing implants, associated with increased lateralization.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References