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ORIGINAL ARTICLE

Influence of surgical approach on functional outcome in reverse shoulder arthroplasty

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KEYWORDS
Reverse shoulder arthroplasty;
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Summary
Introduction: Reverse shoulder arthroplasties (RSA) can be performed using a Deltopectoral (DP) or alternatively a Transdeltoid (TD) approach.
Hypothesis: Although the humeral cut is lower by TD approach, this should not affect postoperative functional results.
Material and methods: This retrospective multicentric study evaluated the complete medical records of RSA implanted between October 2003 and December 2008. Inclusion criteria were: follow-up of at least 1 year, a complete file including a comparative radiological work-up making it possible to analyze eventual arm and humeral lengthening. Evaluation of postoperative function was based on Active Anterior Elevation (AAE).
Results: We studied 144 RSA in 142 patients. One hundred and nine RSA were implanted by the DP approach and 35 by the TD approach. Mean lengthening of the humerus compared to the controlateral side by DP approach was 0.5 ± 1.3 cm while there was a mean shortening of -0.5 ± 1.0 cm by TD approach ($P < 0.001$). The difference in cut was partially compensated by using thicker polyethylene inserts with the TD approach. Mean arm lengthening compared to the controlateral side was 1.7 ± 1.7 cm by DP approach and 1.2 ± 1.4 cm by TD approach (mean difference 0.5 cm; (95% CI −0.1; 1.2). AAE for RSA by DP approach was $145 \pm 22°$ and $135 \pm 29°$ by TD approach (mean difference 10°, 95% CI −1; 21).

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Discussion: RSA results in improved AAE because of restored deltoid tension and an increase in the deltoid lever arm. The humeral cut by TD is lower, but this was partially corrected in this study by the use of thicker polyethylene inserts. Nevertheless there is no significant clinical difference in postoperative function between the two approaches.
Level of Evidence: Level IV. Retrospective therapeutic study.

Introduction

Reverse shoulder arthroplasty (RSA), which was first developed by Paul Grammont [1], is a real advancement in shoulder surgery. The geometric inversion of the implanted joint components has two essential biomechanical consequences. Medialization of the center of rotation optimizes the deltoid lever arm, so that more anterior and posterior muscle fibers are solicited and centrifugal forces are transformed into centripetal forces. Increasing the subacromial space by lowering the humerus results in an increase in deltoid strength by restoring deltoid tension which corrects rotator cuff deficiencies. The indications for this technique have progressively been extended and more and more of these arthroplasties are now performed. Different surgical approaches are possible for this type of arthroplasty.

The transacromial approach, used by Grammont, is now less popular. The Deltopectoral (DP) and Transdeltoid (TD) approaches are now the most common approaches, and they both have their advantages and disadvantages. The DP approach allows better positioning of the glenoid component, reducing loosening and inferior impingement. Moreover active external rotation is better preserved with this approach [2]. Also, this approach does not compromise the deltoid, which is the future motor of the shoulder. Logically, it is generally used in case of revision surgery. The TD approach has the advantage of obtaining better postoperative stability, in particular, because the subscapularis tendon and the anterior ligament complex are preserved. [2]. Thus it is less necessary to lengthen the arm, potentially reducing the incidence of neurological damage, or fracture of the acromion or scapular spine [3]. The TD approach can be indicated in case of RSA for fractures of the superior humerus or if there is a history of surgery with this same approach. There are no studies in the literature to date which show that one approach is better than another. To our knowledge there are no studies comparing the functional results after RSA with the two types of surgical approach. We hypothesized that the humeral cut was lower with the TD approach, but that this would not affect postoperative function. The aim of this study was to evaluate the functional results after RSA using the DP or TD approaches as well as lengthening of the arm and the humerus.

Materials and methods

This retrospective study analyzed RSA performed between October 2003 and December 2008 in four centers. Four of the authors of this study performed the arthroplasties (GW, PC, TBE, FS). Inclusion criteria were: (1) primary surgery, (2) a follow-up of at least one year, (3) evaluation of functional results at the final follow-up based on Active Anterior Elevation (AAE) graded by goniometry and (4) a complete radiological work-up allowing evaluation and comparison of arm (acromion-elbow distance) and humeral (top of the head-elbow) lengths on the operated and controlateral sides using a previously validated protocol (Fig. 1) [3].

Surgical technique

The choice of the surgical approach was essentially based upon the surgeon's preferences. A Reversed Aequalis implant (Tornier Inc, Montbonnot, France) was used in all cases. The surgical technique was standardized and has been described in detail [4,5]. The postoperative protocol and

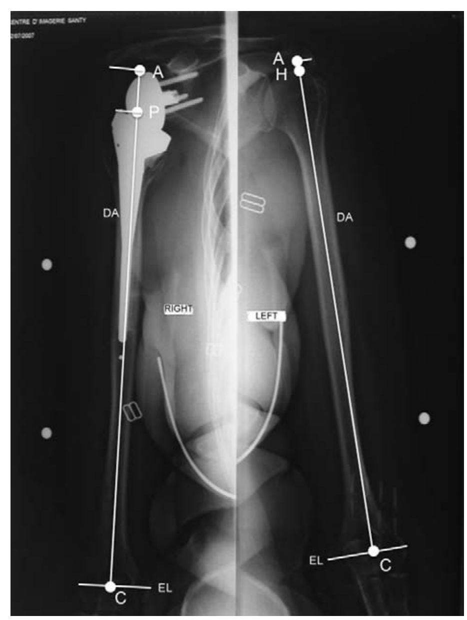

Figure 1 The epicondylar line (EL) was defined between the most lateral part of the epitrochlea and the epicondyle on X-rays using a postoperative ipsilateral ruler. The diaphyseal axis (DA) was defined as a line going through the center of the proximal humeral medullary canal. The intersection between EL and DA represents the point C and the intersection between DA and the top of the humeral head is point H. Point A is the intersection of a perpendicular line going intersecting the most lateral, inferior point of the acromion. Point P is the intersection of a perpendicular line on DA going through the top of the implant. If enlargement by the X-ray is taken into account, the length of humerus is represented by the distance C—H or C—P and the length of the arm by C—A.

rehabilitation also followed a previously validated protocol [6].

Statistical analysis

Demographic data were compared between the two groups using a non-parametric Mann-Whitney U test for continuous variables and the Chi^2 test and Pearson coefficient (or the Fisher exact test in small groups) for categorical variables. The mean differences and the corresponding 95% confidence intervals were also calculated for the principle results (arm length, humeral length, AAE) (95% CI). Statistical analyses were performed using version 15.0 SPSS software for Windows® (SPSS Inc., Chicago, Illinois, USA).

Results

This study included 144 RSA in 143 patients. Preoperative data for the study population are shown in Table 1. Both groups were similar for mean age, operated side, dominant side and follow-up. There were more women in the TD group. The clinical and radiological results are shown in Table 2. The mean postoperative AAE was 140 ± 27° (range, 30—180°). The AAE was 145° in the DP approach group and 135° in the TD approach group with a mean difference of 10° (95% CI −1; 21).

There was a mean lengthening of the humerus compared to the controlateral side by the DP approach, while there was a mean shortening by TD approach and the difference was statistically significant (mean difference 1 cm, 95% CI 0.5; 1.5). This difference in the cut was partially compensated for by the implantation of thicker polyethylene inserts when the TD approach was used (Table 2). The difference in arm lengthening compared to the controlateral side between the two approaches was 0.5 cm (95% CI −0.1; 1.2). Augmentation devices were used in the DP group to restore humeral length in case of revision surgery and traumatic sequellae in seven cases and for perioperative instability in one case. The three patients in whom bilateral RSA was required had complete initial radiological work-ups so radiological data were available for both implants.

Discussion

RSA can be an alternative therapeutic option for a certain number of glenohumeral pathologies that may result in functional deficiencies that are often significant as well as severe pain. Function is improved with these implants because deltoid tension is restored and the deltoid lever arm is increased. In this study, mean postoperative AAE was 140°. These functional results are comparable to those described by Sirveaux et al. [7]. The mean AAE by the TD approach was slightly lower (by 10°) than by the DP approach. This difference between the two approaches is not clinically significant. Whatever the choice, splitting the deltoid does not seem to modify functional results after physical rehabilitation. The type of approach should be decided upon in relation to the surgeon's experience and the patient's individual characteristics. Nevertheless, it seems logical to use the DP approach for revision surgery. The TD approach seems preferable in the presence of potential postoperative instability or in case of RSA for a fracture of the proximal humerus. We did not find any variation in the AAE in relation to the initial etiology. This does not support the results obtained by Wall et al. [8]. Until now, evaluation of deltoid lengthening has only been based on subjective perioperative elements. By using objective pre- and postoperative measures for arm lengthening, we were able to show a difference between the DP and TD approaches. The humeral cut is lower with the TD approach. This was partially compensated for in this study by the use of a 9 and 12 mm polyethylene insert in 34.3% of cases and 42 mm glenospheres in 11.4% of cases. Other studies have shown that restoring humeral and arm length is crucial to obtain good functional results and implant stability [3,9]. It is therefore important to correct the low humeral cut with a thicker polyethylene insert or even an augmentation device, whatever the surgi-

Table 1 Preoperative demographic data.

	Delto pectoral (n = 109)	Transdeltoid (n = 35)
Women (%)	75 (68.8)	30 (85.7)
Men (%)	34 (31.2)	5 (14.3)
Mean age ± DS	72.8 ± 8.9	75.1 ± 6.4
Side (%)		
Right	79 (72.5)	27 (77.1)
Left	30 (27.5)	8 (22.9)
Dominant shoulder (%)	70.6	65.7
Diagnosis (%)		
Glenohumeral arthritis	94 (86.2)	34 (97.1)
Rheumatoid polyarthritis	4 (3.7)	—
Trauma or sequellae	8 (7.3)	1 (2.9)
Avascular necrosis	1 (0.9)	—
Recurrent glenohumeral instability	2 (1.8)	—
Mean follow-up ± DS	18.3 ± 14.0	19.7 ± 12.9

SD: standard deviation.

Table 2 Clinical and radiological results.

	Deltopectoral ($n = 109$)	Transdeltoid ($n = 35$)	Mean difference (95% CI)	p-value
Polyethylene thickness (%)				0.001
6 mm	99 (90.8)	23 (65.7)		
9 mm	8 (7.3)	11 (31.4)		
12 mm	2 (1.8)	1 (2.9)		
Use of augmentation device	4	0		0.252
Size of the glenosphere				
36	100 (91.7)	31 (88.6)		
42	9 (8.3)	4 (11.4)		0.518
Mean AAE ± SD (ranges)	145 ± 22° (80—180°)	135 ± 29° (60—170°)	10° (−1; 21)	0.113
Mean lengthening compared to controlateral side ± SD (ranges)				
Humerus	0.5 ± 1.3 cm (−3.0 − 5.2 cm)	−0.5 ± 1 cm (−4.7 − 1.6 cm)	1.0 cm (0.5; 1.5)	< 0.001
Arm	1.7 ± 1.7 cm (−3.0 − 5.2 cm)	1.2 ± 1.4 cm (−3.5 − 3.1 cm)	0.5 cm (−0.1; 1.2)	0.062

SD: standard deviation, AAE: active anterior elevation.

cal approach. Preoperative planning that makes it possible to restore humeral and arm length during revision surgery, or for implant replacement, fracture sequellae or substance loss can be useful.

Limiting factors

This study was limited by its retrospective and multicentric format making it difficult to gather data and impossible to evaluate postoperative external rotation. Moreover preoperative functional data were not available in all patients. Finally, there were relatively few cases by TD approach ($n = 35$), resulting in a relatively large confidence interval for the mean AAE difference.

Conclusion

The humeral cut by the TD approach is lower, but this is partially corrected by the use of a thicker polyethelene insert. Postoperative anterior active elevation is fairly similar with the two approaches.

Disclosure of interest

AL, AL, PC: no conflict of interest.
TBE, FS, GW: financial interest in the company Tornier S.A.

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