Ipsilateral Total Shoulder and Elbow Arthroplasties in Patients Who Have Rheumatoid Arthritis*

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Abstract

Background: **The data on seventeen patients with rheumatoid arthritis who had been managed with ipsilateral total shoulder and elbow arthroplasties were analyzed to determine whether the operative technique, the presence of total shoulder and total elbow prostheses in the same upper extremity, or complications of the arthroplasties affected the result in each joint or the overall functional outcome of the upper extremity.**

Methods: **Seventeen patients with rheumatoid arthritis who were managed with a total of eighteen ipsilateral total shoulder and elbow arthroplasties were evaluated. The most recent physical examination was at an average of six years and six months (range, two years and one month to fourteen years) postoperatively. Radiographs, including 40-degree oblique and axillary radiographs of the shoulder as well as anteroposterior and lateral radiographs of the elbow, were made at an average of six years and eleven months (range, two years and two months to twenty-two years and eleven months) postoperatively. The radiographs of the shoulder were examined for loosening of the glenoid component, glenohumeral subluxation, and radiolucency at the bone-cement or bone-implant interface.**

The functional results of the total shoulder arthroplasties were evaluated with use of the rating systems of Neer et al. and Cofield. The Mayo elbow-performance score was used to evaluate elbow function. A rating system was also developed to assess the overall function of the upper extremity, including pain and motion of both the elbow and the shoulder. With this system, the overall function of the upper extremity was rated as excellent, good, fair, or poor.

Results: **Evaluation of the shoulders revealed substantial relief of pain and an increase in active elevation. On radiographic evaluation, eight glenoid and five humeral components were considered to be loose. There were no reoperations. According to the rating system of Neer et al., eight shoulders had a satisfactory result and eight had an unsatisfactory result with limited active abduction. Limited-goals rehabilitation was successful after one shoulder arthroplasty and unsuccessful after another. There were two type-B periprosthetic humeral fractures.**

There was also substantial relief of pain in the elbows as well as an increase in the extension-flexion arc; the pronation-supination arc was sufficient for tasks of daily living. There was no radiographic loosening. Two elbows had an avulsion of the triceps, and two had aseptic loosening (one of which also had a worn bushing); all four needed a reoperation. One other elbow had persistent ulnar neuritis.

The average interval between the arthroplasties was two years and eight months when the shoulder was replaced first and three years and five months when the elbow was replaced first. The interval between the joint replacements and the sequence of the joint replacements were not found to influence the outcome. Function of the extremity was improved by replacement of either the shoulder or the elbow alone; however, it improved significantly only when both joints were replaced ($p = 0.03$). According to combined clinical outcomes scores, there were nine excellent outcomes, four good outcomes, four fair outcomes, and one poor outcome after ipsilateral total shoulder and elbow arthroplasties.

Conclusions: **When there is severe arthritis of both the shoulder and the elbow, consideration should be given to replacing both joints in order to obtain optimum functional and clinical outcomes. The possibility of fracture of the humeral shaft necessitates an alteration of the technique for ipsilateral total shoulder and elbow arthroplasties.**

Joint replacement is an established treatment for patients who have end-stage rheumatoid arthritis in the upper extremity[1-4,6-11,14-25,27,28,32,34,36,38]. The shoulder and elbow may be so severely affected that total joint arthroplasty is needed at both sites. Ipsilateral total shoulder and elbow arthroplasties have been performed under these circumstances[14]. In the present study, we evaluated patients with rheumatoid arthritis who had been managed with ipsilateral total shoulder and elbow arthroplasties in order to determine whether the operative technique of the arthroplasties, the presence of prostheses in the ipsilateral shoulder and elbow, or the

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unique complications of the arthroplasties influence either the result for each joint or the combined outcome for the upper extremity.

Materials and Methods

We identified seventeen patients with rheumatoid arthritis who had been managed with ipsilateral total shoulder and elbow arthroplasties between January 1, 1974, and December 31, 1995. This study was approved by the Institutional Review Board. The patients were seen and were contacted at regular intervals[7,26-28]. All of the patients were examined by one of the senior two of us (R. H. C. or B. F. M.) at least two years after the second arthroplasty. The most recent physical examination after the second arthroplasty was at an average of six years and six months (range, two years and one month to fourteen years). The most recent radiographs were made at an average of six years and eleven months (range, two years and two months to twenty-two years and eleven months) after the second arthroplasty. The most recent contact with the patient for questioning with regard to the status of the shoulder occurred at an average of seven years and eight months (range, two years and one month to twenty-two years and eight months) postoperatively, and the most recent contact with the patient for questioning with regard to the status of the elbow occurred at an average of seven years and ten months (range, two years and two months to twenty years and two months) postoperatively. Of the seventeen patients, seven had died by the most recent follow-up evaluation, with the time of death averaging nine years and eight months (range, five years and eleven months to fourteen years and three months) after the second arthroplasty.

There were twelve women and five men, and the average age was fifty-four years (range, thirty-two to seventy-one years) at the time of the first arthroplasty (Tables I and II). The arthroplasty was performed on the dominant side in thirteen patients. One patient was managed with ipsilateral total shoulder and elbow arthroplasties bilaterally. Thirteen limbs had grade-III and five had grade-IV disease according to the American Rheumatism Association classification of progression[33]. One patient had had a previous rotator-cuff repair. Four patients had had previous treatment of the elbow, which included two total elbow arthroplasties (which had been complicated by migration of the prosthesis), one excision of the radial head, and one excision of nodules on the olecranon. In addition, eight patients had had a total of nineteen operations on the ipsilateral wrist and hand and fourteen patients had had a total of twenty-eight operations on the contralateral upper extremity. Stability of the elbow joint was graded according to the method of Morrey and Adams[28].

The operative techniques of total shoulder and total elbow arthroplasty and the postoperative care have previously been described in detail[7,28,29]. A Neer prosthesis (Kirschner Medical, Fairlawn, New Jersey) was used in twelve of the eighteen shoulder arthroplasties, and a Cofield prosthesis (Smith and Nephew, Memphis, Tennessee) was used in the other six. A Coonrad-Morrey semiconstrained implant (Zimmer, Warsaw, Indiana) was used in thirteen of the eighteen elbow arthroplasties, a Coonrad constrained implant (Zimmer) was used in two, and a Coonrad semiconstrained implant (Zimmer) was used in three.

In the shoulders, fourteen humeral components were press-fit and four were fixed with cement, and fifteen glenoid components were fixed with cement and three were fixed without cement. In the elbows, sixteen prostheses were fixed with cement and two were fixed without cement. It is important to note that two patients had a large full-thickness rotator cuff tear and were managed with limited-goals rehabilitation[7,29]. In ten extremities, the shoulder arthroplasty preceded the elbow arthroplasty, with an average interval between the operations of two years and eight months (range, three months to seven years and ten months). In eight extremities, the elbow arthroplasty preceded the shoulder arthroplasty, with an average interval of three years and five months (range, three months to ten years and seven months). The average interval between the arthroplasties was three years (range, three months to ten years and seven months) overall.

For radiographic analysis of the shoulders, 40-degree posterior oblique radiographs with the shoulder in internal and external rotation as well as an axillary radiograph were used. These radiographs were reviewed for the presence of radiolucent lines about the component or at the bone-cement interface, a shift in the position of the component, and glenohumeral subluxation. Loosening of the glenoid component was assessed on the basis of the extent of these radiolucent lines about the component as well as on the basis of the position of the component[35]. The elbows were assessed with anteroposterior and lateral radiographs. The preoperative radiographs were evaluated for the severity of rheumatoid disease[28]. The postoperative radiographs were assessed for the adequacy of the cementing technique[26], for the extent of the radiolucency[26], and for the incorporation of the bone graft between the anterior extension of the humeral prosthesis and the humerus[28].

The rating systems of Neer et al.[29] and Cofield[7] were used to assess the results of the shoulder arthroplasties. The Mayo elbow-performance score[26-28] (Table III) was used to assess the results of the elbow arthroplasties. Four activities of daily living are common to both the shoulder and the elbow-rating system, and they were evaluated before the first arthroplasty, before the second arthroplasty, and at the time of the most recent follow-up. These activities include combing hair, eating with a utensil, dressing, and perineal care (Table IV). A score of 10 points was assigned for the ability to perform each of these tasks with the involved limb, and 0

TABLE
PREOPERATIVE AND POSTOPERATIVE FINDINGS

Case	Gender, Age *(yrs.)*	Involved Side	Previous Op.	Preop. Pain	Preop. Motion *(degrees)* Elev.	Extern. Rot.	Intern. Rot.	Date of Op.	Operative Findings
1	M, 69	L		Severe	10	10	L3	6/7/83	
2	F, 59	R	Rotator cuff repair	Moderate	30	20	Sacrum	4/12/79	Large rotator cuff tear and fascia lata graft
3	F, 53	R		Moderate	60	20	L1	2/20/80	Arthritis of acromioclavicular joint
4	F, 57	R		Moderate	85	10	L3	9/22/83	Small rotator cuff tear
5	F, 32	R		Moderate	40	30	L5	11/8/90	Moderate glenoid erosion
6	F, 57	R		Mild	45	20	L4	6/4/86	Thinned rotator cuff and moderate glenoid erosion
7	F, 63	R		Severe	80	70	L2	7/6/80	Thinned rotator cuff
8	F, 56	R		Mild	60	75	Sacrum	5/21/82	
9	M, 63	R		Mild	90	40	Sacrum	2/18/85	Severe glenoid erosion
10	F, 52	L		Moderate	60	15	L3	9/30/86	Thinned rotator cuff and moderate glenoid erosion
11	M, 70	R		Moderate	100	45	L1	11/3/93	
12	F, 45	L		Severe	80	30	Sacrum	4/27/82	Thinned rotator cuff
	F, 45	R		Severe	40	45	L4	4/15/82	Thinned rotator cuff
13	F, 71	R		Moderate	115	0	Sacrum	4/6/84	
14	M, 69	R		Moderate	95	40	L4	10/8/91	Large rotator cuff tear
15	F, 35	R		Severe	30	5	Sacrum	6/2/89	Thinned rotator cuff and moderate glenoid erosion
16	F, 52	R		Mild	40	60	L3	10/15/85	Small rotator cuff tear and moderate glenoid erosion
17	M, 58	R		Severe	70	20	L5	9/4/84	Small rotator cuff tear, severe glenoid erosion, and severe humeral bone loss necessitating bone graft

points were assigned for inability to perform the specific task. A total functional score for each limb was calculated at each of the three evaluative periods.

An overall measure of clinical outcome for the involved upper extremity was developed. This included consideration of pain in the shoulder, pain in the elbow, motion of the shoulder, and motion of the elbow (Table IV), with a possible maximum score of 100 points. A score of 80 points or more indicated an excellent outcome; 66 to 79 points, a good outcome; 45 to 65 points, a fair outcome; and less than 45 points, a poor outcome.

Statistical analysis was performed with Wilcoxon's rank-sum test for comparison of ordinal and continuous variables between groups. Changes in the individual ordinal and continuous variables were assessed with Wilcoxon's signed-rank test. Association of pairs of ordinal or continuous variables was estimated with Spearman's rank-correlation coefficient. Comparisons

I

RELATED TO TOTAL SHOULDER ARTHROPLASTY

Pain	Postop. Motion *(degrees)* Elev.	Extern. Rot.	Intern. Rot.	Duration of Follow-up *(mos.)*	Complications (Treatment)	Radiographic Findings
Mild	65	40	L3	79		Severe superior subluxation and loose glenoid component
Occasionally moderate	20	20	Sacrum	159	Fracture, humeral shaft (brace)	1.5-mm incomplete radiolucent line about glenoid component
Occasionally moderate	80	25	L2	61		1.5-mm incomplete radiolucent line about glenoid component and 1-mm incomplete radiolucent line about humeral component
Mild	30	30	L3	49		Loose glenoid and humeral components
Mild	70	15	L3	58		
None	90	30	T8	113		Severe superior subluxation and loose glenoid and humeral components
Mild	115	20	L2	62	Fracture, humeral shaft (brace)	Mild superior subluxation and loose glenoid component
Occasionally moderate	30	40	Sacrum	67		Severe superior subluxation
Mild	90	30	L1	113		Moderate superior subluxation and loose glenoid and humeral components
None	100	70	L5	120		Severe superior subluxation and 1.5-mm incomplete radiolucent line about glenoid component
None	160	55	T12	25		
Mild	140	30	L2	172		1.5-mm incomplete radiolucent line about glenoid component
Mild	130	30	L2	172		Moderate superior subluxation and loose glenoid component
None	80	70	Sacrum	84		Moderate superior subluxation
None	150	90	T4	60		Severe superior subluxation and loose glenoid and humeral components
None	90	10	Sacrum	68		Severe superior subluxation
Mild	90	60	L3	57		Severe anterosuperior subluxation and loose glenoid and humeral components
None	60	80	L4	132		Severe superior subluxation and 1.5-mm incomplete radiolucent line about glenoid component

of proportions between groups were made with Fisher's exact test. Changes in functional scores were assessed with the sign test.

Results

Shoulder Arthroplasty

Preoperatively, there was severe pain in six shoulders, moderate pain in eight, and mild pain in four (Table I). Postoperatively, there was no pain in seven shoulders, mild pain in eight, and intermittent moderate discomfort with unusually vigorous activities in three. Pain decreased significantly after the operation ($p < 0.0001$). Pain relief was not found to be related to age, gender, a tear of the rotator cuff, range of motion, American Rheumatism Association classification, or radiographic changes. Preoperatively, active elevation averaged 63 degrees (range, 10 to 115 degrees), external rotation averaged 31 degrees (range, 0 to 75 degrees), and inter-

TABLE
PREOPERATIVE AND POSTOPERATIVE FINDINGS

Case	Gender, Age *(yrs.)*	Involved Side	Previous Op.	Preop.			
				Pain	Ext.-Flex. *(degrees)*	Grade[28]*	Stability
1	M, 69	L		Severe	30-140	3	Grossly unstable
2	F, 64	R	Medial epicondylectomy, total elbow arthroplasty (Mayo), and resection arthroplasty	Moderate	40-100	NA	Moderately unstable
3	F, 48	R		Moderate	7-135	3	Grossly unstable
4	F, 57	R		Mild	45-120	3	Moderately unstable
5	F, 32	R		Moderate	0	3	Stable
6	F, 58	R		Moderate	30-120	3	Stable
7	F, 57	R		Moderate	40-120	3	Moderately unstable
8	F, 54	R		Severe	25-150	2	Grossly unstable
9	M, 52	R		Moderate	60-150	4	Grossly unstable
10	F, 60	L	Total elbow arthroplasty (Pritchard-Walker)	Moderate	20-135	NA	Moderately unstable
11	M, 67	R		Moderate	40-130	3	Stable
12	F, 45	L		Moderate	25-125	3	Moderately unstable
	F, 45	R		Moderate	45-115	3	Moderately unstable
13	F, 71	R		Severe	35-130	3	Grossly unstable
14	M, 71	R		Moderate	40-110	3	Stable
15	F, 36	R		Moderate	60-100	3	Stable
16	F, 60	R	Excision, radial head	Moderate	30-120	4	Grossly unstable
17	M, 59	R	Excision, olecranon nodule	Moderate	50-130	4	Grossly unstable

*NA = not available.

nal rotation ranged from the sacrum to the first lumbar vertebra. Postoperatively, active elevation increased an average of 26 degrees, to 88 degrees (range, 20 to 160 degrees); external rotation increased an average of 11 degrees, to 41 degrees (range, 10 to 90 degrees); and internal rotation ranged from the sacrum to the fourth thoracic vertebra. There was a significant increase in active elevation ($p = 0.02$) and internal rotation ($p = 0.04$), but no significant change in external rotation ($p = 0.10$) could be detected with the numbers available. Postoperative elevation had a significant inverse relationship with grade-IV disease according to the American Rheumatism Association classification of progression ($p = 0.006$). After the operation, seven shoulders were considered by the patients to be much better; eight, to be better; and three, to be the same as before the operation. No patient thought that the shoulder was worse.

A radiolucent line of varying thickness and extent was present at the bone-cement or bone-implant interface about seventeen glenoid components. Eight shoulders had radiographic evidence of definite loosening of the glenoid component; in seven the glenoid component had shifted position, and in one there was a complete radiolucent line of at least 1.5 millimeters in thickness at the bone-cement interface. Radiographic indications of loosening were not found to be related to age, gender, range of motion, a tear of the rotator cuff, grade IV of the American Rheumatism Association classification, type of implant, or glenohumeral joint subluxation. Four press-fit humeral components and one cemented humeral component had shifted in position over time and were considered to be radiographically

II
RELATED TO TOTAL ELBOW ARTHROPLASTY

Date of Op.	Postop. Pain	Postop. Ext.-Flex. *(degrees)*	Duration of Follow-up *(mos.)*	Complications (Treatment)	Radiographic Findings
1/31/83	None	45-140	83		<2-mm radiolucent line about ulnar component
8/28/84	None	30-125	97	Fracture, humeral shaft (brace)	<2-mm radiolucent line about ulnar and humeral components
12/18/75	None	20-130	82		
5/2/83	Mild	30-120	45		
8/21/90	None	45-90	72		
10/19/87	None	10-140	58		≥2-mm radiolucent line about humeral component
2/4/74	Mild	30-140	86	Fracture, humeral shaft (brace)	
7/25/80	Mild	5-145	121		
7/16/74	None	25-150	242		
7/12/94	Mild	25-125	26	Aseptic loosening (revised)	<2-mm radiolucent line about ulnar component and ≥2-mm radiolucent line about humeral component
5/1/90	None	10-150	66		<2-mm radiolucent line about ulnar component
9/15/82	Mild	30-145	168	Partial triceps avulsion (repaired)	
9/7/82	Mild	30-115	168	Complete triceps avulsion (repaired)	
7/5/84	Mild	25-155	96	Worn bushing (revised) and aseptic loosening (revised)	<2-mm radiolucent line about humeral component
7/15/93	None	30-120	39		
11/20/90	None	40-90	72		
2/8/93	None	40-125	45	Persistent ulnar neuritis (no treatment)	<2-mm radiolucent line about ulnar and humeral components
10/17/85	Mild	35-135	120		<2-mm radiolucent line about ulnar component

loose. This loosening was not found to be associated with the factors just mentioned. Moderate or severe glenohumeral subluxation was present postoperatively in eleven shoulders and, again, this was not found to be associated with any of the variables listed. Sixteen shoulders could be rated with the standard rating systems[7,29]: eight were excellent or satisfactory, and eight were unsatisfactory. Of the two shoulders treated with limited-goals rehabilitation, one was rated as having a successful result and one, as having an unsuccessful result. All shoulders with an unsatisfactory or unsuccessful rating had a limitation in the range of active abduction.

Elbow Arthroplasty

Preoperatively, there was severe pain in three elbows, moderate pain in fourteen, and mild pain in one (Table II). Postoperatively, there was no pain in ten elbows and mild pain in eight. This relief of pain was significant ($p < 0.0001$). Preoperatively, extension averaged 35 degrees (range, 0 to 60 degrees), flexion averaged 118 degrees (range, 0 to 150 degrees), pronation averaged 55 degrees (range, 0 to 90 degrees), and supination averaged 39 degrees (range, 0 to 80 degrees). Postoperatively, extension averaged 28 degrees (range, 5 to 45 degrees), flexion averaged 130 degrees (range, 90 to 155 degrees), pronation averaged 65 degrees (range, 40 to 85 degrees), and supination averaged 61 degrees (range, 15 to 85 degrees). The improvement in the extension-flexion arc averaged 19 degrees, and this improvement was significant ($p = 0.003$). The increase in the pronation-supination arc averaged 32 degrees, and this was not found to be significant ($p = 0.08$).

Preoperatively, seven elbows were grossly unstable, six were moderately unstable, and five were stable. Postoperatively, all of the elbows were stable. The average score for activities of daily living was 12 points (range, 0 to 25 points) preoperatively and 18 points (range, 0 to 25 points) postoperatively.

On immediate postoperative radiographic assessment, the cementing technique was graded as adequate for fifteen of the humeral components and as inadequate for one; it was graded as adequate for all of the cemented ulnar components. No progressive radiolucency developed at the bone-cement interface of the one humeral component that did not have cement extending to its tip. At the time of the most recent follow-up, there was a radiolucent line of two millimeters or more in thickness about less than 50 percent of the bone-implant or bone-cement interface of two humeral components and a radiolucent line of less than two millimeters about less than 50 percent of the interface of three additional humeral components. In addition, there was a radiolucent line of less than two millimeters in thickness involving less than 50 percent of the bone-cement interface of six ulnar components. There was no radiolucency around the two press-fit total elbow prostheses. None of the eighteen humeral or ulnar components had shifted in position. The anterior humeral bone graft had been incorporated in ten of the fifteen limbs in which an anterior graft was needed.

The average Mayo elbow-performance score was 35 points preoperatively and 81 points postoperatively. Six elbows were rated as excellent; nine, as good; two, as fair; and one, as poor.

TABLE III

MAYO ELBOW-PERFORMANCE SCORE[26-28]

Function	Score *(points)*
Pain (45 points)	
None	45
Mild	30
Moderate	15
Severe	0
Motion (20 points)	
>100 degrees	20
50 to 100 degrees	15
<50 degrees	5
Stability* (10 points)	
Stable	10
Moderate instability	0
Gross instability	0
Daily function (25 points)	
Hair-combing	5
Feeding oneself	5
Perineal care	5
Putting on shirt	5
Putting on shoes	5
Maximum possible total†	100

*Stable = no apparent varus-valgus laxity clinically, moderate instability = less than 10 degrees of varus-valgus laxity, and gross instability = 10 degrees or more of varus-valgus laxity.

†A total score of 90 points or more indicates excellent function; 75 to 89 points, good function; 60 to 74 points, fair function; and less than 60 points, poor function.

Combined Evaluations

The average time between the two arthroplasties was two years and eight months (range, three months to seven years and ten months) when the shoulder was replaced first, and it was three years and five months (range, three months to ten years and seven months) when the elbow was replaced first. This difference in intervals was not significant ($p < 0.17$). The sequence of the total joint arthroplasties was not found to influence the results of the arthroplasties, the ratings for the shoulders ($p = 0.71$) or the elbows ($p = 0.25$), or the functional scores ($p = 0.24$), with the numbers available.

The ability to perform individual activities of daily living was assessed for both the shoulders and the elbows, and functional scores were determined (Fig. 1). Although each joint replacement improved the function of the individual joint, it did not improve the function of the adjacent joint that had not been replaced. Only when both joints had been replaced was there a significant increase in the functional score for the extremity ($p = 0.03$).

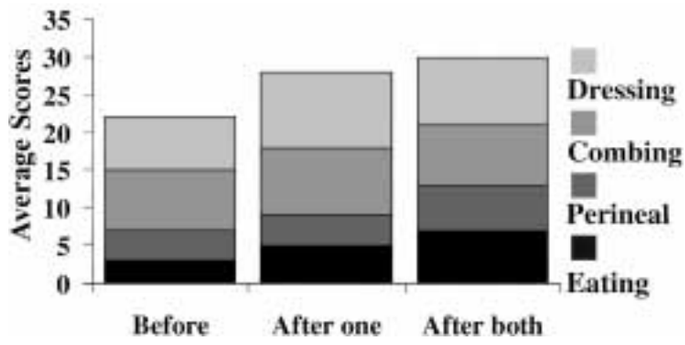

FIG. 1

The average functional score for each of the activities of daily living was determined before the first arthroplasty, before the second arthroplasty, and after both arthroplasties (at the most recent follow-up evaluation). The difference between the average total score before the first arthroplasty and that at the most recent follow-up evaluation was significant ($p = 0.03$).

TABLE IV
CLINICAL UPPER-EXTREMITY SCORE

Variable	Score *(points)*
Level of elbow pain (20 points)	
None	20
Mild	15
Moderate	5
Severe	0
Level of shoulder pain (20 points)	
None	20
Mild	15
Moderate	5
Severe	0
Motion* (20 points)	
≥285 degrees	20
161 to 284 degrees	15
≤160 degrees	5
Function (40 points)	
Hair-combing	10
Feeding oneself	10
Perineal care	10
Dressing	10
Maximum possible total†	100

*Motion was calculated by adding the numbers of degrees of elevation of the shoulder, the extension-flexion arc of the elbow, and external rotation of the shoulder.

†A total score of 80 points or more indicates excellent function; 66 to 79 points, good function; 45 to 65 points, fair function; and less than 45 points, poor function.

Overall, the average clinical score of the upper extremity was 77 points (range, 60 to 100 points) postoperatively, with nine extremities graded as excellent; four, as good; four, as fair; and one, as poor. Of the thirteen extremities (in twelve patients) that were grade III according to the American Rheumatism Association classification of progression, ten were graded as excellent or good and three were graded as fair or poor. Of the five extremities that were grade IV according to this classification, two were graded as good and three were graded as fair or poor.

Complications and Reoperations

There were eight complications in seven patients, five of which necessitated a reoperation. Two patients sustained a type-B fracture of the humeral shaft[37]: one fracture occurred at five years and one month after the second arthroplasty and the other, at eight years and five months after the second arthroplasty. Both fractures occurred in patients in whom the humeral component of the shoulder prosthesis had been fixed without cement and the humeral component of the elbow prosthesis had been fixed with cement. Both patients also had severe generalized osteoporosis. None of the humeral components in these two patients was radiographically loose. The first patient was managed nonoperatively with a brace, and the fracture united at 4.5 months. The outcome of the fracture in the second patient is unknown, as this patient was managed elsewhere and had died by the time of the present review.

There was one persistent ulnar neuritis following an elbow replacement. There were two avulsions of the triceps tendon (one was partial and one was complete), and both occurred early in the postoperative period. These avulsed tendons were successfully resutured to the olecranon. At the time of the most recent follow-up, the Mayo elbow-performance score for both elbows was 80 points. Two elbows had symptomatic aseptic loosening, one of which also had a worn bushing. Both of these elbows were revised. One of these elbows was given a Mayo elbow-performance score of 80 points at the time of the most recent follow-up, and the other was given a score of 65 points.

Discussion

Neer et al.[29] reported the results of total shoulder arthroplasty in fifty patients who had rheumatoid arthritis. Twenty-eight of these patients had an excellent result, twelve had a satisfactory result, and three had an unsatisfactory result. An additional seven, who were managed on a limited-goals basis, had a successful result. One of us (R. H. C.)[7] reported on twenty-nine shoulders in twenty-four patients who had rheumatoid arthritis; six of these shoulders had excellent function, eleven had satisfactory function, seven had unsatisfactory function, and an additional three had a successful result of limited-goals rehabilitation and two had an unsuccessful result. Those authors and others[1,2,21,23,31,35] found limited gains in elevation, moderate gains in external rotation and internal rotation, and reliable relief of pain after total shoulder arthroplasty in patients who had rheumatoid arthritis. Friedman et al.[14] found that patients who had severe rheumatoid disease had lesser gains in motion but sustained relief of pain. Our findings in the shoulder concur with the findings of those studies.

Radiolucent lines about the glenoid component or at the bone-cement interface were present in 31 percent of patients with rheumatoid arthritis reported on by Neer et al.[29] and in thirty (71 percent) of the forty-two patients with rheumatoid arthritis reported on by Torchia et al.[35]. In those reports, as in ours, radiolucency about the glenoid component was not a prognostic indicator of a poor outcome[12]. Moderate or severe subluxation of the humeral head was noted postoperatively in fourteen (67 percent) of the twenty-one patients with rheumatoid arthritis reported on by Torchia et al. and in thirty-four (55 percent) of the sixty-two patients reported on by Sneppen et al.[31]. In the present study, moderate or severe postoperative subluxation of the humeral head did not influence the outcome of total shoulder arthroplasty. This finding is in agreement with that of Boyd et al.[5].

The early results of total elbow arthroplasty in patients who have rheumatoid arthritis have been disappointing, with high rates of failure and reoperation[10,19,20,32,36]. The results of procedures that have been

performed with semiconstrained devices have been more promising[4,16,17,24], perhaps because of the more accurate recreation of elbow mechanics[30]. In a previous study of seventy-eight patients with rheumatoid arthritis who had been managed with a modified semiconstrained Coonrad prosthesis, two of us (D. R. J. G. and B. F. M.)[15] reported a rate of survival of the prosthesis of 92 percent, a rate of good or excellent results of 86 percent, and a rate of reoperation of 13 percent after ten to fifteen years of follow-up. In the present study of a selected group of patients who had severe polyarticular rheumatoid arthritis, the outcome of the total elbow arthroplasty was not affected by advanced disease (grade III or IV of the American Rheumatism Association classification of progression).

The American Rheumatism Association classification of progression is used to grade rheumatoid disease, but it primarily measures the deterioration or change in function of the lower extremity. However, it has been used in the orthopaedic literature to grade the severity of rheumatoid arthritis[14,21]. We suggest that a measure of the severity of rheumatoid disease is the number of large joints or joint regions (such as the hand and wrist) involved. Logically, patients who have rheumatoid arthritis of the shoulder and elbow that is severe enough to necessitate joint arthroplasties should be assumed to be more severely affected than those who have isolated disease of the shoulder or elbow.

Our results demonstrate that total shoulder arthroplasty and total elbow arthroplasty in patients who have rheumatoid arthritis are largely independent events, with the sequence and interval between the arthroplasties not influencing the final outcomes, ratings, or functional scores. Friedman and Ewald[13] found that there was a greater functional improvement when total elbow arthroplasty was performed first than when total shoulder arthroplasty was performed first. However, this was not our experience. Function was scored at three time-intervals: before the first arthroplasty, between the first and second arthroplasties, and at the time of the most recent follow-up. It has been well documented that function of the upper extremity improves after a single joint is replaced[1,2,7,29,35]. However, this does not appear to be the case for patients who have more severe rheumatoid arthritis with involvement of multiple joints in the upper extremity. Function is not significantly improved for those patients until the second affected joint is also replaced. After that second replacement was performed, the good results of joint arthroplasty in the upper extremity that have been reported in patients with single-joint disease were duplicated in the more severely affected patients in our series.

Humeral fracture between implants remains a concern. This complication occurred twice in the present series. Both of the patients had a proximal humeral component fixed without cement and a distal humeral component fixed with cement. The vacant segment of the humeral shaft was osteoporotic, which may be a result of the more severe rheumatoid disease in this particular group of patients. On the basis of our experience, we now advise using methods to reduce the stress riser over the unfilled humeral segment. If standard-length shoulder and elbow components are used together, bone cement should bridge the small distance between the prostheses. If shorter humeral components are used, a cement-restriction device should be used to ensure a long length (approximately sixty millimeters or more) of unfilled humerus between the cement columns.

Currently, as in the past, the more symptomatic joint is replaced first in patients who have severe rheumatoid disease in both the shoulder and the elbow. When both joints have lost cartilage and are painful, both are replaced. If the involvement is similar, there is a slightly longer interval between the first and second procedures if the elbow is replaced first. In the unusual situation of both joints being replaced within a short interval (less than two months), the elbow is best replaced first if a contemporary, unconstrained total shoulder arthroplasty and a semiconstrained total elbow arthroplasty are to be performed. This recommendation is based on the principle of avoiding excess torsional forces on the newly implanted joint during the second procedure, before there is sufficient time for soft-tissue healing.

As a result of this study, we have concluded that the results of total shoulder arthroplasty and total elbow arthroplasty in the same extremity are acceptable but somewhat inferior to the results of arthroplasty of a single joint of the upper extremity. Patients who have severe rheumatoid arthritis in the upper extremity must have both the shoulder and the elbow replaced to obtain significant functional gains in the entire extremity. The danger of pathological fracture necessitates an alteration in the technique of total shoulder and total elbow arthroplasty when used in the ipsilateral extremity. The sequence of the joint replacement arthroplasties and the interval between the arthroplasties may be determined on the basis of clinical need without fear of compromising the final outcome.

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