Short-term results after reversed shoulder arthroplasty (Delta III) in patients with rheumatoid arthritis and irreparable rotator cuff tear

Michael John · Géza Pap · Felix Angst ·
Matthias P. Flury · Sebastian Lieske ·
Hans-Kaspar Schwyzer · Beat Rene Simmen

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Abstract The purpose of this study was to describe the outcome after reversed Delta III shoulder prosthesis in patients with rheumatoid arthritis (RA) and irreparable rotator cuff tear. Fifteen patients (17 joints) were prospectively analysed using the Constant-Murley score (CS). Comprehensive outcome measure was carried out by means of four widely used questionnaires as well as clinical and radiographic examinations at an average of 24.3 months postoperatively. The CS improved significantly from 19 to 59.5 points. The mental (MSC) and physical (PCS) component summary score of the Short Form 36 (SF-36) reached 108% and 77%, respectively, while the DASH (Disabilities of the Arm, Shoulder, and Hand) was 58% of a comparative norm population. Remaining deficits were documented by SPADI (Shoulder Pain and Disability; 54.4 points) and ASES (clinical and patient-orientated American Shoulder and Elbow Surgeons; 84.3 and 61.3 points, respectively). No radiological signs of loosening were found, but scapular notching occurred in four cases.

M. John (✉) · S. Lieske
Department of Orthopaedics, Otto-von-Guericke University,
Leipziger Str. 44,
39120 Magdeburg, Germany
e-mail: michajohn100@web.de

G. Pap
Department of Orthopaedics and Traumatology, Park Hospital,
Leipzig, Germany

F. Angst · M. P. Flury · H.-K. Schwyzer · B. R. Simmen
Schulthess Klinik,
Zurich, Switzerland

F. Angst
Rehaclinic Zurzach,
Zurzach, Switzerland

Reversed arthroplasty provides a substantial improvement of shoulder function in patients with RA. The high incidence of notching is of concern.

Resume Résultats à court terme de la prothèse inversée de type Delta III chez les patients porteurs d'une arthrite rhumatoïde et d'une lésion irréparable de la coiffe. Objectif: décrire le devenir du patient après mise en place d'une prothèse d'épaule inversée type Delta III, chez les patients présentant une arthrite rhumatoïde (RA) et des lésions irréparables de la coiffe. Méthode: 15 patients (17 articulations) ont été analysés de façon prospective en utilisant le score de Constant Murley (CS). Le devenir clinique des patients a été exploré grâce à 4 questionnaires utilisés communément tant sur le plan clinique que radiographique avec un examen en moyenne à 24,3 mois post-opératoires. Résultats: le score de Constant a été amélioré de façon significative passant de 19 à 59,5 points. Le score MCS et PCS ainsi que le score SF-36 sont passés respectivement de 108 à 77%, le score DASH à 58% comparables à la norme de la population. Les déficits résiduels ont été randomisés par le score SPADI 54,4 points et ASES respectivement de 84,3 à 61,3 points. Aucun signe radio de descellement mais 4 cas d'encoche scapulaire ont été relevés. En conclusion, la prothèse inversée d'épaule permet d'avoir une amélioration très substantielles chez les patients présentant une arthrite rhumatoïde. La fréquence importante des encoches est à surveiller.

Introduction

Advanced arthritic destruction of the glenohumeral joint in combination with an irreparable rotator cuff tear poses

a complex problem for the orthopaedic surgeon [8, 13, 23, 25].

The pathology of the rheumatoid arthritis (RA) shoulder differs from that of the rotator cuff-tear arthropathy (RCTA) or osteoarthritis shoulder. RA patients with rotator cuff tears usually have a long history of their systemic disease, with medical treatment causing general osteoporosis (poor bone quality) and a compromised immune system [25]. Arthritic involvement in other joints, i.e. hands, wrists, elbows, hips, or knees are common, and young patients are more often affected [15, 24, 25]. The radiographic appearance is similar to that of RCTA, but is commonly accompanied by a higher grade of destruction [25]. Severe wear of the glenoid and the coracoid process in addition to progressive erosion of the acromial bone stock with insufficiency of the coracoacromial arch are frequently seen [13, 25]. Asymmetrical destruction of the more central and superior parts of the glenoid increases not only the upward migration of the humeral head but also limits the scope of surgical treatment [7]. Most rheumatoid shoulders assessed as Larsen grades 4 or 5 have a remarkable rotator cuff disease [10, 13]. Cuff pathology more often involves the infraspinatus and teres minor muscles in addition to the supraspinatus, causing severe internal rotation deformity [15].

Therefore, the treatment of the damaged cuff is considered to be very challenging [8, 12, 13, 23]. Total shoulder replacement has been shown to fail due to early glenoid loosening [3, 7, 18, 23, 25]. Hemi-arthroplasty, including bipolar prosthesis and surface replacement, provides partial pain relief but poor functional results [3, 7, 8, 12, 19, 20, 25]. In the treatment of RCTA, reverse total prosthesis, such as those developed by Grammont et al. have been used recently [2, 6, 11]. Many clinical studies show very good results in terms of pain release, satisfaction, and function for patients with RCTA, with follow-up ranging from two to seven years [4, 8, 17, 21, 22, 23].

Results of reverse arthroplasty in RA shoulders are rare and include a very small number of patients [8, 15, 24]. Therefore, the treatment benefits of the procedure are controversial. In our department, patients with severe RA and irreparable cuff deficiency have been treated with the DELTA III arthroplasty (DePuy, International Ltd., Leeds, England) for several years. The purpose of this study was to evaluate our clinical and radiographic outcomes of the DELTA III arthroplasty in a consecutive series of RA patients treated for painful pseudoparesis of the arm due to irreparable rotator cuff deficiency. Patients were prospectively analysed using the Constant-Murley score (CS). In addition, clinical follow-up was conducted using a comprehensive assessment set, including four patient-orientated questionnaires [1].

Material and methods

Of 127 consecutive Delta III arthroplasties, 22 prostheses (17.3%) were implanted in 20 patients with seropositive rheumatoid arthritis at the Schulthess Klinik Zurich, Switzerland.

Indications for surgery included chronic and painful pseudoparesis (defined as active shoulder elevation of $<90^\circ$ in the presence of free passive forward elevation) with strong limitations in activities of daily living (ADL) due to an irreversible rupture of at least the supraspinatus tendon and either the subscapularis or the infraspinatus tendon.

Diagnostically, the rotator cuff was evaluated by clinical examination (using the CS scoring system), radiography (true/plain anteroposterior in internal and external rotation, axillary lateral and outlet view), ultrasonography, and direct joint magnetic resonance arthrography (MRA) with contrast medium. Patients had radiological signs of advanced arthritic joint destruction (Larsen IV-V) and a markedly narrowed or eliminated subacromial space (Hamada and Fukuda stage IV-V) [9, 10]. According to the Goutallier classification, fatty degeneration of the supraspinatus and infraspinatus muscle was greater than stage II [5].

We used a delto-pectoral approach as a standard, without detachment of the deltoid muscle. The humeral component was generally cemented. In all cases, the 36-mm glénosphere and, (in order to restore appropriate tension in the deltoid), the standard lateralised humeral polyethylene cups were implanted.

Passively- and actively-assisted exercises were started immediately after surgery. Between the physical therapy sessions, the arm was immobilised in a sling. After six weeks, the limitations in mobility were reduced stepwise, and emphasis was then placed on strengthening and mobilisation of the shoulder muscles.

All patients were invited for a clinical examination. The follow-up assessment consisted of a structured interview, clinical examination, and radiographic/ultrasonographic imaging. A comprehensive and proven evaluation set comprising a selection of self-assessment questionnaires covering the specific joint and general health status including SF-36, DASH, SPADI, and ASES with a patient-orientated (pASES) and a clinical (cASES) part, was used for the interview [1]. Additional information about existing concomitant diseases (comorbidity questionnaire), socio-demographic data, and patient contentedness were collected [1]. The clinical examination was closely orientated towards the completion of the cASES and the CS. For the latter, a comparison with the initial clinical examination results could be made. The examination was done by an independent physician (M.J.) who was not involved in the treatment. Imaging (except MRA) was repeated in order to assess the component position, signs of

loosening, and mechanical dysfunction. Inferior scapular notching was classified according to the system of Nerot [17, 21]. Ultrasonographic symptoms of joint irritation and inflammation (e.g. effusion) were also a focus of attention. Joint mobility was evaluated using a goniometer. Isometric joint strength in 90° abduction (sitting position) was measured (three-fold repetition) using a standardised spring balance PESOLA (up to 20 kg).

Statistical analysis

Descriptive statistics for all instrument scores used were given on a scale ranging from 0 to 100 (0=worst, 100=best). Normative values were calculated and stratified by sex, age, and comorbidity for the SF-36 and DASH, as well as for the CS adapted to age and sex. Pairwise comparisons with normative values and/or the preoperative findings were carried out using Wilcoxon's rank sum test for nonparametric statistics, since data were not normally distributed. The statistical analyses were carried out using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Statistical significance was accepted at the 5% level; *p* values are given in the corresponding tables.

Results

A total of 15 (75%) patients with 17 (77.3%) shoulder prostheses (two bilateral) were evaluated after an average follow-up of 24.3 months (range 11.5–40.9 months). Five patients (five joints) were lost to follow-up. Three patients had died, and two patients declined participation (one patient lived too far away, another had multiple morbidity). The demographic data of the 15 patients examined are given in Table 1.

Table 2 summarises the mean results of each instrument's score and their comparison with normative data. The scores were high for mental health and pain, relatively high for the clinical scores (CS, cASES), but low with regard to the dimensions measuring specific physical functions and abilities. Results for the DASH and the SF-36 dimensions (physical component summary (PCS), physical function,

and role physical) remained significantly below the normative figures. This was also the case when the CS results were compared with their adjusted normal values. In contrast, general health, bodily pain and all the mental health dimensions of the SF-36 were equivalent to or exceeded the normative values.

Persisting functional impairment was also documented by the patient-oriented SPADI and pASES.

The CS increased from a mean of 19 preoperatively to a mean of 59.5 after Delta III prosthesis. The improvement was significant not only for the total score but also for all scales (Table 3).

With regard to the latest symptoms of pain in the affected shoulder, nine patients claimed to be totally free of any pain, while six and two patients reported little and moderate pain, respectively (scale: no pain, little, moderate, severe). Compared to the preoperative joint state, the situation improved considerably in 11 and slightly in six cases (scale: much better, slightly better, unchanged, slightly worse, much worse). For 14 patients, their expectations from the operation were fulfilled, and all patients would decide in favour of the operation if they found themselves in the same preoperative situation.

The follow-up radiographs showed no indication of implant loosening. Shoulder instability and dislocation were not observed. Scapular notching was recognised to be in stage 1–2 in four patients (23.5%). Ultrasonographic control revealed a subdeltoid effusion in two patients and a joint synovialitis in one case. At the time of follow-up, none of the implants had required surgical revision.

Discussion

All patients in our series had an irreparable rotator cuff tear with severe functional impairment and advanced arthritic destruction of the shoulder joint (Larsen IV–V). The subjective and objective outcome values, in an average period of two years after implantation of a reversed Delta III prosthesis, clearly document a high degree of patient satisfaction and substantial improvement in function.

Table 1 Demographic data of the patient group (*n*=15) with rheumatoid arthritis

Demographic	Value
Number of treated joints / patients	17 / 15
Mean follow-up time (months)	24.3 (range 11.5–40.9)
Mean age of the patients (years) at the time of the operation	67.3 (range 46.3–84.9) (6 patients were younger than 65)
Gender of patients	10 women / 5 men
Side of the affected shoulder joint according to gender	9 × right (8 women, 1 man); 8 × left (4 women, 4 men); 2 × both sides (2 women)
Affected joint on the dominant side	10

Table 2 Mean results after summarising all scores used for 15 patients (17 joints)

Evaluation	Mean	Minimum	Maximum	Standard deviation	Norm	% Norm	<i>p</i>
SF-36 Physical function	39.0	5.0	80.0	26.5	64.5 ^a	60.5	0.009
SF-36 Role physical	35.0	0.0	100.0	40.9	60.1 ^a	58.2	0.041
SF-36 Bodily pain	44.1	12.0	100.0	22.2	49.1 ^a	89.8	0.233
SF-36 General health	49.5	15.0	87.0	20.6	51.9 ^a	95.4	0.820
SF-36 Vitality	46.3	10.0	100.0	21.4	51.7 ^a	89.6	0.173
SF-36 Social function	73.5	25.0	100.0	23.6	79.2 ^a	92.8	0.460
SF-36 Role emotional	80.0	0.0	100.0	41.4	79.1 ^a	101.1	0.306
SF-36 Mental health	72.0	28.0	100.0	21.1	66.9 ^a	107.6	0.233
SF-36 PCS	30.0	15.2	50.7	9.4	39.0 ^a	76.9	0.008
SF-36 MCS	53.9	28.7	68.1	10.6	50.0 ^a	107.8	0.173
DASH Symptoms	69.4	25.0	100.0	23.8	83.9 ^a	82.7	0.047
DASH Function	43.7	11.0	87.0	26.2	85.2 ^a	51.3	0.001
DASH Total	49.0	18.0	89.0	23.2	84.7 ^a	57.9	0.001
SPADI Pain	63.1	35.0	100.0	23.9	-	-	-
SPADI Function	45.9	11.0	98.0	29.3	-	-	-
SPADI Total	54.5	25.0	97.0	23.9	-	-	-
pASES Pain	72.5	40.0	100.0	22.9	-	-	-
pASES Instability	84.4	50.0	100.0	19.6	-	-	-
pASES Function	50.1	7.0	97.0	24.2	-	-	-
pASES Total	61.3	40.0	98.0	19.8	-	-	-
cASES Motion active	55.6	30.0	87.0	13.9	-	-	-
cASES Motion passive	62.4	34.0	97.0	15.6	-	-	-
cASES Symptoms	94.7	75.0	100.0	8.5	-	-	-
cASES Strength	86.7	60.0	100.0	14.8	-	-	-
cASES Stability	96.7	50.0	100.0	12.9	-	-	-
cASES Total	84.3	67.0	98.0	5.9	-	-	-
CS Pain	12.3	5.0	15.0	3.7	-	-	-
CS ADL	14.6	9.0	19.0	3.0	-	-	-
CS Mobility	24.62	10.0	36.0	7.2	-	-	-
CS Strength	6.2	0.0	11.0	3.0	-	-	-
CS Total	59.5	34.0	81.0	14.2	73.12 ^b	81.4	0.019

The Wilcoxon rank sum test was used for comparison.

SF-36 Short Form 36, *PCS* physical component summary of SF-36, *MCS* mental component summary of SF 36, *DASH* disability of the arm, shoulder and hand, *SPADI* shoulder pain and disability index, *pASES* patient American Shoulder and Elbow Surgeons questionnaire (ASES), *cASES* clinical American Shoulder and Elbow Surgeons questionnaire (ASES), *CS* Constant-Murley score

^a Norm population normative values after correction for gender, age and comorbidity

^b Norm population normative values after correction for gender and age

The SF-36 has a high discrimination capacity in detecting changes of health and quality of life in rheumatic patients [1]. The mental component results reached a level comparable to the values of a general normative population, representing the improvement in life quality due to remarkable pain relief, increased ADL, and reduction in the negative psychosocial effects of RA. However, perfect health, reflected by a score of 100, cannot be expected for a 67-year-old person with RA and concomitant diseases (average 3, range 1–7). Functional limitations are evidenced

by the low scores on the function scales and subscales (Table 2). The markedly worse results in the DASH (51.3% of norm), compared to those in PCS of the SF-36 (76.9% of norm), favoured RA, affecting the arm to a greater extent. This assumption was corroborated by SPADI and pASES, where the function subscales revealed the worst results. The cASES results tended to be higher than those of the pASES, indicating that the physician's rating of the patient's health was more optimistic than the patient's own assessment [1]. However, patients remarkably improved their shoulder

Table 3 Comparison of the pre- and postoperative shoulder joint status according to the outcomes of the Constant-Murley score in points (unless data were differently defined) ($n=17$ joints)

Category of the Constant score	Preoperative mean	Postoperative mean	<i>p</i> (level of significance)
Pain	1.33	12.3	0.001
Activities of daily living (ADL)	6.4	14.6	0.007
Range of motion	9.7	26.4	0.004
Flexion/ anteversion (degrees)	68.4	123	0.003
Abduction (degrees)	65.9	119.7	0.001
External rotation	0.4	7.3	0.001
Internal rotation	3.4	4.4	0.43
Power	1.6	6.2	0.007
Total	19	59.5	0.018

The Wilcoxon signed-rank test was used for comparison

function by 40.5 points on average, reaching 80.7% of a normal population for the CS score [1]. Despite the gross pathological changes in RA, CS results of 60 points and more after reverse shoulder arthroplasty can be expected. These findings have also been confirmed in a longer follow-up [8, 15, 24], and the treatment effects have remained stable for at least five years (Table 4). However, the functional results are likely to deteriorate progressively after six years [8].

In contrast to other studies using cementless fixation of the humeral component, we did not observe any radiological sign of loosening, migration or stress shielding with the cemented stem at the time of follow-up (Table 4). This was also the case for the glenoid component. We are aware that these findings must be interpreted very critically because of the short follow-up time. Radiolucent lines around the glenoid component were found in 38.5% and aseptic

loosening in 25% of the cases after a mean follow-up of 87 and 54 months, respectively (Table 4). Guery et al. carried out survivorship analysis for patients after reverse total shoulder arthroplasty, performed for a cuff tear aetiology other than RCTA, including a large subset of patients with RA (>57% of the cases) [8]. The survival rate was 77% at nine years for implant replacement as the endpoint and 77% at seven years when glenoid loosening was the end point [8]. Typically, the survival curve showed a break between one and three years when most of the revisions had to be done due to infection and rapid loosening, but have remained stable afterwards [8].

In four joints (23.5%), we found signs of scapular notching of the inferior part of the scapular neck without extension to the inferior fixation screw of the glenoid component (stage I-II according to Nerot) [21]. Scapular notching was observed radiographically in 50–96% of the

Table 4 Comparison of the functional results after implantation of a reversed total shoulder arthroplasty performed in patients with rheumatoid arthritis and irreparable rotator cuff

Variable	Woodruff et al. [24]		Rittmeister and Kerschbaumer [15]		This study by John et al.	
Number of joints included	13		8		17	
Patient's mean age (y)	64		60.25		67.3	
Follow-up time (mo)	87		54		24.3	
Number (cases) and species of complication	Radiolucent lines around all (cementless) stems (100%) and around the metaglene in 5 cases (38.5%)		One septic implant loosening (12.5%); two aseptic glenoid loosening (25.0%); three failed osteosynthesis following transacromial approach (37.5%)		Scapular notching grade I + II in 4 cases (23.5%)	
	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
SF-36 ^a / SF-12 ^b	MCS	49.36 ^b				53.9 ^a
	PCS	33.4 ^b				30.0 ^a
Constant score		59.0	17	63.0	19	59.5

Pre-op preoperative, *post-op* postoperative, *SF-36* short form-36, *SF-12* short form-12, *PCS* physical component summary of SF-36/ SF-12, *MCS* mental component summary of SF-36/ SF-12

^a Related to the SF-36

^b Related to the SF-12

Table 5 Functional shoulder results after implantation of a bipolar prosthesis in patients with rheumatoid arthritis and irreparable rotator cuff tear based on a search in the literature. Comparison with the results of this study (John et al.) after reversed arthroplasty

Variable	Swanson et al. [19]		Swanson et al. [20]		Lee and Niemann [12]		Boyer et al. [3]		This study by John et al.	
Type of prosthesis	Bipolar HEMI		Bipolar HEMI		Bipolar HEMI		Bipolar HEMI		Reversed TSA	
Number of cases included	10		20		7		12		17	
Patient's mean age (y)	62		62		57.3		58		67.3	
Follow-up time (mo)	41		63		32.6		60+		24.3	
	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
Forward flexion	54°	80.5°	53°	76°	46°	79°	63.8°	83.7°	68.4°	123°
External rotation	18°	30.5°	16°	35°	3°	20°	12°	29.1°	19.8°	52.5°
Abduction	39°	69°	43°	68°	35°	66°	45°	70.4°	65.9°	119.7°
Constant score	Ø	Ø	Ø	Ø	Ø	Ø	16.9	39.4	19	59.5

Pre-op preoperative, *Post-op* postoperative, *HEMI* shoulder hemi-arthroplasty, *TSA* total shoulder arthroplasty

cases [17, 21, 22, 23]. Slight to moderate notching (stage 0–II) was found more frequently (36–50%) than severe grades (16–20% for stage III–IV) [17, 21, 22]. Usually this becomes evident six to eight weeks after implantation but does not seem to progress after one year [8, 14, 17]. Controversy exists about whether notching influences the clinical outcome, and whether the complication rate is dependent on notching [8, 17]. However, direct correlation between the frequency or the grade of notching and the glenoidal loosening rate does not seem to exist.

To avoid glenoid loosening, hemi-arthroplasty was favoured as the treatment of choice [7, 18, 16, 25]. Especially bipolar prosthesis with large heads was thought to centralise joints with cuff insufficiency [16]. It can be used as a surgical alternative in RA patients, but many researchers recommend it only when the coracoacromial arch is intact [3, 12, 15, 20]. However, complications, e.g. overstuffing and progressive wear/erosion of the glenoid and/or acromion, were frequently reported, causing further deterioration of the initial poor bone stock [11, 16, 18]. The literature contains very few reports dealing with RA patients suffering from irreparable rotator cuff tear; even if pain relief was achieved, the function remained poor, and patient satisfaction decreased with time after the procedure (Table 5) [3, 12, 16, 19, 20, 23]. Bipolar prosthesis was therefore recommended as a salvage procedure reserved for older (RA) patients with very low demands to be performed as late as possible [7, 23].

In contrast, the subjective and objective shoulder values in our study, after reversed arthroplasty in RA patients with irreparable cuff deficiency, were generally higher than the results reported following bipolar arthroplasty (Table 5). In this study, we could also show that rheumatoid patients regained shoulder functions to a great extent, comparable to RCTA patients with this type of prosthesis [2, 11, 17, 21–23].

We therefore conclude that the implantation of the DELTA III prosthesis is a valuable procedure for the treatment of an irreparable rotator cuff tear in RA patients (Table 4). We think that improvement in quality of life justifies the use of the DELTA III prosthesis in RA patients, even if the survivorship of the prosthesis might be limited. Younger patients are more often affected, therefore facing a prolonged period of reduced life quality. Earlier referral for the operation might present the patient in a less destructive stage of the disease, resulting in more glenoid bone stock to work with. This could be one possibility of increasing the number of patients with adequate bone support for firm anchorage of the glenoid component in order to improve the long-term survival of the prosthesis. In cases of implant loosening, conversion of the DELTA III prosthesis to a hemiarthroplasty of type DELTA I remains an option. Complete revision in order to replace the DELTA III with a hemiarthroplasty as an “ultima ratio” procedure is still possible. However, because of the limited experience and high complication rate in RA patients, this implant should be reserved for situations in which an acceptable clinical outcome cannot be expected with another treatment modality.

The evaluation set used for the comprehensive shoulder assessment was proven for its clinical significance. All instruments involved were available in a validated and tested form. Direct comparisons of the results with other studies and with population normative data are possible [1, 15, 24]. We are convinced that by conducting this study we have established a reference that allows for comparison with future results and have helped to estimate the outcome in RA patients after reversed shoulder arthroplasty.

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