The Coonrad-Morrey Total Elbow Arthroplasty in Patients Who Have Rheumatoid Arthritis

A Ten to Fifteen-Year Follow-up Study*

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ABSTRACT: Sixty-nine patients (seventy-eight elbows) who had rheumatoid arthritis were managed with a Coonrad-Morrey total elbow arthroplasty between 1981 and 1986. At the time of the present review, forty-one patients (forty-six elbows) were alive and had been followed for at least ten years after the procedure (Group 1). The remaining twenty-eight patients (thirty-two elbows) had died or had had a revision less than ten years after the procedure or had been followed for less than ten years (Group 2). The patients in Group 1 had a younger mean age at the time of the procedure, but all other preoperative parameters were similar for both groups.

At the latest follow-up evaluation, 97 per cent of the elbows (forty-five of the forty-six in Group 1 and thirty-one of the thirty-two in Group 2) were not painful or were only mildly painful. The mean arc of flexion-extension was 28 to 131 degrees; this represents an increase of 13 degrees (15 degrees in Group 1 and 7 degrees in Group 2) compared with the preoperative value. The mean arc of pronation was 68 degrees, and the mean arc of supination was 62 degrees; this represents an increase of 21 degrees. The results for seventy-four of the seventy-eight elbows (all forty-six in Group 1 and twenty-eight of the thirty-two in Group 2) were considered satisfactory by the patients. One patient thought that the status of the elbow was unchanged compared with preoperatively, and three thought that it was worse.

Seventy-six of the seventy-eight elbows had long-term radiographic evaluation; the two remaining elbows were excluded because a resection arthroplasty had been performed. There were two loose ulnar components; one was associated with an infection, and the other had been causing no symptoms at the time of the patient's death. In addition, both components were radiographically loose in an elbow that had had a revision without cement after a previous total elbow arthroplasty. Five bushings (7 per cent) were completely worn, and six (8 per cent) were partially worn.

Complications occurred in eleven elbows (14 per cent) and were serious, necessitating reoperation, in ten (13 per cent). Delayed complications included three avulsions of the triceps, two deep infections, two ulnar fractures, and one fracture of an ulnar component. In addition, two elbows were revised because of aseptic loosening. No patient had persistent ulnar neuritis or serious skin complications.

At the latest clinical follow-up evaluation, according to the Mayo elbow performance score, forty-three of the seventy-eight elbows had an excellent result; twenty-six, a good result; seven, a fair result; and two (both in Group 2), a poor result. The rate of survival of the prosthesis was 92.4 per cent, with 86 per cent good or excellent and 14 per cent fair or poor results.

Total elbow arthroplasty is now a recognized and preferable option compared with synovectomy or interpositional arthroplasty for the management of most patients who have rheumatoid arthritis[1,5,7,8,11,14-17]. Most prostheses have one of two designs: coupled (semiconstrained) or uncoupled (resurfacing). The uncoupled design relies on intact capsuloligamentous structures for stability of the elbow, whereas the coupled design relies on mechanical linkage.

The Coonrad-Morrey total elbow prosthesis is a semiconstrained device that has been used at our institution since 1981 for the full spectrum of pathological conditions of the elbow. All reports to date, to our knowledge, have focused on the specific indications for and the performance of this prosthesis according to the underlying diagnosis. The purpose of the current report is to describe the ten to fifteen-year results of use of this prosthesis in patients who had rheumatoid arthritis.

Materials and Methods

This retrospective review includes a consecutive series of patients who had insertion of a Coonrad-Morrey total elbow prosthesis (Zimmer, Warsaw, Indiana) for the treatment of rheumatoid arthritis between January 1, 1981, and December 31, 1986. Of the original seventy-one patients, two refused to give consent for a review

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TABLE I
THE MAYO ELBOW PERFORMANCE SCORE[13,17,19]

	No. of Points*
Pain (45 points)	
None	45
Mild	30
Moderate	15
Severe	0
Range of motion (20 points)	
>100 degrees	20
50-100 degrees	15
<50 degrees	5
Stability† (10 points)	
Stable	10
Moderate instability	5
Gross instability	0
Daily function (25 points)	
Combing hair	5
Feeding oneself	5
Hygiene	5
Putting on shirt	5
Putting on shoes	5
Maximum possible total	100

*At least 90 points = excellent, 75 to 89 points = good, 60 to 74 points = fair, and less than 60 points = poor.

†Stable = no apparent varus-valgus laxity clinically, moderate instability = less than 10 degrees of varus-valgus laxity, and gross instability = at least 10 degrees of varus-valgus laxity.

of their medical histories and were therefore excluded from the study. Thus, the records of sixty-nine patients (seventy-eight elbows) were available for review ten to fifteen years after the total elbow arthroplasty. The study was approved by the Institutional Review Board.

There were nineteen men and fifty women. Sixty-seven patients were right-handed, and only two were left-handed. Nine patients had a bilateral staged procedure. At the time of the operation, three patients had a job that involved manual labor, three performed desk work, thirty-two worked at home, and thirty-one were retired.

The typical pathological findings in rheumatoid arthritis have been described previously in detail[17]. In grade-I disease, the only radiographic change is osteoporosis and the pathological process is various degrees of synovitis; in grade-II, there is narrowing of the joint; in grade-III, there are architectural changes; and in grade-IV, there is gross destruction[17]. In addition to rheumatoid arthritis, a posttraumatic non-union of the distal part of the humerus was seen in three elbows and was treated with the Coonrad-Morrey elbow replacement at five, nine, and thirty-two months after the injury. Twelve elbows had the Coonrad-Morrey arthroplasty as a revision procedure because of aseptic loosening of a total elbow prosthesis of another design, and one elbow had an acute fracture of the distal part of the humerus.

Seventeen elbows had had a previous operation. As mentioned, twelve had had a previous total elbow replacement, with a Mayo implant (Howmedica, Rutherford, New Jersey) used in six, a Coonrad implant (Zimmer) used in four, and a Pritchard implant (DePuy, Warsaw, Indiana) used in two. Four elbows had had a previous open reduction and internal fixation for the treatment of a fracture of the distal part of the humerus, and one had had a resection of fracture fragments.

The Coonrad-Morrey total elbow prosthesis was inserted in all patients by one of eight surgeons at our institution. In sixty-three elbows, the Mayo approach was used[3]; this involves maintaining the triceps in continuity with the fascia of the forearm and elevating these structures from medial to lateral. In three elbows, a variation of this approach, whereby the triceps and fascia were elevated from lateral to medial, was carried out[3]. In ten elbows the triceps was split longitudinally, and in two it was left in continuity[16]. Sixty-eight elbows had subcutaneous translocation of the ulnar nerve anteriorly, and ten had no transfer. This decision was based on the presence of symptoms related to the ulnar nerve and the preference of the surgeon. The senior one of us (B. F. M.) transfers the nerve in all patients. The prosthesis was cemented in place in seventy-five elbows and was not cemented in three.

The postoperative management varied somewhat as has been described previously[4,13,15,18,21]. Recently, the upper extremity has been elevated in extension overnight and active and active-assisted motion has been begun on the day after the operation. Formal physical therapy was not (and still is not) used to attain motion and regain function.

The present series includes the consecutive experience of eight surgeons from our department who performed elbow replacements during this time-period. The results for thirty-nine of the seventy-eight elbows were described previously, in a report on the initial fifty-eight procedures performed by the senior one of us[16].

The patients were followed and assessed regularly in a manner that was reported previously[4,13,17,19,23,26]. The most recent follow-up evaluation was performed with an examination at our institution for thirty-six elbows and with use of a questionnaire and examination by a local physician for forty-two. The patients were evaluated with use of both functional and radiographic systems[17,23].

The Mayo elbow performance score is used to assess pain, motion, stability, and daily function as has been described previously[13,17,19] (Table I). A result was considered satisfactory if an excellent or good rating was attained with the Mayo elbow performance score.

The radiographic evaluation was based on both preoperative radiographs and radiographs made at the time of the latest follow-up evaluation[17,21]. Two elbows were not included in the latest radiographic evaluation because they had had a resection arthroplasty; thus, the radiographs for seventy-six elbows were evaluated. The cementing technique was graded as adequate, marginal, or inadequate according to the system described

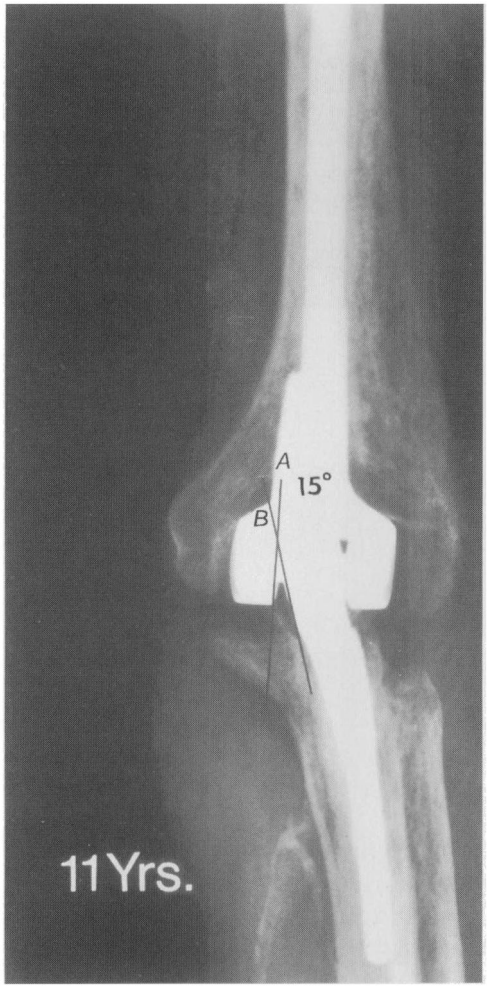

FIG. 1

Anteroposterior radiograph showing a semiconstrained Coonrad-Morrey total elbow prosthesis eleven years postoperatively. Line A is perpendicular to the axis of the bushings, and line B is parallel to the axis of the proximal part of the ulna. The angle between the lines — in this instance, 15 degrees — is measured to reflect the degree of wear of the bushings.

previously[6,23]. The cementing technique is considered to have been adequate if there is a radiolucent line of less than one millimeter in width and there is cement extending past the tip of the implant, marginal if there is a radiolucent line of two millimeters and there is cement extending past the tip, and inadequate if there is a radiolucent line of more than two millimeters and no cement past the tip. The extent of any radiolucent lines and the presence and incorporation of bone graft between the anterior flange of the prosthesis and the distal part of the humerus also were recorded. In addition, wear of the bushings was estimated by measuring the angle between a line perpendicular to the axis of the bushings and the longitudinal axis of the proximal segment of the ulnar component on the anteroposterior radiograph (Fig. 1). The articulation is designed to have 7 degrees of varus-valgus laxity (3.5 degrees in varus and 3.5 degrees in valgus) in the anteroposterior plane; thus, an ulnohumeral angle of more than 3.5 degrees but no more than 5 degrees in either the varus or the valgus direction was regarded as evidence of partial wear. When the angle was more than 5 degrees in either direction, the bushings were regarded as completely worn (Fig. 2).

Twenty-four patients (twenty-eight elbows) died less than ten years after the operation, and five patients (six elbows) died between ten and fifteen years postoperatively. Another two patients (two elbows), who were alive ten years after the operation, had not been followed for ten years; one of these patients refused to have additional follow-up after thirty-six months, and the other was institutionalized with dementia and was followed for only sixty-two months. Two additional patients (two elbows) had a revision less than ten years postoperatively. The seventy-eight elbows were divided into two groups: those that had been followed for at least ten years (Group 1; forty-six elbows) and those that had been followed for less than ten years (Group 2; thirty-two elbows) because of death, revision, or an incomplete record. The mean duration of follow-up was 136 months (range, 120 to 184 months) in Group 1 and forty-nine months (range, one to 104 months) in Group 2. There was no difference between the two groups with regard to the distribution of patients according to gender or the dominant extremity. The mean age at the time of the operation was 58.7 years (range, thirty-five to seventy-seven years) in Group 1 and 66.6 years (range,

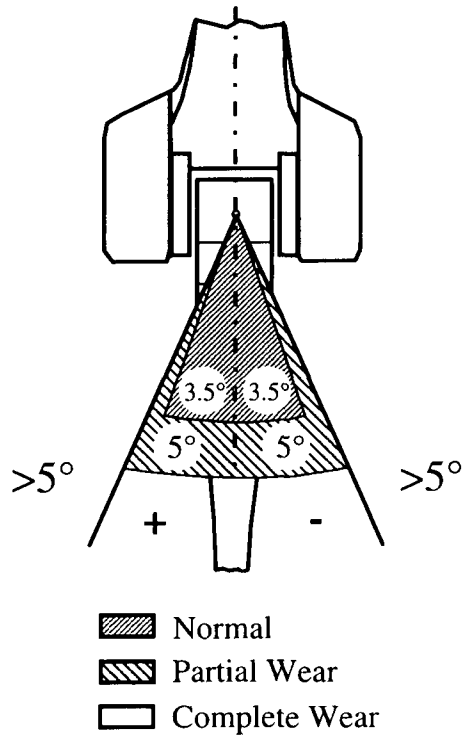

FIG. 2

Schematic drawing of a semiconstrained total elbow prosthesis, showing the definitions of wear of the bushings. Partial wear = more than 7 degrees and no more than 10 degrees, and complete wear = more than 10 degrees.

TABLE II

RESULTS FOR THE SEVENTY-EIGHT ELBOWS AT THE LATEST FOLLOW-UP EVALUATION

	Group 1* (N = 46)		Group 2* (N = 32)		Overall Series (N = 78)	
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
Pain† *(no. of elbows)*						
None	0 (0%)	29 (63%)	1 (3%)	18 (56%)	1 (1%)	47 (60%)
Mild	6 (13%)	16 (35%)	3 (9%)	13 (41%)	9 (12%)	29 (37%)
Moderate	15 (33%)	1 (2%)	6 (19%)	0 (0%)	21 (27%)	1 (1%)
Severe	25 (54%)	0 (0%)	22 (69%)	1 (3%)	47 (60%)	1 (1%)
Mean range of motion† *(degrees)*						
Extension	33	31	34	25	34	28
Flexion	121	134	128	126	124	131
Pronation	53	68	61	68	56	68
Supination	54	65	53	60	53	62
Stability‡ *(no. of elbows)*						
Stable	13 (28%)	46 (100%)	4 (13%)	30 (94%)	17 (22%)	76 (97%)
Moderately stable	10 (22%)	0 (0%)	16 (50%)	0 (0%)	26 (33%)	0 (0%)
Grossly unstable	23 (50%)	0 (0%)	12 (38%)	2 (6%)	35 (45%)	2 (3%)
Mean score for daily function‡§ *(points)*	18	22	14	20	16	21
Mean elbow performance score‡ *(points)*	46	90	38	84	42	87

*Group 1 = elbows that were followed for at least ten years and Group 2 = elbows that were followed for less than ten years.

†Extension refers to the flexed position from which the patient extends the upper extremity. Flexion refers to the amount of additional flexion that is possible from the original flexed position.

‡See text and Table I for definitions.

§The maximum possible score is 25 points.

fifty-one to eighty-one years) in Group 2; this difference was significant ($p = 0.001$).

Statistical Analysis

Statistical analysis was performed with use of the Wilcoxon rank-sum test for comparison of ordinal or continuous variables between groups. The Fisher exact test was used to compare proportions between groups. Changes in ordinal or continuous variables were assessed with use of the Wilcoxon signed-rank test. Survivorship analysis was performed with use of the method of Kaplan and Meier.

Results

Survivorship Analysis

With use of revision of the bushings or removal of one or both components as the end point, Kaplan-Meier analysis of the cumulative probability of survival of the Coonrad-Morrey total elbow prostheses for the first twelve years after the operation revealed a rate of survivorship of 94.4 per cent (95 per cent confidence limit, 89 to 99.9 per cent) at five years, with sixty-one prostheses at risk, and 92.4 per cent (95 per cent confidence limit, 85.9 to 99.1 per cent) at ten years, with forty-three prostheses at risk (Fig. 3).

Outcome

At the time of the latest follow-up, according to the Mayo elbow performance score forty-three elbows (twenty-six in Group 1 and seventeen in Group 2; 55 per cent) had an excellent result, twenty-six (eighteen in Group 1 and eight in Group 2; 33 per cent) had a good result, seven (two in Group 1 and five in Group 2; 9 per cent) had a fair result, and two (both in Group 2; 3 per cent) had a poor result. The increase in the Mayo elbow performance score between the preoperative evaluation and the most recent follow-up evaluation was significant ($p < 0.0001$).

We believe that the outcome of Coonrad-Morrey total elbow arthroplasty can be estimated conservatively by using the Mayo elbow performance scores and classifying all patients who were alive but had not been followed for at least ten years and all those who were alive but did not have the index prosthesis *in situ* at the time of the latest follow-up as having had a fair or poor result. Therefore, at a minimum of ten years after the arthroplasty or before the time of death, sixty-seven (86 per cent) of the seventy-eight elbows had a good or excellent result and eleven (14 per cent) had a fair or poor result.

The results for seventy-four elbows (all forty-six in Group 1 and twenty-eight in Group 2; 95 per cent) were considered to be satisfactory by the patients. One patient thought that the status of the elbow was the same as it had been preoperatively, and three (all in Group 2) thought that the elbow was worse than it had been before the operation.

Relief of Pain

Initially, forty-seven elbows were severely painful, twenty-one were moderately so, and nine were mildly so (Table II). At the time of the latest follow-up, forty-

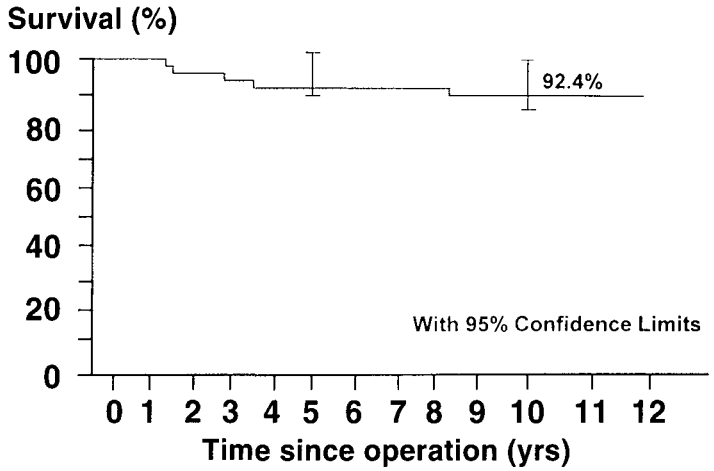

FIG. 3

Kaplan-Meier survivorship graph, with revision as the end point, for the seventy-eight Coonrad-Morrey total elbow prostheses. The 95 per cent confidence limits are shown at five and ten years.

seven elbows were not painful, twenty-nine were mildly so, one was moderately so, and one was severely so. With the numbers available, no significant difference was detected in the preoperative level of pain between the two groups ($p = 0.993$). Pain decreased significantly after the operation ($p < 0.0001$).

Range of Motion

At the time of the latest follow-up, the mean arc of flexion-extension was 103 degrees for the overall series — an increase of 13 degrees (15 degrees in Group 1 and 7 degrees in Group 2) compared with the preoperative value (Table II). The mean arc of pronation-supination was 130 degrees for the overall series — an increase of 21 degrees compared with the preoperative value. The mean arcs of flexion-extension and pronation-supination in both groups were considered to be normal, functional ranges of motion[22]. No significant difference was found, with the numbers available, in the values for preoperative flexion, extension, pro-

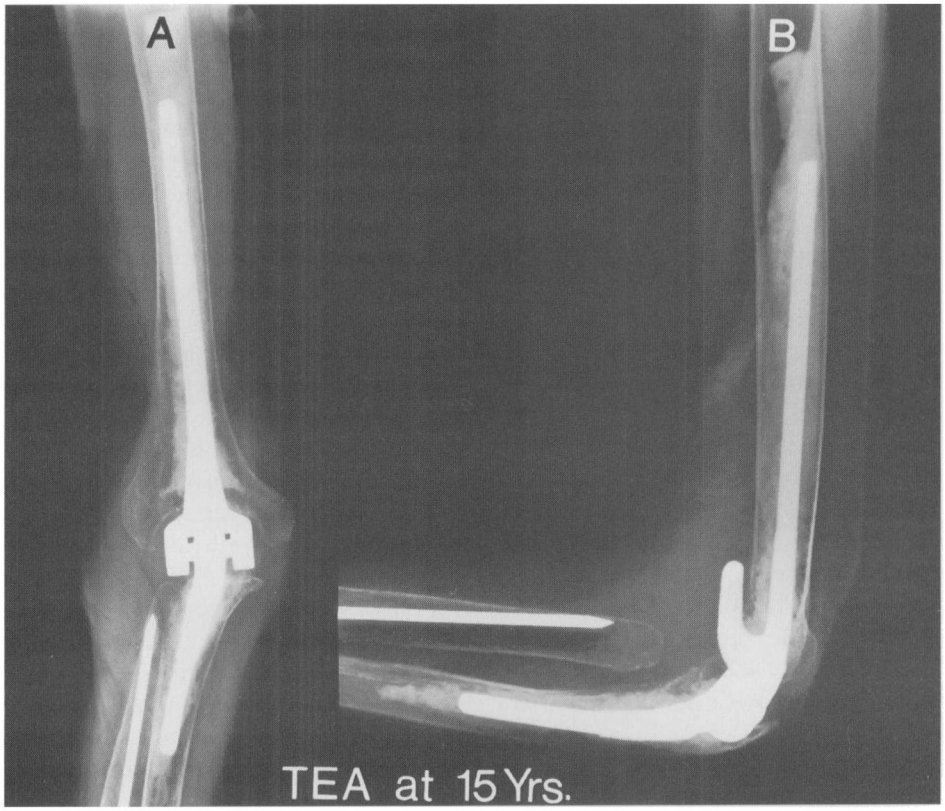

FIG. 4

Anteroposterior (A) and lateral (B) radiographs of a Coonrad-Morrey total elbow prosthesis (TEA) 180 months postoperatively.

TABLE III
RESULTS AT THE LATEST RADIOGRAPHIC EVALUATION*

	Group 1†	Group 2†	Overall Series
Rheumatoid arthritis (only elbows that had a primary total elbow arthroplasty)[17]‡			
Grade IV	10/37	8/29	18/66
Grade III	26/37	21/29	47/66
Grade II	1/37	0/29	1/66
Distal humeral bone loss (only elbows that had a revision total elbow arthroplasty)‡			
Grade II	5/7	4/5	9/12
Grade III	1/7	0/5	1/12
Grade IV	1/7	1/5	2/12
Adequate cementing technique‡			
Humeral component	43/44	26/29	69/73
Ulnar component	44/44	28/29	72/73
No cement	2/44	1/29	3/73
Radiolucent lines‡			
Humeral component			
<2 mm and <50%	2/46	2/30	4/76
>2 mm and >50%	0/46	0/30	0/76
Circumferential	1/46	0/30	1/76
Ulnar component			
<2 mm and <50%	2/46	2/30	4/76
>2 mm and >50%	1/46	0/30	1/76
Circumferential	1/46	2/30	3/76
Wear of bushings			
Partial wear	6/46	0/30	6/76
Complete wear	3/46	2/30	5/76
Incorporation of bone graft between anterior flange of prosthesis and distal part of humerus	36/46	28/30	64/76

*The values in the table represent the numbers of elbows.
†Group 1 = elbows that were followed for at least ten years and Group 2 = elbows that were followed for less than ten years.
‡See text for definitions.

nation, or supination between the two groups (p = 0.481, 0.984, 0.135, and 0.747, respectively). There was a significant increase in flexion, extension, pronation, and supination compared with the preoperative values (p = 0.026, 0.0205, 0.0002, and 0.0090, respectively).

Stability

The preoperative instability that is inherent in rheumatoid arthritis was reliably corrected by the total elbow arthroplasty (Table II). No significant difference was detected, with the numbers available, in the preoperative values for stability between Groups 1 and 2 (p = 0.975). At the latest follow-up evaluation, no patient in whom the prosthesis was *in situ* reported any subjective sensation of instability or demonstrated any objective instability.

Daily Function

The ability to perform five tasks of daily function — combing the hair, feeding oneself, performing hygiene, putting on a shirt, and putting on shoes — was assessed by each patient. The preoperative scores for daily function were similar for the two groups of patients (p = 0.233) (Table II). There was a significant increase in the scores for daily function between the preoperative and postoperative evaluations (p = 0.003).

Radiographic Assessment

Two patients who had had a resection arthroplasty because of chronic infection were excluded from the most recent radiographic evaluation but were included in the preoperative assessment. Of the sixty-six elbows that had had a primary total elbow arthroplasty, eighteen (27 per cent) had grade-IV rheumatoid arthritis, forty-seven (71 per cent) had grade-III, and one (2 per cent) had grade-II[17] (Table III). Of the twelve elbows that had had a revision total elbow arthroplasty, nine had grade-II bone loss (the trochlea is absent but the humeral condyles are present), one had grade-III (one condyle is absent), and two had grade-IV (both condyles are absent)[21].

The mean duration of radiographic follow-up was 115 months for Group 1 and thirty-four months for Group 2. None of the five elbows that had a marginal cement mantle (a radiolucent line of two millimeters) had a progressive radiolucent line. Radiographic loosening was defined as a progressive radiolucent line of more than two millimeters that was completely circumferential about the prosthesis. One humeral component and three ulnar components were radiographically loose (Table III). In addition, before the latest follow-up, two elbows had radiographic evidence of loosening and were revised. Five elbows (7 per cent) had complete wear of the bushings, and six (8 per cent) had partial wear. Sixty-five elbows (86 per cent) had no radiographic evidence of wear of the bushings (Fig. 4). The three humeral implants that had been fixed without cement showed no evidence of migration, but all had evidence of a neocortex about the distal portion.

Complications and Reoperations

Eleven (14 per cent) of the seventy-eight elbows had a total of fourteen complications, necessitating reoperation in ten elbows (13 per cent). There were three intraoperative complications, all condylar fractures; one was treated with open reduction and internal fixation, one was treated with an excision, and the third was ignored.

There were eleven postoperative complications, which included three avulsions of the triceps (one traumatic), two deep infections, two fractures of the ulna, and one fracture of the ulnar component. In addition, one humeral component and two ulnar components that had been inserted with cement and one total elbow prosthesis that had been inserted without cement were symptomatically loose, necessitating revision.

Two of the avulsions of the triceps occurred in the

early postoperative period and were treated with reattachment to the olecranon with use of a crisscross suture, as has been described previously[17]. The third avulsion occurred during a fall 100 months after the operation and was treated with reattachment in the same manner as the other two.

Both deep infections led to multiple procedures. One patient needed two muscle flaps (a brachioradialis flap and a latissimus dorsi flap) to cover the elbow after débridement, but an excisional arthroplasty was eventually performed. Two years later, reimplantation of a prosthesis was done at another institution; however, the elbow continued to be infected. The other patient had two débridements before having an excisional arthroplasty; the infection remained quiescent, and the patient refused additional procedures.

One patient sustained a fracture of the ulna in the region of the olecranon during a forceful manipulation by a physical therapist. The patient was managed non-operatively, but a fibrous union of the olecranon developed and the patient had active extension strength that was only grade 3 of 5 and a marked extension contracture. The patient refused additional intervention. Another patient sustained a fracture of the ulna at the tip of the ulnar component and was managed with open reduction and external fixation. The fracture united uneventfully.

One patient sustained a fracture of the ulnar component after repeatedly lifting a weight of approximately twenty-two kilograms, which greatly exceeded the recommended guidelines (2.25 kilograms for repetitive lifting and 4.5 kilograms for single-episode lifting) for patients who have had a total elbow arthroplasty. The component was revised with use of a two-millimeter-diameter high-speed burr to remove the cement about the well fixed distal portion of the implant. Needle-nosed vice-grip pliers then were used to grasp the tapered implant, which was readily removed with use of a disimpaction hammer. At the time of writing, four years after the revision, the patient was asymptomatic.

Two patients had a revision because of aseptic loosening. In one, who subsequently died, the original prosthesis had been inserted without cement. The patient was asymptomatic at the time of the final follow-up visit. The other patient initially had had aseptic loosening of the ulnar component, which was revised; however, the new component subsequently became loose, both the original humeral component and the new ulnar component were removed, and the patient was managed with an excisional arthroplasty. The patient refused additional intervention.

Poor Outcome

Two patients had a poor outcome at the latest follow-up evaluation. In the first patient, the Coonrad-Morrey total elbow arthroplasty had been performed in order to revise an unstable unconstrained total elbow prosthesis. At the latest follow-up evaluation, the patient had a limited range of motion and severe pain and performed activities of daily living poorly. The patient refused additional intervention and, after thirty-six months, refused additional follow-up. The second patient was the patient who had the deep infection that did not resolve despite a resection arthroplasty and reimplantation performed elsewhere. This patient had a limited range of motion and poor function at the latest follow-up evaluation.

Pain

One patient had severe pain, as just described, and another had moderate pain at the latest assessment. The patient who had moderate pain had an excellent range of motion, good daily function, and normal radiographic findings. This patient refused additional investigation to determine the cause of the pain.

Discussion

Studies of the results of unconstrained total elbow arthroplasty in patients who have rheumatoid arthritis have shown acceptable results with regard to relief of pain, but the rates of instability have ranged from 9 per cent (three of thirty-five) to 15 per cent (three of twenty)[6,7,24,26]. Recent results of semiconstrained arthroplasty, which included improvements in operative technique for the treatment of rheumatoid arthritis, were encouraging[3]. In a study of fifty-eight elbows, Morrey and Adams reported forty excellent results (69 per cent), thirteen good results (22 per cent), four fair results (7 per cent), and one poor result (2 per cent) at a mean of 3.8 years postoperatively[17]. The present report confirms that those results have been sustained over time. The thirty-nine elbows that were included in both the earlier study[17] and the current one had additional follow-up averaging 4.6 years. During this period, one patient in whom an infection had been previously suspected was managed with a resection arthroplasty elsewhere. Another patient sustained a fracture at the tip of the ulnar component, which healed uneventfully after open reduction and internal fixation. There was no change in the status of the remaining thirty-seven elbows. We believe that continued surveillance is important in order to fully understand the long-term implications of elbow replacement. The difference in the mean ages of the two groups was approximately eight years. The older patients were less likely to be followed for at least ten years; many of them died during the ten-year period.

Only a few reports in the literature describe long-term follow-up after total elbow arthroplasty in patients who have rheumatoid arthritis. Ewald et al. followed 202 elbows that had had a capitellocondylar total elbow arthroplasty and reported that, at a mean of sixty-nine months, the patients had decreased pain, better functional status, and a greater range of motion (except extension) compared with the preoperative status. Kasten

and Skinner reported on thirty-four elbows that had had a total elbow arthroplasty for different conditions. At a mean of 7.6 years after the procedure, seventeen (77 per cent) of the twenty-two elbows affected by rheumatoid arthritis had a good or excellent result and five (23 per cent) had a fair or poor result. Gschwend et al. reported on complications at a mean of 4.3 years after semiconstrained total elbow arthroplasties. They noted a complication in thirteen (11 per cent) of 118 elbows affected by rheumatoid arthritis and revision in ten (8 per cent). King et al. reported a mean Mayo elbow performance score of 87 points at a mean of six years in forty-one patients who had had a revision with use of a Coonrad-Morrey prosthesis. These results compare favorably with those in the present series, especially given that our outcome analysis was performed at least ten years after the operation. Schneeberger et al. recently reported the intermediate-term results of forty-one semiconstrained total elbow arthroplasties that had been performed for the treatment of posttraumatic osteoarthrosis. At a mean of five years, thirty-four elbows (83 per cent) had a good or excellent result and seven (17 per cent) had a fair or poor result. While these findings are comparable with those in the present study, patients who have posttraumatic osteoarthrosis seem to have a markedly higher rate of reoperation than do those who have rheumatoid arthritis: the rate of reoperation was nine (22 per cent) of forty-one in the study by Schneeberger et al. compared with ten (13 per cent) of seventy-eight in our study. This difference is due primarily to fractures of the ulnar component that occurred in the patients who had posttraumatic osteoarthrosis. Fracture of the medial epicondyle tends to occur when the medial collateral ligament remains attached to this structure, which is weakened by the preparation required for use of the humeral yoke, as seen in our experience with distal humeral non-unions. However, condylar fractures have little relevance; a number-5 non-absorbable suture is simply placed around the condyle to stabilize it to the implant.

We believe that avulsion of the triceps early in the postoperative period reflects the early learning curve for reattachment of the triceps with use of the Mayo approach[3]. This complication has not been encountered at our institution since early in our series, although it is always possible that traumatic avulsion will occur with acute overload of the triceps attachment. Deep infection developed in two elbows (3 per cent) in the present series; this represents a marked reduction compared with the rates in our previously reported series[17,20], but the rate is higher than that seen after replacement of major joints in the lower extremity at our institution[2,9]. It is routine, at our institution, to use one gram of vancomycin for each forty-gram package of cement in all total elbow arthroplasties (primary and revision).

Kraay et al. reported a 90 per cent rate of survival of the prosthesis after 113 non-consecutive semiconstrained total elbow arthroplasties in patients who had inflammatory arthritis. One salient feature of our study is that the operations were performed by eight surgeons at a single institution. Thus, the results do not represent those of one surgeon who had extensive experience and expertise but, rather, they represent those of a number of surgeons with variable experience. We believe that our study shows that, with appropriate training, an excellent outcome can be achieved and sustained after total elbow arthroplasty in patients who have rheumatoid arthritis.

We currently use the Mayo approach[3] for all primary total elbow arthroplasties in patients who have rheumatoid arthritis. We reflect the triceps extensor mechanism, transfer the ulnar nerve, and mix the methylmethacrylate with one gram of vancomycin for each packet of cement. The elbow is maintained in extension in a splint overnight, and active and active-assisted range-of-motion exercises are begun on the first postoperative day. Physical therapists do not participate at any time during the rehabilitation process. A sling occasionally is used to treat discomfort.

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