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Comparison of outcomes after reverse shoulder arthroplasty in patients with rheumatoid arthritis and cuff tear arthropathy

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Background: The reverse shoulder arthroplasty (RSA) was originally designed for cuff tear arthropathy (CTA). Over time, the indications have expanded to rheumatoid arthritis (RA). This study aimed to compare the outcomes of RSA in patients with RA and CTA to determine if there is any impact on clinical and radiographic outcomes.
Methods: In this retrospective comparative study (performed from August 2010 to March 2017), 61 shoulders from 59 consecutive patients (RA group: 24 patients [26 shoulders], CTA group: 35 patients [35 shoulders]) who underwent primary RSA, were included. The average follow-up period was 31 months (range, 24-64 months). Patients were assessed with the use of the visual analog scale pain score, the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score, the Single Assessment Numeric Evaluation score, range of motion (ROM), and imaging studies included the β angle, glenoid component superior tilt, and scapular notching.
Results: The clinical results improved significantly in both groups, but there was no statistically significant difference between the RA group and the CTA group. Significant intergroup differences were observed regarding the β angle ($73° \pm 11°$ for the RA group vs. $85° \pm 8°$ for the CTA group; $P < .001$) and glenoid component superior tilt (12 cases for the RA group vs. 4 cases for the CTA group; $P < .001$) at the final follow-up. The Scapular notching was observed in 19 (73%) and 24 (69%) shoulders in the RA and CTA groups, respectively ($P = .662$). There were 7 (27%) complications in the RA group and 3 (9%) in the CTA group. Fractures involving greater tuberosity, lesser tuberosity, acromion, glenoid, and peri-implant were observed either intraoperatively or postoperatively in 6 shoulders in the RA group and in 3 shoulders in the CTA group. One case of transient musculocutaneous nerve palsy in the RA group was noted. None of the patients required revision surgery for any reason.
Conclusion: Compared with CTA patients, RA patients achieved similar clinical outcomes following RSA. However, surgeons should pay attention to the positioning of the glenoid component during the surgery and the risk of intraoperative fractures in RA patients.
Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Keywords: Reverse shoulder arthroplasty; rheumatoid arthritis; cuff tear arthropathy; comparison; outcomes; superior tilt; complication

Reverse shoulder arthroplasty (RSA) was designed for cuff tear arthropathy (CTA) characterized by massive rotator cuff tear, degenerative glenohumeral joint, and superior migration of the humerus.[1] Destruction of the glenohumeral joint resulting from rheumatoid arthritis

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(RA) is typically associated with rotator cuff deficiency in the form of frank tearing or rotator cuff dysfunction.[34] Progressive superior migration of the humeral head following rotator cuff deficiency was an inevitable consequence of the disease. Eventually, RA may develop a condition similar to CTA, even though the pathoanatomy is different, and based on this, RSA was also performed in RA patients. Several studies have reported that RSA for RA results in significant pain relief and improvements in functional shoulder motion.[9,18,19,22,30,34]

However, RA patients often have severe glenoid bone defects and poor bone quality, making surgery much more difficult. Primarily, there are concerns regarding the longevity of the glenoid component regarding the baseplate position. In addition, prolonged use of steroids and immunosuppressants increase the risk of infection. For these reasons, the RSA outcomes for RA patients are controversial in comparison with those of CTA patients.

Although some studies have assessed the overall outcomes on RSA in RA patients, the clinical and radiographic outcomes and complications between patients with RA and CTA have not been well defined. Therefore, this study aimed to compare the (1) postoperative clinical outcomes, (2) radiographic outcomes including the β angle described by Maurer et al,[26] and (3) complications of RSA between patients with RA and those with CTA.

Materials and methods

Patients

This study was a retrospective case-control study of patients with RA and CTA who underwent RSA. A retrospective review of Hanyang University Seoul Hospital RSA registry was used to identify all primary RSAs performed by a single surgeon between August 2010 and March 2017 using the Aequalis Reverse prosthesis (Tornier, Houston, TX, USA) and Aequalis Ascend Flex prosthesis (Tornier, Bloomington, MN, USA).

RA patients who had RSA performed were identified. RA was identified by the International Classification of Disease code M05. Additionally, the diagnosis of RA was further validated with a preoperative chart review, and a rheumatologist completed the prescription of disease-modified antirheumatic drugs (DMARDs). Then, the exclusion criteria, including surgery caused by infection or fracture, revision surgery, incomplete baseline data, and loss to follow-up before 2 years, were applied.

CTA patients were identified within the registry by excluding all patients with a diagnosis of inflammatory disease or autoimmune disorders, and the additionally mentioned exclusion criteria. CTA was defined as grade 1 or higher in the Hamada classification[17] with rotator cuff compromise.

Surgical technique

The surgery was performed under general anesthesia, with the patient placed in the 30° beach chair position by a single senior author (B.G.L.) using the deltopectoral approach. The Aequalis Reverse prosthesis was used in 27 cases and the Aequalis Ascend Flex prosthesis in 34 cases. The subscapularis peel off was performed, and the tendon was tagged for later reinsertion. The humeral head resection was made with a retroversion angle of 20° using a rotation guide with the forearm axis set at neutral rotation. Following humeral preparation, we removed the remnant labrum, so that the glenoid could be exposed entirely. Subsequently, the glenoid step was performed using the standard surgical technique, according to the company instrumentation manual. The articular cartilage and sclerotic bone of the glenoid were removed using a flat reamer, and the baseplate was carefully positioned approximately 2-3 mm inferior to the center of the glenoid with a 10° inferior tilt to reduce scapular notching.[29] In most of the patients, a 25-mm-diameter circular baseplate with a 15-mm-long central peg was used. In the cases of bony increased-offset (BIO) RSA, the 25-mm-diameter baseplate with a 25-mm-long peg was used. For a small number of patients with a large glenoid, a baseplate with a diameter of 29 mm was used. Fixation was obtained using two 4.5-mm convergent compressive screws and two 4.5-mm divergent locking screws. A 36-mm-diameter glenosphere was used in all patients. Then, the humeral implant was implanted. The implants were reduced using a trial polyethylene. Next, their range of motion (ROM), stability, and the surrounding muscle tension were confirmed to determine the thickness of polyethylene. The subscapularis tendon and joint capsule were reattached to the lesser tuberosity of the humerus.

BIO-RSA with a structural humeral head bone graft was performed on 6 RA patients (7 shoulders) with severe bone loss of the glenoid.[8] When the lateral border of greater tuberosity of the humerus was located more medial than was the lateral margin of the acromion caused by medial glenoid erosion on the anteroposterior (AP) radiograph of the shoulder (Fig. 1), we performed BIO-RSA for several benefits such as decreasing inferior scapular notching and improving shoulder rotation, prosthetic stability, and cosmetic shoulder contour.[3] When there was a severe bone loss without significant medialization of the glenohumeral joint, a bone graft from the humeral head besides BIO-RSA was used.

The patients were placed in an abduction brace for 6 weeks. They began performing pendulum exercises the day after the surgery. Passive ROM exercises were initiated carefully 2 weeks after the surgery. Active ROM and strengthening exercises were started 6 weeks after the surgery. In BIO-RSA cases, the delayed rehabilitation protocol was adopted. Pendulum exercises were started immediately, but any other motion was not permitted until 4-6 weeks postoperatively, depending on bone quality. After 4-6 weeks, passive ROM exercises were started. After 8 weeks, active ROM exercises, except for heavy lifting, were allowed. After confirming that solid bony union of the graft was obtained, muscle-strengthening exercises were initiated at 12-16 weeks postoperatively.

Clinical assessment

The patients were regularly evaluated preoperatively and postoperatively in the outpatient department. The demographic data of the patients, including age at surgery, sex, affected arm (dominant or nondominant), body mass index, surgical

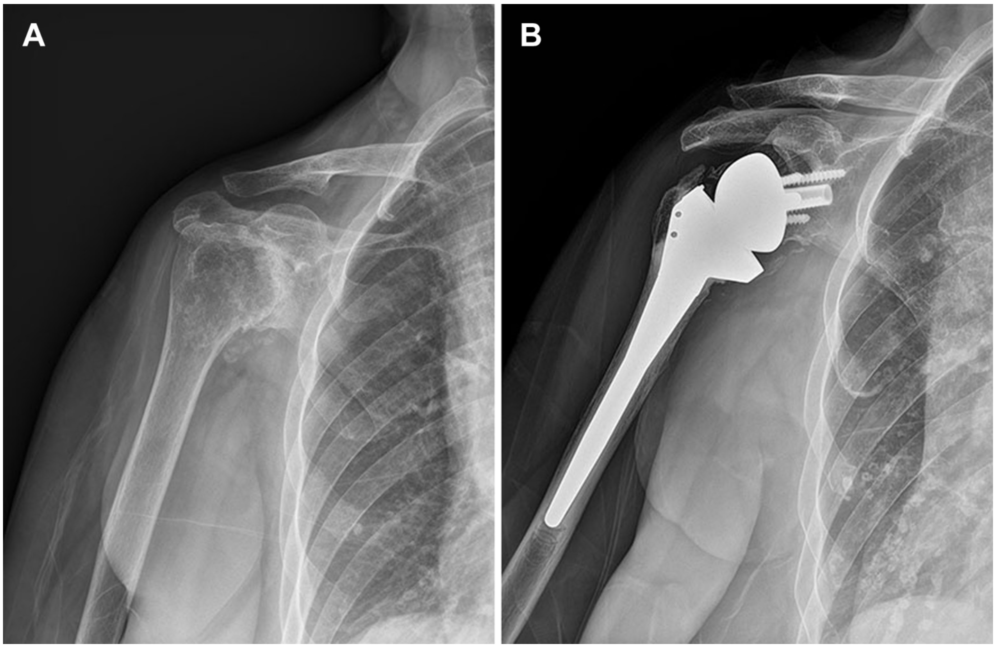

Figure 1 (**A**) Preoperative radiograph of a 61-year-old patient with rheumatoid arthritis showing medialization of glenohumeral joint caused by glenoid erosion. (**B**) Postoperative radiograph taken 34 months after bony increased-offset reverse shoulder arthroplasty.

instrument, and operative technique, were obtained by a chart review. The preoperative and final follow-up clinical data were collected including active shoulder ROM (forward flexion, abduction, external rotation, and internal rotation), visual analog scale (VAS) pain score, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) score, and Single Assessment Numeric Evaluation (SANE) score.

Radiographic assessment

AP shoulder radiograph and AP radiographs of the glenohumeral joint in neutral rotation, axillary, 30° caudal tilt, and supraspinatus outlet view were obtained in all patients. Preoperative computed tomographic scans were performed to evaluate the erosion of the glenohumeral joint and anatomic shape of the scapular neck. Magnetic resonance imaging was performed to evaluate the status of the rotator cuff including muscular insufficiency and fatty infiltration using well-established classification schemes.[12,14] On a true preoperative AP radiograph of the shoulder, all patients were evaluated for medial glenoid wear using the classification system of Lévigne et al[24] and the patterns of glenoid erosion using the Favard classification.[31] The preoperative and postoperative β angle was measured on the AP radiograph to determine glenoid inclination, as described by Maurer et al.[26] The β angle is defined as the angle between the glenoid fossa line and the supraspinatus fossa. The angle was measured in the inferolateral quadrant between these 2 lines. The β angle demonstrated excellent reliability to assess glenoid component inclination on postoperative radiographs in RSA patients as well as glenoid inclination in native shoulders.[32] Radiographs obtained from the most recent follow-up were evaluated for the base plate or humeral stem loosening and scapula notching. Scapular notching on the AP view was assessed as described by Sirveaux et al.[31]

Statistical analysis

All tests were 2-sided. Data between both groups were analyzed with the independent *t* test for the normally distributed numerical variables, the Mann-Whitney test for the non–normally distributed numeric variables, and the chi-square test for the categorical variables. A paired *t* test was also used to compare the preoperative and postoperative data. The data were recorded as the mean ± standard deviation for all continuous variables. A P value $<.05$ was considered statistically significant. Data analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Patients

A total of 61 shoulders that met the inclusion criteria were evaluated; 26 shoulders (24 patients) and 35 shoulders (35 patients) were included in the RA and CTA groups, respectively. The RA group was statistically younger and had a lower body mass index. The average follow-up period was 31 months (range, 24-64 months). The cases of BIO-RSA or RSA with bone graft were significantly higher in the RA group. In addition, patients with osteoporosis were significantly higher in the RA group. Demographic data are summarized in Table I. Most patients in the RA group were taking steroids (20 shoulders, 77%) and 1 or more DMARDs (24 shoulders, 92%).

Table I Preoperative demographic comparisons

	RA	CTA	*P* value
N	26	35	
Age, yr	65.1 ± 7.9	73.9 ± 5.5	**<.001**
Sex			.56
Female	24 (92)	34 (97)	
Male	2 (8)	1 (3)	
Affected arm			.40
Right	17 (65)	25 (71)	
Left	9 (35)	10 (29)	
BMI	21.7 ± 3.1	23.7 ± 2.7	**.01**
Follow-up period (month)	30 (24-48)	32 (24-64)	.70
Preop. ROM			
Forward flexion	82° ± 33°	73° ± 31°	.31
Abduction	81° ± 33°	71° ± 33°	.27
External rotation	28° ± 18°	32° ± 21°	.51
Internal rotation	L5	L5	.55
Preop. VAS pain score	7.1 ± 1.4	6.7 ± 2.0	.52
Preop. ASES score			
Pain	14.6 ± 6.9	16.6 ± 10.1	.41
Function	14.1 ± 6.0	13.7 ± 6.2	.82
Total	28.7 ± 9.4	30.3 ± 12.7	.61
Preop. SANE score	28.7 ± 9.9	32.0 ± 9.9	.22
Goutallier grade			
Supraspinatus	3.4 ± 0.7	3.0 ± 0.9	.12
Infraspinatus	3.0 ± 1.3	2.8 ± 1.0	.63
Subscapularis	2.3 ± 1.1	2.1 ± 1.5	.43
Teres minor	2.1 ± 1.3	1.7 ± 1.4	.24
Bone graft	10 (38)	1 (3)	**<.001**
BIO-RSA	7 (27)	0 (0)	
Bone graft besides BIO-RSA	3 (12)	1 (3)	
Circular glenoid baseplate diameter			>.99
25 mm	24 (92)	33 (94)	
29 mm	2 (8)	2 (6)	
Humerus stem fixation method			.79
Cemented	17 (65)	24 (69)	
Press fit	9 (35)	11 (31)	
T score ≤ −2.5	16 (62)	12 (34)	**.035**

BMI, bone mass index; *Preop.*, preoperative; *ROM*, range of motion; *VAS*, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score; *SANE*, Single Assessment Numeric Evaluation; *BIO-RSA*, bony increased-offset reverse shoulder arthroplasty; *RA*, rheumatoid arthritis; *CTA*, cuff tear arthropathy.
Continuous variables are presented as mean ± SD or mean (range). Categorical variables are presented as numbers (percentages). Statistically significant values are in bold.

Clinical outcomes

Table II summarizes the preoperative and postoperative data. There was a statistically significant improvement in postoperative VAS pain score, ASES total score, and SANE score in both the RA and CTA groups. The RA group showed statistically significant improvements in all planes of motion (forward flexion, $P < .001$; abduction, $P < .001$; external rotation, $P = .017$; and internal rotation, $P = .017$). The CTA group also showed significantly improved ROM except for internal rotation. However, there were no significant differences in postoperative ROM, VAS pain score, ASES total score, and SANE score between the RA and CTA groups (Table III).

Radiographic outcomes

Preoperative and postoperative radiographic findings are shown in Tables IV and V. The stage of glenoid medial wear using the Lévigne classification was significantly different in both groups ($P < .001$). The stage of glenoid medial wear was higher in the RA group (Figs. 1 and 2). The patterns of

Table II Comparisons of preoperative and postoperative clinical outcomes for each group

	RA		*P* value	CTA		*P* value
	Preop.	Postop.		Preop.	Postop.	
Forward flexion	82° ± 33°	137° ± 27°	**<.001**	73° ± 31°	140° ± 23°	**<.001**
Abduction	81° ± 33°	132° ± 26°	**<.001**	71° ± 33°	132° ± 24°	**<.001**
External rotation	28° ± 18°	39° ± 14°	**.017**	32° ± 21°	41° ± 13°	**.011**
Internal rotation	L5	L4	**.017**	L5	L4	.63
VAS pain score	7.1 ± 1.4	2.4 ± 1.8	**<.001**	6.7 ± 2.0	2.4 ± 1.7	**<.001**
ASES score						
Pain	14.6 ± 6.9	38.3 ± 8.7	**<.001**	16.6 ± 10.1	37.9 ± 8.5	**<.001**
Function	14.1 ± 6.0	29.8 ± 5.3	**<.001**	13.7 ± 6.2	30.9 ± 6.9	**<.001**
Total	28.7 ± 9.5	68.1 ± 10.5	**<.001**	30.3 ± 12.7	68.7 ± 12.2	**<.001**
SANE score	28.7 ± 9.9	77.6 ± 9.6	**<.001**	32.0 ± 9.9	78.1 ± 11.5	**<.001**

VAS, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score; *SANE*, Single Assessment Numeric Evaluation; *RA*, rheumatoid arthritis; *Preop.*, preoperative; *Postop.*, postoperative; *CTA*, cuff tear arthropathy.
Values are presented as mean ± SD. Statistically significant values are in bold.

Table III Comparisons of postoperative clinical outcomes between groups

	RA	CTA	*P* value
Forward flexion	137° ± 27°	140° ± 23°	.66
Abduction	132° ± 26°	132° ± 24°	.96
External rotation	39° ± 14°	41° ± 13°	.66
Internal rotation	L4	L4	.34
VAS pain score	2.4 ± 1.8	2.4 ± 1.7	.86
ASES score			
Pain	38.3 ± 8.7	37.9 ± 8.5	.88
Function	29.8 ± 5.3	30.9 ± 6.9	.21
Total	68.1 ± 10.5	68.7 ± 12.2	.83
SANE score	77.6 ± 9.6	78.1 ± 11.5	.86

VAS, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score; *SANE*, Single Assessment Numeric Evaluation; *RA*, rheumatoid arthritis; *CTA*, cuff tear arthropathy.
Values are presented as mean ± SD.

glenoid erosion using Favard classification was significantly different in both groups ($P < .001$). The Favard type E1 glenoid (16 shoulders, 62%) was the most common in the RA group (Figs. 1 and 2), and type E0 glenoid (19 shoulders, 54%) was the most common in the CTA group. The preoperative β angle was significantly lower in the RA group than in the CTA group (76° ± 6° for the RA group vs. 79° ± 5° for the CTA group; $P = .020$). Significant intergroup differences were also observed regarding β angle at final follow-up (73° ± 11° for the RA group vs. 85° ± 8° for the CTA group; $P < .001$). The glenoid component superior tilting was present in 16 shoulders, with 12 shoulders (46%) in the RA group and 4 shoulders (11%) in the CTA group. There was a significant difference in the incidence of glenoid component superior tilting between both groups ($P < .001$).

The inferior scapular notching was observed in 19 (73%) and 24 shoulders (69%) in the RA and CTA groups, respectively. In the RA group, notching was rated as grade 1 in 10 shoulders (38%), grade 2 in 6 shoulders (23%), and grade 3 in 3 shoulders (12%). In the CTA group, notching was rated as grade 1 in 15 shoulders (43%), grade 2 in 7 shoulders (20%), and grade 3 in 2 patients (6%). The rate of scapular notching tended to be higher in the RA group than in the CTA group, but this was not statistically significant ($P = .662$).

Complications

Complications are summarized in Table VI. Complications occurred in 7 of 26 patients (27%) with RA and 3 of 35 patients (9%) with CTA. Within the RA group, complications included greater tuberosity fractures in 4, lesser tuberosity in 1, glenoid fracture in 1, and transient musculocutaneous nerve palsy in 1. Within the CTA group, complications included lesser tuberosity fracture in 1, acromial fracture in 1, and periprosthetic humeral fracture in 1. There was no revision case in both groups.

Discussion

Higher complication and revision rates and lower clinical outcomes have been a concern for RA patients with associated comorbidities, use of immunosuppressants including DMARD, and poor bone quality.[13,15,35] However, this study showed that the clinical outcomes after RSA in RA patients were not inferior compared with those of CTA patients. The overall postoperative clinical scores, including ROM and VAS, ASES, and SANE scores, did not differ between the RA and CTA groups.

Table IV Comparisons of preoperative radiographic outcomes between groups

Parameter	Description	RA	CTA	*P* value
Lévigne classification				**<.001**
Stage 1, n (%)	Subchondral bone intact or minimally deformed	3 (12)	27 (77)	
Stage 2, n (%)	Wear reaching the base of the coracoid	19 (73)	7 (20)	
Stage 3, n (%)	Wear beyond the base of the coracoid	4 (15)	1 (3)	
Favard classification				**<.001**
E0, n (%)	Superior humeral migration with no glenoid erosion	2 (8)	19 (54)	
E1, n (%)	Concentric glenoid erosion	16 (62)	5 (14)	
E2, n (%)	Glenoid erosion predominantly in the superior pole	2 (8)	5 (14)	
E3, n (%)	Global glenoid erosion more severe in the superior pole	5 (19)	6 (17)	
E4, n (%)	Glenoid erosion predominantly in the inferior pole	1 (4)	0 (0)	
Preop β angle		76 ± 6	79 ± 5	**.020**

RA, rheumatoid arthritis; *CTA*, cuff tear arthropathy.
Categorical variables are presented as numbers (percentages). Values of preoperative β angle are presented as mean ± SD. Statistically significant values are in bold.

Table V Comparisons of postoperative radiographic outcomes between groups

	RA	CTA	*P* value
N	26	35	
β angle at final follow up	73° ± 11°	85° ± 8°	**<.001**
Glenoid component superior tilt (%)	12 (46)	4 (11)	**<.001**
Scapular notching (%)	19 (73)	24 (69)	**.66**
Scapular notching degree (%)			
Grade 1	10 (38)	15 (43)	
Grade 2	6 (23)	7 (20)	
Grade 3	3 (12)	2 (6)	
Grade 4	0 (0)	0 (0)	

RA, rheumatoid arthritis; *CTA*, cuff tear arthropathy.
Values of β angle at final follow-up are presented as mean ± SD. Categorical variables are presented as numbers (percentages). Statistically significant values are in bold.

Although RSA has been used as a surgical treatment option for RA patients with rotator cuff insufficiency and glenohumeral joint erosion, RSA for RA patients has been controversial. Gerber et al[13] reported that advanced RA should not be considered a well-established indication for RSA. Guery et al[15] mentioned that RSA using the Grammont type of prosthesis in RA patients should be performed extremely carefully because of the high rate of surgical revisions. In their series, 2 of 8 RA patients (25%) had revision due to infection. Recently, several studies on RSA in RA patients reported significant improvements in terms of pain relief and functional outcomes without higher complications.[9,19,22,34]

The results of RSA in RA patients in this study are similar to those previously reported. Hattrup et al analyzed 19 shoulders with prosthesis from 4 different companies. At a mean follow-up of 37 months, the flexion improved from 68° to 138°, the VAS pain score decreased from 6.5 to 1, with an increase in the ASES score from 27 to 76. They found scapular notching in 42% of the shoulders. Notably, 2 scapular spine fractures, 1 acromial fracture, 1 dislocation, and 1 ulnar neuropathy occurred. They believed that these complications were balanced by the typical substantial improvement of pain and function from RSA in RA patients.[18]

To our knowledge, few studies have compared RSA outcomes in RA to those in CTA without RA. Jauregui et al[20] compared 919 RSA with RA and 8097 RSA without RA in terms of demographics, hospitalization, and early complication rate, performed between 2010 and 2013 through the United States Nationwide Inpatient Sample. In the RA cohort, the patients were younger, had longer hospitalization, and more prosthetic-related and greater tuberosity–related complications. However, as in our study, few studies have compared the RSA results between RA and CTA in terms of clinical and radiographic outcomes.

We observed a significant improvement in ROM and VAS pain, ASES, and SANE scores in both groups. An increase of 12-17 points in the ASES scores is considered a minimal clinically important difference in patients with rotator cuff problems.[33] This suggests that the change in the ASES score in our study was sufficiently significant in both groups to have clinical importance.

The glenoid component superior tilt in RSA can lead to early aseptic loosening and failure. It can also increase the risk of scapular notching, which is the most common radiographic complication.[7,16,31] In our study, the β angle at final follow-up in the RA group was significantly smaller. The superior tilting was significantly higher in the RA group than in the CTA group. There are several reasons for the high incidence of glenoid component superior inclination in the RA group. First, compared with CTA, the native

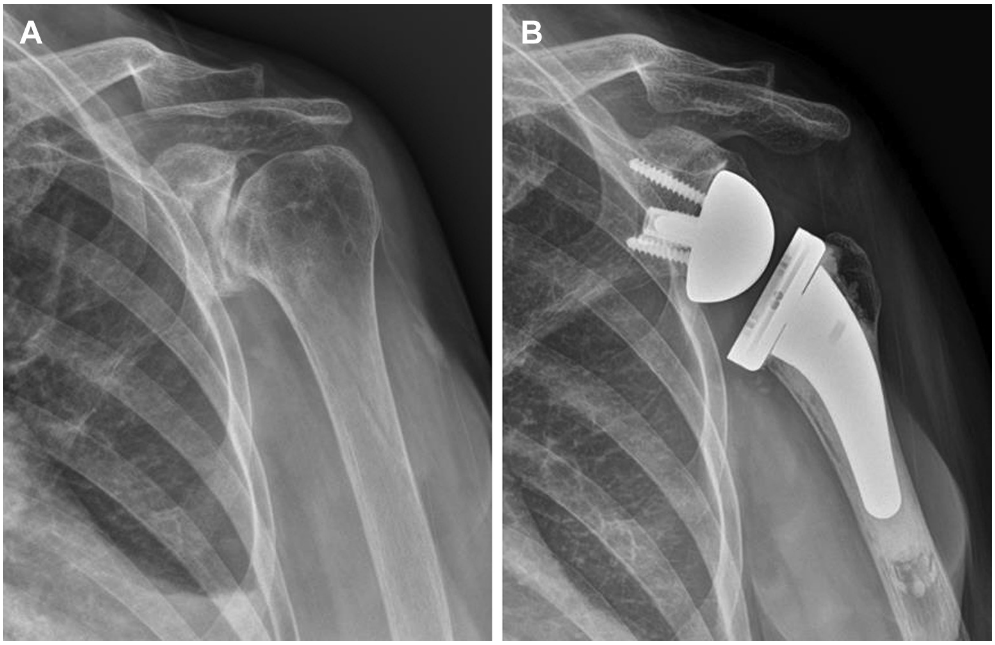

Figure 2 (**A**) Preoperative radiograph of a 63-year-old patient with rheumatoid arthritis showing the Favard type E1 glenoid. (**B**) Postoperative radiograph taken 26 months after reverse shoulder arthroplasty.

Table VI Complications

	RA	CTA
N	7	3
Greater tuberosity fracture	4	0
Lesser tuberosity fracture	1	1
Acromion fracture	0	1
Glenoid fracture	1	0
Periprosthetic fracture	0	1
Neurologic complication	1*	0
Complication rate (%)	27	9
Revision rate (%)	0	0

RA, rheumatoid arthritis; *CTA*, cuff tear arthropathy.
* Transient musculocutaneous nerve palsy.

glenoid inclination evaluated by the β angle before surgery was more superiorly tilted by erosion. The extent and location of glenoid erosion are reported to be risk factors for the superior tilt of the glenoid component.[5] Second, the patterns of glenoid erosion, according to Favard classification, were significantly different in both groups. In the CTA group, the Favard type E0 glenoid (19 shoulders, 54%) was the most common. The type E0 glenoid has a relatively lower risk of superior glenoid component tilting than in other types.[10] However, in the RA group, there were only 2 cases with type E0 glenoid (8%), and type E1 glenoid (16 shoulders, 62%) was the most common. Boileau et al[2] reported that the risk of baseplate implantation with a superior tilt is underestimated when using the β angle in cases with Favard type E1 glenoid. Thus, surgeons should pay particular attention to Favard type E1 glenoid for avoiding superior glenoid component tilting. Third, there were several patients with significant medialization of the glenohumeral joint caused by severe glenoid erosion. It is difficult to correct the glenoid inclination by glenoid reaming for concern about glenoid bone stock in these patients. In these cases, it is necessary to correct the glenoid version and inclination using a bone graft, which has some technical difficulties. Moreover, severe glenoid bone loss may obscure local landmarks for glenoid version and inclination, predisposing to errors of assessment and improper placement of the baseplate.[23]

To avoid superior glenoid component tilting in the RA groups, preoperative determination of glenoid orientation and of the degree of glenoid bone loss is essential. When the glenoid bone stock is in good condition with minimal erosion, the superior tilt of the glenoid component can be reduced by reaming the inferior part of glenoid. If severe glenoid bone loss is present, an inferiorly inclined bone graft should be considered. In cases with significant medialization of the glenohumeral joint, the angled BIO-RSA is a viable and good solution for avoiding superior component tilting.[4] Finally, in all cases, when landmarks are difficult to identify or in a case of advanced glenoid wear, patient-specific baseplates may be helpful.[25]

The scapular notching rate was higher in the RA group, but not statistically significant. Although most scapular notching cases (61% for the RA group vs. 63% for the CTA group) were regarded as mild (grade 1 or 2), a longer follow-up is needed to determine the impact of scapular notching on clinical outcomes including the survival rate of the implant.

There was no case of infection or instability in this cohort study. No shoulder required revision surgery. The overall complication rate was higher in the RA group (27%) than in the CTA group (9%). Cho et al,[6] in a systematic review of 7 studies, noted the overall complication rate of RSA in RA patients to be 20.4% (range, 0%-38%). The intraoperative fractures during RSA were observed in 6 shoulders (23%) and 1 shoulder (3%) for each respective group. The intraoperative fracture cases in the RA group were 4 fractures of the greater tuberosity, 1 fracture of the lesser tuberosity, and 1 fracture of the glenoid fracture. In our study, there were more patients with osteoporosis in the RA group (62%) than in the CTA group (34%), and most RA patients were taking steroids (77%) and DMARDs (92%). RA patients may be at increased risk for intraoperative fractures due to osteoporosis from corticosteroid therapy and extensive bone defects.[11] Therefore, careful precautions, such as tolerable bone defect coverage or proper implant placement or drug control to achieve sufficient bone quality before surgery, are particularly required for RSA in RA patients to reduce the risk of intraoperative fractures.

The limitations of our study include the difficulty in matching the RA group to the CTA group. RA patients were younger than CTA patients. This may be because of the criteria of insurance coverage for shoulder arthroplasty in South Korea.[21] Only elderly patients aged ≥65 years with rotator cuff dysfunction receive insurance coverage for RSA in South Korea. However, the insurance for RSA due to RA is covered without age limitation as long as it satisfies the clinical manifestation. Moreover, patients were not matched on the basis of body mass index. In studies between weight loss and inflammatory joint disease, RA is known to be associated with significant weight loss, and this study may have shown this difference.[28] The other limitation was that we included 2 different prosthesis types manufactured by the same company. Tornier's implants in South Korea changed from Aequalis Reverse prosthesis to Aequalis Ascend Flex prosthesis around 2014. However, a previous study showed that medialized (Grammont) reverse design (Aequalis Reverse prosthesis) and short-stem lateralized reverse design (Aequalis Ascend Flex prosthesis) provided similar midterm clinical outcomes and ROM.[27] Moreover, in this study, surgeries were performed by a single surgeon using the same surgical technique regardless of the prosthesis design. Finally, this study has a small sample size and short follow-up. However, this study has the largest series of patients from a single center compared to the previously published articles.

Conclusions

This study shows that the clinical outcomes after RSA in RA patients were not inferior compared with those of CTA patients. However, superior tilting of the glenoid component, scapular notching, and overall complications were observed more in RA patients. Appropriate intraoperative precautions are required to minimize complications in RA patients. Mid- and long-term results are needed to ensure that similar clinical outcomes will continue.

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