Failed arthroplasty of the elbow

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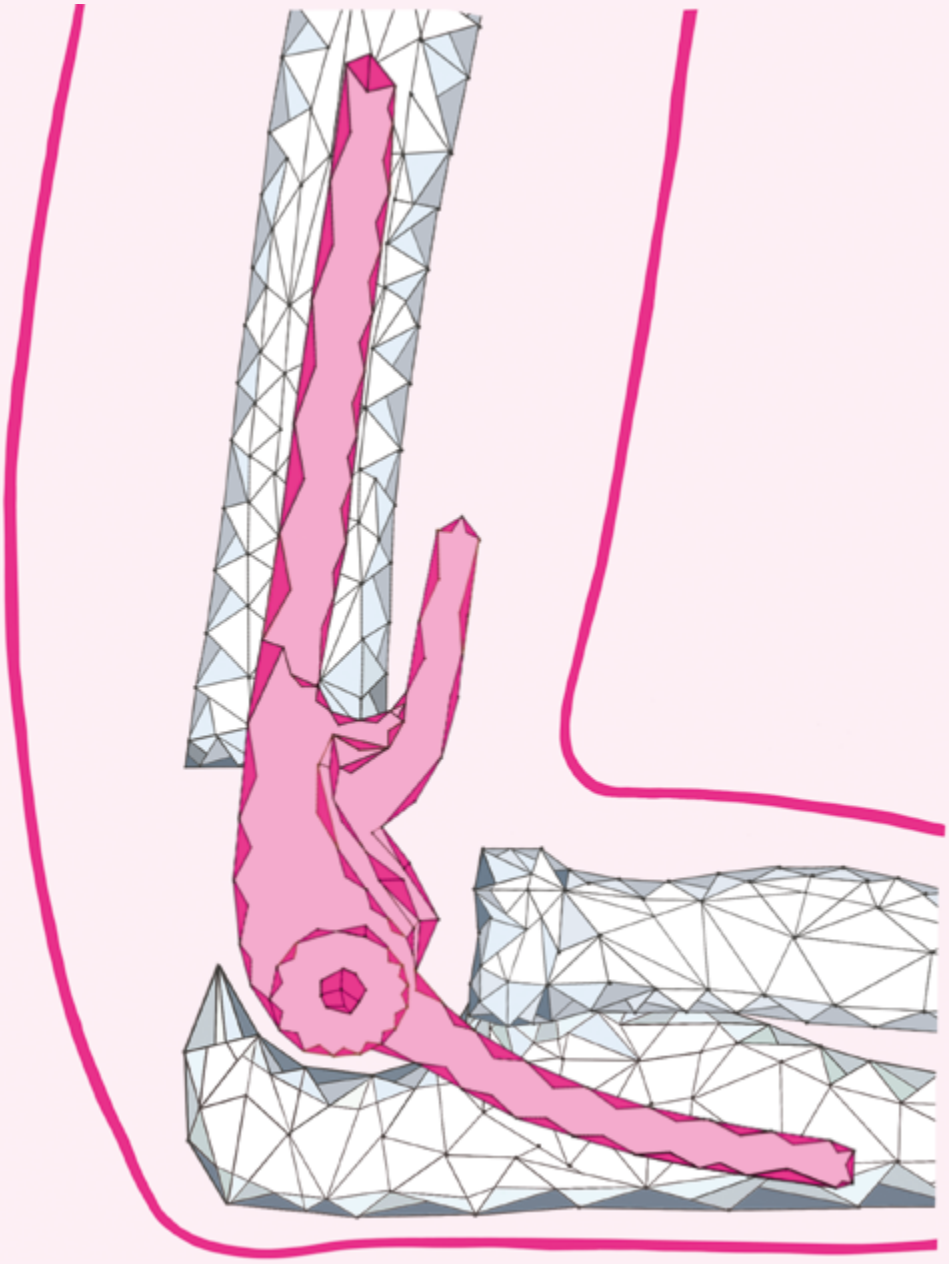

Chapter 7

Clinical and radiographic outcome of revision surgery of total elbow prosthesis: midterm results in 19 patients

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Abstract

Background

The aim of this study is to report on the midterm outcomes and complications of revision surgery of total elbow arthroplasty.

Methods

All patients who had undergone total elbow arthroplasty revision surgery between 2009 and 2014 with semiconstrained total elbow prostheses were prospectively enrolled in the study. Records were reviewed for demographic data; baseline measurements; and several follow-up assessments including the Mayo Elbow Performance Score (MEPS), visual analog scale (VAS) score for pain, Oxford Elbow Score, range of motion, satisfaction and radiographs.

Results

A total of 19 revision arthroplasties were included. At a mean follow-up of 57 months, there had been 1 re-revision and 2 removals. One patient was excluded from follow-up because of confounding comorbidity. At last follow-up, MEPS and VAS pain scores both improved ($p<0.01$). The rate of combined good and excellent results on the was 53%. The mean VAS scores for pain at rest and with activity were 2 and 4, respectively. Fair results for the Oxford Elbow Score were reported, with a mean score of 28 points. Range of motion improved to an average flexion-extension arc of 108° ($p<0.01$), and the pronation-supination arc improved to an average of 123° ($p<0.01$). All elbows were stable at last follow-up ($p<0.01$). Radiographs showed non-progressive osteolysis around the prosthesis in 3 cases (19%) and suspicion of loosening in 1 (6%). In 11 patients postoperative complications occurred. Of 15 patients, 13 (87%) were satisfied with the result of the revision procedure.

Conclusion

Revision of total elbow prostheses leads to satisfactory results, less pain, and better elbow function. This procedure is related to a relatively high complication rate.

Introduction

According to implant databases, total elbow arthroplasty (TEA) has been performed more often in the past 4 decades.[1] TEA is considered a successful treatment for a variety of conditions, such as rheumatoid arthritis, acute fractures, and (posttraumatic) osteoarthritis.

Previous studies considered TEA to be successful. Although the results are improving, complication rates of up to 62% have been reported in primary TEA cases.[2-7] This percentage is much higher compared with hip and knee arthroplasties.[1] The long-term survival rates range from about 60% in posttraumatic cases to 90% in patients with rheumatoid arthritis after 10 years.[8, 9] As the number of total elbow replacements increases, more revision surgery can be expected. Aseptic loosening and instability are the most important reasons for revision.[2, 4, 6, 10-14] Polyethylene wear or malposition of the prosthesis can result in both loosening and instability.[2, 15] Other indications for revision are infection and periprosthetic fractures.[16]

Most surgeons use a semiconstrained type of TEA when performing a revision, as semiconstrained models provide intrinsic stability and relieve the often-affected ligamentous structures. Nevertheless, second revision rates remain high, with a rate of 28% to 30% after 10 years after primary revision.[16] Previous studies reporting on the outcome after revision surgery using the Coonrad-Morrey prosthesis showed good results in pain relief and elbow function, but improvement of range of motion (ROM) should not always be expected.[17-20]

Considering the expected increase in TEA procedures, it is important to evaluate the results after revision surgery critically to support decision-making on revision of TEA in the future. The aim of this study was to report on the clinical and radiographic outcomes of revision surgery of TEA using the Coonrad-Morrey total elbow (Zimmer, Warsaw, Indiana, USA) in a European non-designer center. We hypothesized that revision surgery would lead to improved elbow function.

Materials and methods

Patient population

All patients who received a revision of TEA at our institution between March 2009 and June 2014 were included. Preoperatively, patients were seen in the outpatient clinic and filled in patient-reported outcome questionnaires. The follow-up consisted of questionnaires at 1, 3, 5 and 7 years after revision and a visit to the outpatient clinic. Patients who forgot to make an appointment after surgery were actively recruited by telephone and asked to make an appointment. In all cases a Coonrad-Morrey TEA (Zimmer) TEA was used. A highly experienced elbow surgeon (D.E.) performed all revision surgical procedures.

The preoperative medical history of all patients was collected. During preoperative assessment, ROM was determined with a goniometer and elbow function was evaluated with use of the Mayo Elbow Performance Score (MEPS). In addition, the patients completed a visual analog scale (VAS) score (0 -10) for pain at rest and during activity. At postoperative

follow-up visits, the assessments included the same parameters. Since 2013, the Oxford Elbow Score (OES) has been added to the questionnaires. To assess patient satisfaction directly instead of retrieving it from other questions, a question regarding satisfaction with the revision was asked during all follow-up visits. This question could be answered yes, moderately satisfied or no.

Plain anteroposterior and lateral radiographs were obtained preoperatively and at each reassessment. Two surgeons (B.T. and D.E.) analyzed the radiographs for loosening of the implant, periprosthetic fracture, periarticular ossification, lucency, and dislocation or subluxation. Osteolysis was evaluated as described by King et al[17] (Figure 1). Periarticular ossification was scored as described by Hastings and Graham.[21] In case of discrepancy in analysis of the 2 observers a consensus was made.

Surgical technique

The surgeon assessed the stability of the elbow joint with the patient under anesthesia just before the surgical procedure (Table 1): grade 1, stable; grade 2, mild instability; or grade 3, severe instability. During surgery, the patient was placed in the lateral decubitus position with the arm on an armrest. Routine antibiotic prophylaxis was given in 18 of 19 cases, because in 1 case, deep infection was suspected, and valid surgical cultures had to be obtained. A sterile silicone ring tourniquet was placed around the upper arm, as proximally as possible to allow for proximal extension of the incision if needed. After incision, skin flaps were created as thick as possible to minimize the chances of necrosis. The ulnar nerve was routinely identified and cleared of scar tissue as needed but was not routinely transposed. Because all cases were

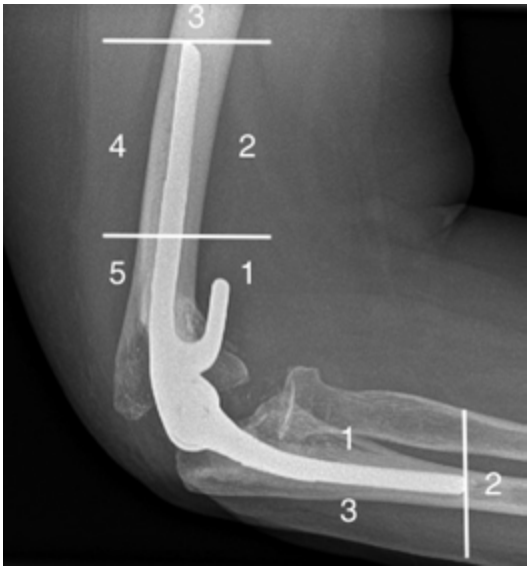

Figure 1. Regions of osteolysis as described by King et al.[17]

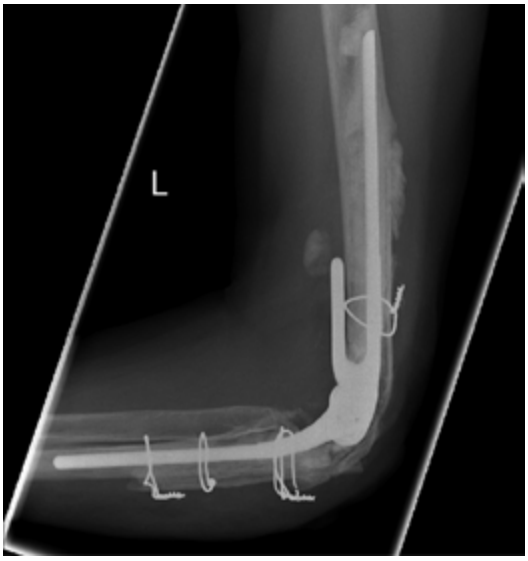

Figure 2. Use of an allograft strut graft of the fibula because of poor bone quality fixated with use of cerclage wires.

referred to our center, no complete data were available on the management of the ulnar nerve during the initial surgical procedures. However, previous ulnar nerve transposition was not observed.

A variation in the extensiveness of loosening of the primary prosthesis was noted, with a variety of remaining bone stock and in the quality of the soft tissues as triceps tendon. All patients had an intact radial head. A triceps-splitting approach was used in 2 cases, whereas the triceps-tongue approach was used in 17. Using the Wrightington approach, we released the annular ligament with a bony attachment that could be easily refixated using a transosseous suture.[22] Release of collateral stabilizing structures (if present) was performed by a sharp subperiosteal release from the medial and lateral epicondyle. In all patients cement was used in the primary surgical procedure. The complete cement mantle in the humeral and ulnar shaft was removed and in 8 patients an osteotomy (6 humerus and 2 ulna) was necessary to perform the removal.

In all patients a trial prosthesis was inserted to assess the correct height of the prosthesis and the elbow was tested for stability and ROM. Afterward, the trial components were removed. In all patients the final implant was placed with use of pressured vacuum-mixed cement. In 6 patients an allograft strut graft of the fibula was used and fixated with use of cerclage wires (Figure 2), because of poor bone quality. This was the ulna component in 2 patients, the humeral component in 1, and both component in 3. In 18 patients concomitant surgical procedures were performed, including osteotomy, ulnar nerve transposition, and synovectomy (Table 1).

After closure, the tourniquet was released and the elbow was immobilized in a posterior splint at 90° of flexion for 24 hours. Thereafter, the elbow was immobilized in a posterior removable splint in extension. From postoperative day 3, the elbow was mobilized under supervision of a specialized physiotherapist, but active extension was not performed during the first 6 weeks. Prophylaxis for heterotopic ossification was not routinely given.

Statistical methods

Kaplan-Meier survival analysis was used to assess the survival rate of prostheses, the endpoint being removal or second revision of one or more components. Data were censored for death unrelated to the prosthesis. To summarize the data, descriptive statistics were used and differences on outcome parameters before and after revision surgery were compared by use of the Student *t* test and Wilcoxon signed rank test for normally distributed data.

Results

Patients and follow-up

Nineteen elbows in 17 patients (3 men and 14 women) were included in this study. The mean age at revision surgery was 65 years (range, 48-80 years). All patients were right-handed and 6 dominant arms were involved. The index total elbow prosthesis failed for a variety of reasons (Table 1). Polyethylene wear, mostly in combination with loosening, instability and pain, was the most prevalent reason for revision. The mean time between index surgery and revision surgery was 136 months (range, 21-276 months), and the mean age at primary surgery was 54 years (range, 36-78 years). In 2 patients this was the second revision surgery. In one of the second revision cases, the first revision surgical procedure had been performed at our institution (case 19); in none of the regular revision cases had the index surgical procedure been performed at our institution. Two patients were lost to follow-up because of death unrelated to their total elbow prostheses. Demographic data are shown in Table 1, and baseline measurements are shown in Table 2. Type 4 and 5 Kudo total elbow prostheses (Biomet, Warsaw, IN, USA) were revised in 15 elbows, a Latitude total elbow prosthesis (Tornier, Stafford, TX, USA) in 2 elbows, a Souter-Strathclyde total elbow prosthesis (Stryker Howmedica Osteonics, Limerick, Ireland) in 1 elbow and a Coonrad-Morrey prosthesis in 1 elbow.

Complications and survival analysis

In 2 patients (cases 9 and 18) the prosthesis was removed at 16 and 30 months after surgery because of suspicion of deep infection. One patient (case 13) received a second revision arthroplasty because of failure of the ulnar component of the implant 41 months after the first revision surgical procedure. In 8 of the remaining 16 patients (50%) postoperative complications occurred; patient-specific details are shown in Table 3. The 2-year survival analysis showed a rate of 94.7% (95% confidence interval, 63.4%-100%), and the 5-year

Table 1. Demographic data.

Case No.	Sex	Age at surgery, y	Injured side	Handedness	Revision prosthesis	Indication for revision surgery	Index prosthesis	Interval between initial procedure and revision procedure, mo	Indication for index surgery	Concomitant surgical procedures
1	F	78	R	R	CM	Loosening and periprosthetic fracture	Kudo	39	RA	Use of partridge elbow plate and strut graft of the fibula for humeral component
2	F	64	R	R	CM	Luxation and fracture prosthesis	Kudo	165	RA	Transposition of the ulnar nerve, synovectomy, two strut grafts of the fibula for both humeral and ulnar component
3	F	61	L	R	CM	Loosening	Kudo	214	RA	Synovectomy
4	F	65	R	R	CM	Loosening	Kudo	276	LP	Transposition of the ulnar nerve
5	F	51	L	R	CM	Polyethylene wear	Kudo	194	RA	Strut grafts of the fibula both for humeral and ulnar component, fixation of the triceps on the strut graft, synovectomy
6	F	77	L	R	CM	Loosening and fracture prosthesis	Kudo	228	RA	Osteotomy of the humerus, strut graft of the fibula for ulnar component
7	F	61	R	R	CM	Loosening	Kudo	157	RA	Osteotomy of the humerus, synovectomy
8	M	74	L	R	CM	Polyethylene wear	Kudo	146	RA	Transposition of the ulnar nerve, osteotomy of the ulna, two strut grafts of the fibula for both humeral and ulnar component
9	F	65	L	R	CM	Polyethylene wear and periprosthetic fracture	Kudo	160	RA	Osteotomy humerus, synovectomy, strut graft of the fibula for ulnar component
10	F	73	R	R	CM	Polyethylene wear	Kudo	180	RA	Synovectomy, osteotomy ulna
11	M	60	L	R	CM	Polyethylene wear	Kudo	127	RA	Synovectomy, osteotomy humerus, perioperative fracture wherefore fixation with cerclages
12	F	53	R	R	CM	Polyethylene wear	Kudo	204	RA	Synovectomy
13	M	63	L	R	CM	Loosening	Souter	119	RA	Synovectomy

Table 1. (continueds)

Case No.	Sex	Age at surgery, y	Injured side	Handedness	Revision prosthesis	Indication for revision surgery	Index prosthesis	Interval between initial procedure and revision procedure, mo	Indication for index surgery	Concomitant surgical procedures
14	F	80	L	R	CM	Degeneration and malformation of elbow joint	Latitude	21	RA	
15	F	60	L	R	CM	Polyethylene wear	Kudo	58	RA	Synovectomy
16	F	70	L	R	CM	Polyethylene wear	Kudo	61	RA	Osteotomy humerus, synovectomy
17	F	48	R	R	CM	Polyethylene wear	Kudo	111	RA	Osteotomy humerus, synovectomy
18	F	63	L	R	CM	Deep infection	Latitude	84	LP	Removing of 10 gentamycin beads
19	M	67	L	R	CM (ulnar comp.)	Loosening	CM	42	RA	Synovectomy

CM, Coonrad-Morrey; F, female; L, left; M, male; R, right; RA, rheumatoid arthritis.

Table 2. Clinical outcomes before revision surgery.

Case No.	VAS for pain at rest (0-10)	VAS for pain with action (0-10)	Flexion, °	Extension deficit, °	Flexion-extension arc, °	Pronation, °	Supination, °	Pronation-supination arc, °	Valgus instability during revision surgery *	MEPS†
1	2	8	130	10	120	80	70	150	1-2	
2	-	-	120	20	100	40	40	80	3, flail	
3	1	4	130	30	100	80	45	125	3, flail	
4	6	7	110	60	50	70	80	150	3, flail	40, poor
5	3	8	140	40	100	60	60	120	3. flail	55, poor
6	-	-	90	10	80	30	30	60	3, flail	
7	8	10	120	30	90	90	60	150	3, flail	
8	5	8	100	60	40	40	40	80	3, flail	
9	-	-	120	20	100	40	40	80	3, flail	
10	2	4	145	30	115	70	30	100	3, flail	
11	4	8	130	5	125	60	60	120	3, flail	50, poor
12	3	6	140	10	130	30	50	80	3, flail	70, fair
13	6	8	120	40	80	60	60	120	3, flail	60, fair
14	9	9	125	25	100	70	70	140	3, flail	35, poor
15	6	9	120	20	100	90	90	180	3, flail	60, fair
16	7	7	110	25	85	90	80	170	3, flail	45, poor
17	2	7	140	40	100	80	70	150	3, flail	
18	3	10	110	30	80	70	70	140	3, flail	
19	1	3	130	15	115	20	20	40	1	85, good

MEPS, Mayo Elbow Performance Score; VAS, visual analog scale score.
* Valgus instability is graded as 1, stable; 2, mild instability; or 3, severe instability.
† The MEPS is classified as excellent (≥90 points), good (75-89 points), fair (60-74 points), or poor (<60 points).

survival analysis showed a rate of 82.0% (95% confidence interval, 63.4%-100%) (Figure 3). Patient specific data are shown in Table 3.

Radiographic analysis

At a mean follow-up of 57 months, radiographs of the remaining 16 elbows were analyzed. Assessment of postoperative radiographs at the last follow-up visit showed osteolysis around the prosthesis in 4 cases (25%). This osteolysis involved zones 1 through 5 (humeral) in 2 patients and both zone 2 and zone 3 (ulnar) in 1 patient. However, the osteolysis in these 3 patients already existed on the first postoperative radiographs and was therefore a result of poor cementing technique. One patient (case 17, Figure 4) had progressive osteolysis

Table 3. Clinical outcomes at last follow-up after revision surgery.

Case No.	Follow-up, mo	VAS for pain at rest (0-10)	VAS for pain at action (0-10)	Flexion, °	Extension deficit, °	Flexion-extension arc, °
1	52	5	7	130	20	110
2	82	2	7	130	30	100
3	82	1	6	140	0	140
4	78	1	7	130	50	80
5	30	0	0	140	30	110
6	79	-	-	120	25	95
7	69	NA	NA	NA	NA	NA
8	69	0	0	130	30	100
9	33	NA	NA	NA	NA	NA
10	61	4	5	130	50	80
11	59	2	7	120	10	100
12	54	0	0	140	30	110
13§	42	NA	NA	NA	NA	NA
14	43	1	1	140	15	125
15	43	5	8	140	20	120
16	38	5	6	140	5	130
17	37	1	3	140	30	110
18	16	NA	NA	NA	NA	NA
19§	24	2	6	140	30	110

MEPS, Mayo Elbow Performance Score; NA, not applicable; OES, Oxford Elbow Score; ORIF, open reduction–internal fixation; VAS, visual analog scale score.
* Valgus instability is graded as 1, stable; 2, mild instability; or 3, severe instability.
† The MEPS is classified as excellent (≥90 points), good (75-89 points), fair (60-74 points), or poor (<60 points).
‡ The OES scale ranges from 0 to 48 points, with 0 points indicating worst elbow function and 48 points indicating normal elbow function.
§ The same patient, who received re-revision of the ulnar component.

and suspicion of loosening of the implant but scored 100 on the MEPS, scored 32 points on the OES, had good ROM and did not have any symptoms. The patient was informed, and she undergoes assessment, including standard radiographs, once a year. One patient had a periprosthetic fracture of the humerus for which open reduction-internal fixation was performed. Heterotopic ossification was seen in 4 patients (25%) but was not symptomatic.

Clinical results

Clinical results are presented for 15 patients. The results of 2 removed and 1 re-revised prosthesis were excluded, and the results of case 7 were considered unreliable, because clinical and functional assessment was impossible as a result of comorbidities.

Pronation, °	Supination, °	Pronation-supination arc, °	Valgus instability*	MEPS†	OES°	Complications and treatment
60	60	120	1	65, fair	-	
70	60	130	1	65, fair	13	Radial nerve palsy
80	80	160	1	85, good	36	Triceps insufficiency; surgery
80	45	125	1	85, good	18	Triceps insufficiency; surgery
60	60	120	1	100, excellent	22	
60	60	120	1	-	-	
NA	NA	NA	NA	NA	NA	Periprosthetic fracture humerus; ORIF
70	50	120	1	95, excellent	46	
NA	NA	NA	NA	NA	NA	Deep infection; removal
70	60	130	1	80, good	34	
70	70	140	1	70, fair	17	Deep infection; debridement Triceps insufficiency; surgery
60	60	120	1	80, good	40	Deep infection with fistula; debridement
NA	NA	NA	NA	NA	NA	Loosening ulnar component; revision
70	60	130	1	65, fair	41	
70	40	110	1	65, fair	11	
70	70	140	1	70, fair	23	
60	60	120	1	100, excellent	32	Suspicion of loosening; no intervention yet
NA	NA	NA	NA	NA	NA	Ulnar nerve dysfunction; no treatment. Deep infection, loosening; removal
40	40	80	1	75, good	27	Triceps insufficiency; surgery

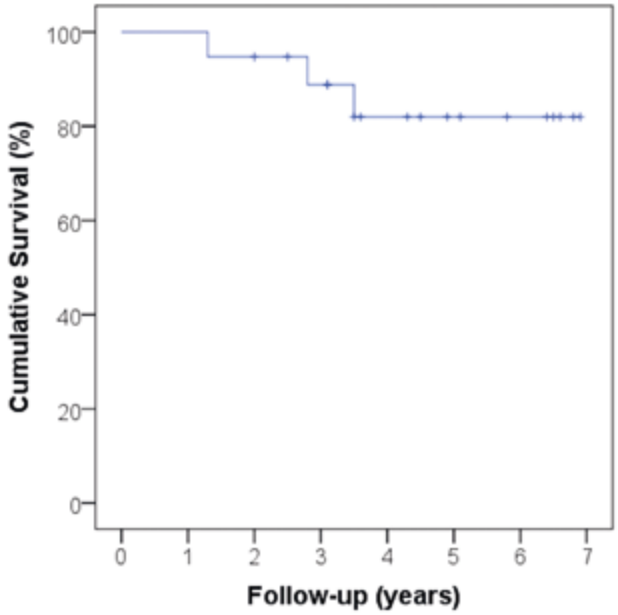

Figure 3. Kaplan-Meier survival analysis.

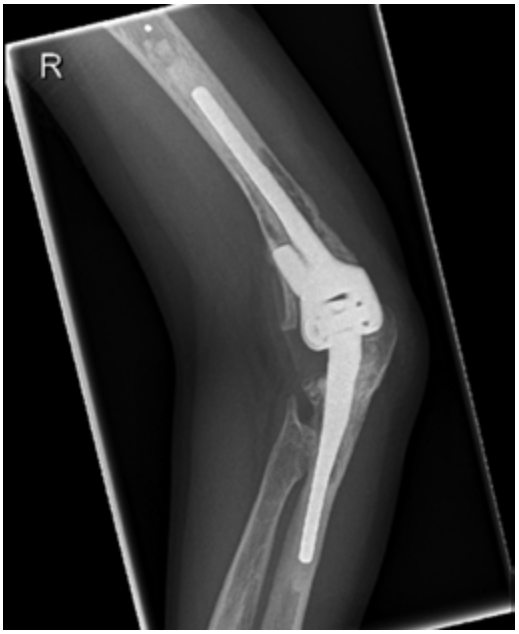

Figure 4. Suspicion of loosening of the humeral component in case 17.

At baseline, the mean flexion-extension arc was 96° (range, 40°-120°) and the mean pronation-supination arc was 120° (range, 40°-180°). At the last follow-up visit, the flexion-extension arc improved to 108° (range, 80°-140°) ($p<0.01$) and the mean pronation-supination arc improved to 123° (range, 40°-160°) ($p<0.01$). In Figure 5 results of ROM in 15 patients over time are presented. In addition, before surgery all but 2 elbows appeared to be flail elbows, graded as valgus instability grade 3. After surgery all elbows improved to stable elbows ($p<0.01$). Patient-specific details are shown in Tables 2 and 3.

At baseline, MEPS results were available in only 9 of 19 cases; there was 1 good result (11%), 3 fair results (33%) and 5 poor results (56%). At last follow-up, the results improved; there were 3 excellent results (20%), 5 good results (33%), 6 fair results (40%) and 1 poor result (7%) ($p<0.01$). In Figure 6 MEPS results in 15 patients over time are presented. No baseline measurements were available for the OES. The mean OES postoperatively was 28 points (range, 11-46 points). Six patients scored between 11 and 24 points, 4 patients between 25 and 36 points and 3 patients between 37 and 48 points. Before surgery, the mean VAS score for pain at rest was 4 (range, 1-9) and the mean VAS score for pain with activity was 7 (range, 3-10). The VAS score for pain at rest improved to a mean of 2 (range, 0-5) at last follow-up ($p<0.01$) and the mean VAS score for pain with activity improved to 4 (range, 0-8) ($p<0.01$).

At final follow-up, 13 of 15 patients (87%) were satisfied with the revision surgical procedure, 1 patient (7%) was moderately satisfied, and 1 patient (7%) was not satisfied at all.

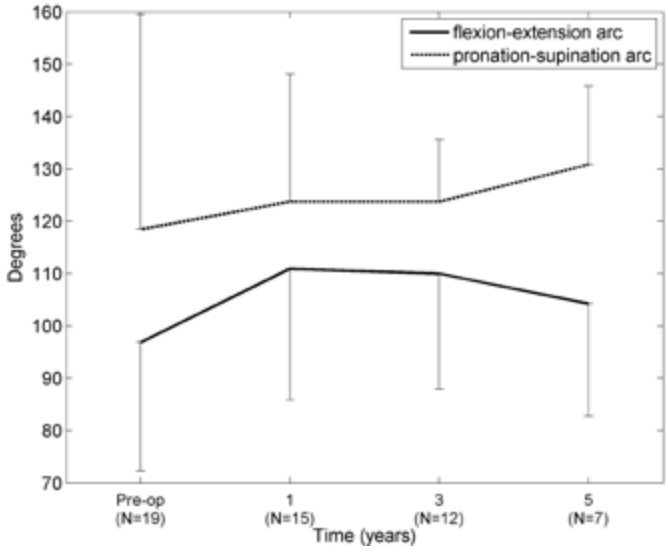

Figure 5. Range of motion over time presented 15 patients.

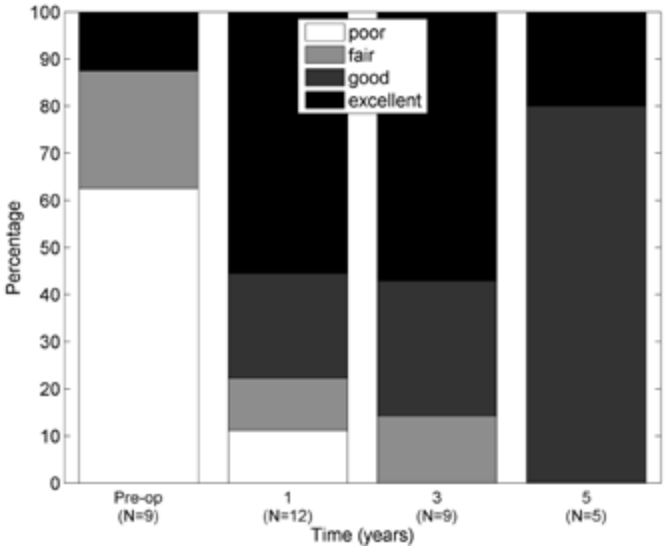

Figure 6. Mayo Elbow Performance Score Results over time presented for 15 patients.

Discussion

This study evaluated the clinical and radiographic outcome of revision surgery of TEA. In the 19 elbows included in this study 4 types of primary prostheses were revised: the Kudo prosthesis in 15 elbows, the semiconstrained version of the Latitude in 2, the Souter-Strathclyde in 1 and the Coonrad-Morrey prosthesis in 1. The Kudo and Souter-Strathclyde total elbow prostheses are both relatively short-stemmed unlinked prostheses compared with the Latitude and Coonrad-Morrey total elbow prostheses, which are both relatively long-stemmed semiconstrained prostheses. These differences could be related to the timeframe in which the primary arthroplasty was performed and might change in the future because more semiconstrained types are used today at our center. We observed that polyethylene wear of the unlinked Kudo prosthesis with forthcoming issues as metallosis and instability was the most reported reason for revision. These problems have been described previously.[2] Symptomatic loosening was the second most common indication for revision. Despite the loosening of the prosthesis in 37% of the cases in the current cohort, all surrounding cement had to be removed to lower the chances of infection of the existing cement mantle and to optimize the fixation of the revision TEA. This leads to more excessive debridement in the ulnar and humeral shafts and has led in our series to one perioperative fracture.

In this study clinical and functional scores improved on all parameters. After revision surgery, stability and ROM of the elbow joint improved, a decrease in pain at rest and during activity was observed, and MEPS results were either good or excellent at last follow-up in 8 of 15 patients (53%). The mean OES of 28 points, with a maximum of 48 points, indicates fair results of revision surgery. The OES was not available at baseline because

the questionnaire was not validated at that time. In Figure 5 ROM results over time are presented. The largest improvements were made in the first year after surgery. After 1 year, ROM remained good but no more improvements in flexion-extension arc were made. An interesting finding is that limited elbow motion was not a reason for revision; in most cases radiographic polyethylene wear, concomitant instability, and pain were reasons to consider revision arthroplasty.

Although clinical scores were good, complication rates in the study cohort were relatively high; in 11 of 19 elbows, postoperative complications occurred. In 1 patient (case 13) the ulnar component of the prosthesis was re-revised, and in 2 patients the revised TEA was removed in the end because of deep infection. We observed some interesting findings in the patients who had received re-revision or removal of their TEA. First, in both patients with indications of late posttraumatic arthritis for the primary prosthesis the revised prosthesis was removed or revised twice. Second, both patients who had undergone a second revision surgical procedure showed insufficiency of the triceps. This triceps insufficiency could be a result of multiple operations affecting the triceps muscle. In all patients who showed triceps insufficiency the triceps-tongue approach was performed. Nowadays, a 'triceps-on' technique is more frequently used at our institution, which is considered favorable in order to reduce complication rates in TEA.[23] However, further research is required to investigate the influence of the various approaches in TEA revision surgery. In addition, 4 smokers were identified in the cohort; 3 of them received a second revision surgical procedure or removal of the prosthesis. This outcome could suggest worse survival analyses in smokers. Statistical analysis on this was underpowered.

This study has several limitations. The number of patients is small, and because in all patients the index surgical procedure was not performed at our hospital, information regarding concomitant surgical procedures such as ulnar nerve transposition and ligamentous reconstruction was not available. In contrast to outcomes of primary TEA, relatively few results of revision surgery using the Coonrad-Morrey prostheses are found in the literature.[17-20, 24] These studies had comparably sized cohorts varying from 20 to 41 patients and a mean follow-up of approximately 5 years. In 2 of these studies, the authors were involved in the design of the implant, and the most recent study dates from 2013. In addition, none of the studies reported on differences in ROM and MEPS results over time. The data from our study may support the surgeon in managing the patient's expectations after revision surgery.

Even though we did not perform sample size calculations to determine statistical power, we observed a difference in ROM, MEPS and VAS scores after surgery, indicating that even relatively small numbers of patients led to significant differences. The strengths of this study are the midterm follow-up time of 57 months and the fact that none of the patients was lost to follow-up, resulting in no selection bias. Furthermore, all patients were operated on a uniform way. Even though our results were statistically significant, this does not guarantee success in clinical practice. However, we can state that patient satisfaction increased in this study. In our opinion, this is a more useful measure of success because patient satisfaction is

the individual interpretation of objective measures. Therefore, we consider our TEA revision surgery as a useful intervention.

Although we recommend revision surgery of TEA as a salvage procedure, an important observation in this study is the relatively young age (65 years) of the patient cohort. The mean age at the time of primary surgery was 54 years. This is essential to acknowledge because complication, removal, and (second) revision rates are still high. These high rates could be related a higher demand and use of the affected elbow and prolonged patient survival in younger patients. Current arthroscopic techniques for debridement of arthritic elbow joints in patients could possibly postpone the implantation of TEA.

Conclusion

The overall midterm outcome of this series of 19 revision surgical procedures of total elbow prosthesis can be considered satisfactory. Revision surgery using the semiconstrained Coonrad-Morrey prosthesis leads to less pain, better elbow performance, and prevention of further deterioration of elbow function. Nevertheless, it is essential to be aware of patients' age at the time of primary surgery and obtaining carful informed consent from patients before revision surgery is necessary because the complication rates are relatively high.

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