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## ORIGINAL ARTICLE

# Long term functional outcome following reverse shoulder arthroplasty in the elderly

J.-F. Cazeneuve\*, D.-J. Cristofari

Department of Orthopaedic and Trauma Surgery, Hospital Center, 33, rue Marcelin-Berthelot, 02000 Laon cedex, France

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## KEYWORDS

Shoulder;  
 Fracture;  
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## Summary

**Introduction:** The aim of this study is to analyze the long-term results and possible complications of the Grammont reverse shoulder prosthesis in the management of recent trauma in the elderly patient.

**Patients and methods:** Two male and 33 female patients of mean age 75 years (range, 58 to 92), operated on for 24 fractures and eleven fracture-dislocations, involving the right side in 11 cases and the left side in 24 cases, were included in a retrospective study and were clinically and radiographically evaluated at a mean follow-up ranging from 1 to 17 years.

**Results:** Eight complications occurred in eight patients (23%): two complex regional pain syndromes, four dislocations, one deep infection and one aseptic loosening of the metaglene. Six patients (17%) had to be reoperated on, without prosthetic replacement in four cases and with revision of their shoulder implant in two. The mean Constant score decreased from 55 to 53 between one postoperative year and last follow-up since patients complained of increased pain and strength loss. This score was 69% of that of the contralateral shoulder. The adjusted Constant score was 68%. Only 58% of the patients were "satisfied" or "very satisfied" with the treatment due to limited shoulder rotations thus preventing proper eating, dressing and body hygiene habits when injury involved the dominant side. Two cases of complete lucent lines surrounding the glenoid component were observed at four and eight postoperative years respectively, a stable inferior bony spur was noted in 14 cases at a mean follow-up of 2.5 years with no functional effects, 20 cases of scapular notching having occurred within two-year follow-up were identified, 10 of which associated with bone resorption and medial proximal humeral lucent lines at the bone-cement interface. The extent of scapular notching progressed with the length of follow-up. Forty-nine percent of the radiographic images were considered abnormal and appeared within seven-year follow-up in 60% of the cases. Clinical and radiographic data comparison revealed a decrease in the Constant score regarding pain, activity, strength and active elevation when scapular notching was associated with abnormal humeral radiographic images.

\* Corresponding author.

E-mail address: [jean-francois.cazeneuve@ch-laon.fr](mailto:jean-francois.cazeneuve@ch-laon.fr) (J.-F. Cazeneuve).

*Discussion:* Despite one single case of aseptic loosening of the metaglene at 12-year follow-up, the results of our series are clinically disappointing and radiographically worrying associated with a substantial rate of complications and reoperations. The long-term functional outcome is far from being identical to the pre-trauma clinical status with a potential evolution toward loss of autonomy when the dominant side is affected. New prosthetic design characteristics and surgical technique improvements should be implemented to improve shoulder adduction but also rotations while preventing the occurrence of scapular notching. In the light of these results, we cannot validate the concept of primary reverse shoulder arthroplasty in the management of recent trauma of the proximal humerus.

*Level of evidence:* Level IV. Retrospective study.

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## Introduction

The management of complex fractures of the proximal humerus in osteoporotic elderly patients suffering from physiological fragility has proven a difficult surgical challenge. Locked or nonlocked screw plates [1], static or dynamic anterograde nailing constructs [2], ball and socket prostheses [3] and hemiarthroplasty [1,4] report poor results since an efficient and reliable re-fixation of the tubercles is difficult or even impossible. Loss of rotator cuff function induced by migration, nonunion or resorption of the tubercles may decrease patient's autonomy [5]. For these reasons and in the management of recent trauma, we have been using the Delta III prosthesis (Depuy – International Ltd) since 1993. This prosthesis relies almost exclusively on the deltoid muscle for stability and movement of the joint. Its reverse geometry medializes the center of rotation, lowers the humerus and increases the deltoid lever arm [6,7].

This work was conducted following our 2006 publication [8] in which we had reported our preliminary functional results. In 2009 [9], we published the short-term radiographic complications reported in retrospective homogeneous series of 35 cases with a 1 to 17-year follow-up period. The aim of the present work is to validate the indication of reverse shoulder arthroplasty for recent trauma of the proximal humerus in elderly patients to restore a stable, functional glenohumeral joint in this challenging population.

## Patients and methods

Between January 1993 and December 2009, 49 osteoporotic patients with displaced comminuted fracture of the proximal humerus underwent reverse shoulder arthroplasty.

Only 35 cases could be reviewed since 12 patients had died and two had moved out. The studied population included two males and 33 females of mean age 75 years (58–92) with 24 fractures and 11 fracture-dislocations classified according to Neer [10], involving the right side in eleven patients and the left side in 25 patients with a mean follow-up of 86 months. Nineteen co-morbidities were associated: rotator cuff tear in six cases, diabetes in five, chronic alcoholism in three, morbid obesity in three and depression in two cases.

Besides standard x-rays, preoperative radiographic assessment always included a CT scan examination for

proper identification of the fracture type and degree of osteoporosis but also for precise anatomical exploration of the scapular neck prior to implantation of the metaglene by combining ideal positioning with limited fracture risk.

The specificities of the surgical management of recent trauma, always performed under general anaesthesia in the semi-sitting position through the antero-lateral approach, included systematic anatomopathological analysis of the humeral head, complete resection of the tubercle bony remnants and damaged tendons of the rotator cuff, positioning of the metaglene central peg in the most appropriate cancellous bone portion of the scapular neck regardless of height and inclination thus favouring primary anchorage, the absence of humeral bone re-cutting, the systematic use (from our second case) of a cemented stem providing immediate fixation which is highly helpful in osteoporotic bone and allows better adjustment of height and deltoid muscle tension, combined or not with insertion of a wedge and/or polyethylene liners of variable thicknesses. The ideal tension was evaluated by interposing the pulp of the fifth finger between the polyethylene cup and the trial glenosphere in patients with optimal curarization. The retroversion angle of the humeral implant was set at 10°. The remaining long portion of the biceps was fixed on the flange of the prosthetic metaphysis. A suction drain was systematically left in place for two days. A simple immobilization with the elbow beside the body was applied for a period of 21 days. Whenever possible, a rehabilitation protocol was initiated and included early active and painless ROM exercises, depending on clinical status of the patients.

The results were clinically and radiographically assessed using the absolute and adjusted Constant and Murley scores [11] for the injured and contralateral shoulders, the "American Shoulder and Elbow Surgeons" rating system (ASES) [12] based on a visual analog scale for pain and a four-grade scale for patient satisfaction (very satisfied, satisfied, neither satisfied nor dissatisfied and dissatisfied). Anteroposterior and Lamy's lateral radiographs were taken and postoperative scapular notching was evaluated according to the Valenti et al. grading systems [13]. Evaluations were performed every month during the first postoperative term then each term during the first year then once a year.

Our sample size was insufficient ( $n=35$ ) to accurately perform a statistical analysis.

**Table 1** Number of complications and treatment.

Complications ( <i>n</i> = 8)	Medical treatment	Reoperation	Prosthetic replacement	Total
Complex regional pain syndrome	2	—	—	2
Infection	0	1	0	1
Dislocation	—	3	1	4
Loosening	—	0	1	1
Total	2	4	2	8

## Results

### Complications

A total of eight complications occurred in eight patients (23%) (Table 1): two cases of complex regional pain syndrome type I (formerly reflex sympathetic dystrophy syndrome) which resolved after medical treatment within six and nine months respectively; six reoperations (17%): a surgical drainage for deep *Acinetobacter* infection at 21 days in one patient who did not require prosthetic replacement, three cases of additional excisions of the tubercle remnants due to a cam effect responsible for superior dislocations thus resulting in good long-term stability, reorientation of the humeral stem at 20° of retroversion in one patient for anterior dislocation at 28 postoperative days induced by the initial voluntary 10° anteversion of the humeral stem which aimed at achieving better internal rotation, and one case of aseptic loosening of the metaglene at 12-year follow-up associated with breakage of the inferior fixation screw (Fig. 1) which required replacement of the glenoid component and conversion to a standard implant since a sufficient bone stock was available, with no associated replacement of the humeral stem. Only minor wear of the polyethylene component was observed (Fig. 2).

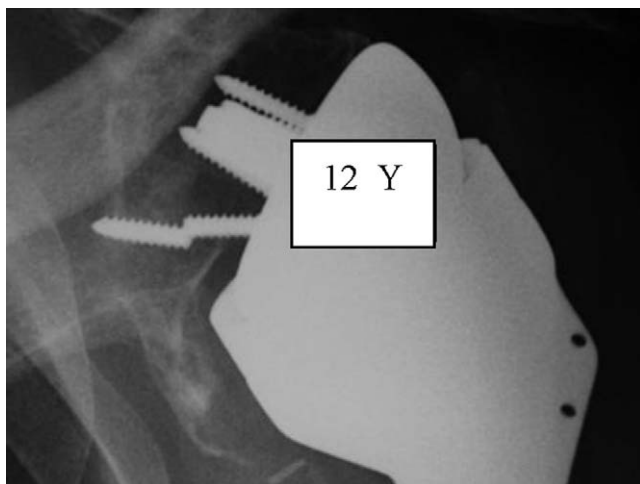
### Clinical results

The Constant and Murley scores at one postoperative year and at last follow-up were compared. This score decreased

from 55 (20 to 84) to 53 points which represented 69% of the contralateral shoulder score (79). Results decreased for pain (14 at 13) and strength (12 at 11). Internal (1/10) and external (1/10) rotations which were initially bad did not improve. Activity (13/20), anterior active elevation (7.5/10) and abduction values (6.5/10) remained identical and favorable (Table 2). The adjusted Constant score decreased from 71 to 68%. Fifteen out of the 35 patients (42%) were not satisfied due to the difficulty or even impossibility to eat, get dressed or wash properly. The pre-trauma functional status was never recovered. When trauma involved the dominant side, a loss of autonomy or even a major increase in dependency was observed in 10 patients (28%).

### Radiographic results

Two complete non-progressive lucent lines of 2 mm thickness surrounding the glenosphere/metaglene components were observed at four and eight-year follow-up respectively in two male patients with a 42 mm glenosphere. Inferior screw breakage associated with small ascending migration of the metaglene at 12 postoperative years was the only reported case of aseptic loosening. Early occurrence of a stable bony spur at the inferior margin of the scapular neck was noted in 14 cases at a mean follow-up of 2.5 years with no effect on postoperative function. Scapular notching was observed in 20 cases (57% of the patients) and occurred within two-year follow-up in all cases. Eight type I, five



**Figure 1** Aseptic loosening of the metaglene at 12 postoperative years.



**Figure 2** Low wear of the polyethylene component at 12 years.

**Table 2** Evolution of the clinical outcome.

Clinical results	At 1-year follow-up	At last follow-up
Mean Constant score	55	53
Mean modified Constant score	71	68
Pain	14	13
Activity	13	13
Strength	12	11
Active anterior elevation	7.5	7.5
Abduction	6.5	6.5
Internal rotation	1	1
External rotation	1	1

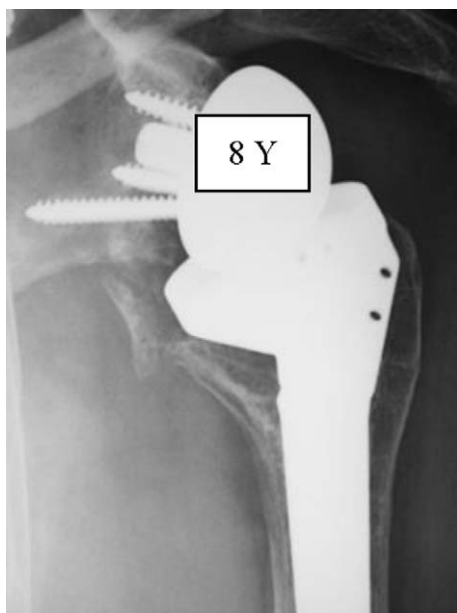
type II, four type 3 and three type 4 scapular notching were reported. The extent of notching increased with the length of follow-up. Two types of scapular notching were identified: isolated notching (Fig. 3) in 10 cases (50%) and 10 notches (50%) (Fig. 4) associated with loss of the medial proximal humeral bone stock in four cases occurring between five and six postoperative years or associated with radiolucencies at the bone-cement interface in six cases observed between five and 11 postoperative years.

A total of 23 out of the 47 radiographic images were considered critical (49%). They were early identified within seven-year follow-up in 60% of the cases (Table 3).

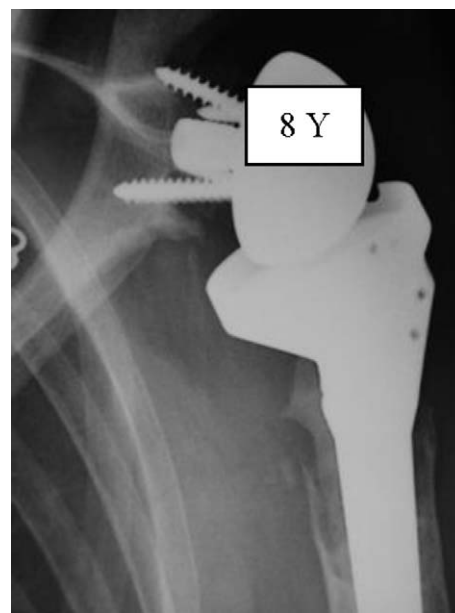
Radiographic and clinical findings comparison revealed that patients with scapular notching associated with abnormal humeral images demonstrated a low Constant and Murley score of 41 points, whereas patients with isolated scapular notching had a Constant and Murley score of 57 points. The decrease in the postoperative Constant and Murley score was observed for all items (Table 4).

## Discussion

The present study reports on the complications and long-term results of the Delta III prosthesis when used in recent trauma without tubercle reinsertion due to their mechanical insufficiency, in osteoporotic elderly patients with precarious physiology. This work is the last section of a three-part study which started in 2006 and was continued in 2009 [8,9]. The obtained functional results are not encouraging. Shoulder rotations are compromised. Despite a medialized center of rotation, the anterior and posterior fibers of the deltoid muscle cannot compensate for rotator cuff deficiency and do not provide satisfactory functional internal and external rotations. A greater retroversion of the humeral stem could improve external rotation but would restrict internal rotation. The implant design restricts rotation and adduction due to repetitive mechanical contact between the polyethylene of the humeral component and the inferior scapular neck [14]. Enhanced external rotation may be achieved through transfer of the *latissimus dorsi* [15] while



**Figure 3** Scapular notching at eight postoperative years with normal humeral image.



**Figure 4** Scapular notching at eight postoperative years with abnormal humeral image.

**Table 3** Radiographic results.

Radiographic image characteristics	Number	Abnormal	Occurring within 7 years
Radiolucencies around the glenosphere	2	2	1
Aseptic loosening of the metaglene	1	1	0
Scapular notching	20	10	20
Humeral radiolucencies	6	6	3
Humeral bone loss	4	4	4
Bone spur	14	0	14
Total	47	49%	60%

improvement of internal rotation may be performed using a new prosthetic design with reduced medialization of the center of rotation and increased offset of the humeral implant thus allowing for a greater recruitment of anterior deltoid fibers [16] or through *pectoralis major* muscle transfer [17]. A greater varus humeral neck-shaft angle implant may improve impingement-free adduction [18]. In our series, the most common complication was dislocation. It is classically related to an improper deltoid muscle tension. Proper restoration of deltoid tension may be difficult due to the lack of humeral bone landmarks. Therefore, use of a spacer, a retentive polyethylene and adjustment of the humeral stem cementation thickness will be helpful [14]. In our study, dislocation events were not related to deltoid tension but rather induced by a cam effect between the tubercle remnants and the glenoidal sphere in three cases and by voluntary initial 10° anteversion of the humeral stem in one case.

Scapular notching was reported in 57% of our patients. This is a well-known and complex issue. The 155° inclination of the humeral implant promotes impingement between the humeral stem and the scapular neck [19] which is increased during adduction movements [20]. According to Clavert, scapular notching results from micro-mobility of the inferior polar screw [21] whereas Simovitch suggests it is induced by torpid infection [22]. The clinical relevance of scapular notching remains controversial. According to Valenti et al., grade 4 scapular notching leads to glenosphere loosening [13] which differs from Werner et al.'s findings [20]. Clinical series published by Sirveaux et al. reported loosening of the

glenoid component when radiolucencies were found around the metaglene fixation screws [23]. In the long-term, loosening could be induced by osteolysis due to wear particles from the polyethylene cup [24]. Scapular notching appears to be of mechanical and biological origin, associated or not with abnormal radiographic images of the proximal humerus [9]. Boileau et al. do not report any osteolysis on the glenosphere at seven-year follow-up except close to scapular notch [14]. Nyffeler et al. advocate inferior placement of the metaglene to prevent postoperative scapular notching [25].

Comparison between our results and those obtained after cuff tear arthropathy and reported during the 2006 SOF-COT symposium reveals some similarities such as identical complication, reoperation and loosening rates but highlights some differences regarding the Constant and Murley scores which remain stable after cuff tear arthropathy whereas it decreases with the length of follow-up in our series and regarding scapular notching which has a lower incidence in our study (56% vs. 68%) but remains a major concern since it is associated, in half the cases, with abnormal humeral radiographic images and poor clinical scores [26,27]. Our study demonstrates radiographic evidence of notch progression while Simovitch report contradictory results [22].

Very few studies have been published regarding the use of reverse shoulder arthroplasty in recent trauma. Despite a high complication rate (28%), comparable to that reported in our series (23%), frequent migration of the tuberosities (53% of the patients) and a mean Constant and Murley score of 44 points, which is inferior to that observed in our series (52 points), Bufquin et al. [28] advocate the routine

**Table 4** Evolution of the Constant score with or without abnormal radiographic images of the proximal humerus.

Impact of abnormal radiographic images of the proximal humerus	Abnormal radiographic images of the proximal humerus with no scapular notching (n = 10)	Abnormal radiographic images of the proximal humerus with scapular notching (n = 10)
Mean Constant score	57	41
Pain	14	11
Activity	14	11
Strength	13	10
Active anterior elevation	7.5	4
Abduction	6.5	3
Internal rotation	1	1
External rotation	1	1



use of reverse shoulder arthroplasty in the management of elderly patients. According to Wall et al. [29] the concept of reverse shoulder arthroplasty is an interesting alternative to prevent tubercle-related issues reported with conventional implants. Sirveaux et al. [30,31] when taking into account the follow-up and high rate of complications and after weighing up the risks and benefits, restrict the use of reverse shoulder arthroplasty to elderly patients demonstrating unfavorable factors for proper tubercle consolidation using a hemiprosthesis, and look forward the development of better adapted implants. Tishe et al. [32] and Kontakis et al. [33] advocate meticulous patient selection to achieve better outcome. Klein et al. [34] are very enthusiastic and consider reverse shoulder arthroplasty as a real therapeutic option in the management of elderly patients due to the satisfactory functional outcome and short operative time. Gallinet et al. [35] report reliable, rapid and predictable clinical results with poor shoulder rotations and advocate the use of reverse shoulder arthroplasty in patients older than 70 years despite a high rate of scapular notching (in 15 out of 19 patients). We have already underlined [36] the relationship between low postoperative Constant–Murley scores and longer follow-up but also the worrying aspect of scapular notching when associated with radiographic evidence of humeral bone loss or radiolucencies at the bone-cement interface. Therefore, a longer follow-up period may lead to a potential loss of autonomy when injury involves the dominant side and a higher complication rate, and a correlation being established between reduced Constant and Murley scores and the occurrence of scapular notching associated with abnormal humeral radiographic images.

Since the whole trauma series report Constant and Murley scores varying from 44 to 88 points and a 25 to 80% incidence of scapular notching, the authors advocate the use of reverse shoulder arthroplasty in patients over the age of 70 or even 75 and recommend careful weighing of the advantages and disadvantages of such technique.

## Conclusion

Reverse shoulder arthroplasty improves abduction in the short-term thus preventing initial post-trauma dependency of patients.

Since the reported technical peri-operative complications are significant, this surgery should be performed by an experienced senior surgeon. Scapular notching, occurring in 50% of the cases in the long-term, is correlated with reduced Constant and Murley scores which may be functionally detrimental when the dominant side is affected.

Such results do not allow us to validate in the long-term the concept of reverse shoulder primary arthroplasty in recent trauma of the proximal humerus. Reverse shoulder arthroplasty should be restricted to fractures occurring in fragile and osteoporotic elderly patients aged over 70 years and involving the non-dominant side.

## Disclosure of interest

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

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