The Kudo elbow prosthesis in rheumatoid arthritis

A consecutive series of 26 elbow replacements in 24 patients followed prospectively for a mean of 5 years

Hans Rahme

Department of Orthopaedics, Uppsala University Hospital, SE-75185 Uppsala, Sweden. E-mail: hans.rahme@ortoped.uas.lul.se
Submitted 01-11-01. Accepted 02-03-09

ABSTRACT – The Kudo prosthesis is the most commonly used elbow implant in Sweden. However, there are few reports of the results, besides those reported by Kudo himself. I have implanted 30 Kudo type 4 or 5 elbow prostheses in 28 patients with rheumatoid arthritis. 3 arthroplastics were revised, 2 because of loosening and 1 because of a periprosthetic ulnar fracture. 6 major peroperative or early postoperative complications occurred, but only 1 of these was a failure. 2 patients developed postoperative ulnar neuropathy, one was transient and the other patient died 1 year after surgery.

26 elbows were available for follow-up at an average 5 (2–8) years after implantation. All 26 functioned well although radiographic loosening of the humeral component was found in 1 patient. The average range of flexion increased by 14 degrees while the extension lag was unchanged (35 degrees). Activities of daily living had improved markedly and all but 3 patients were satisfied with their elbow.

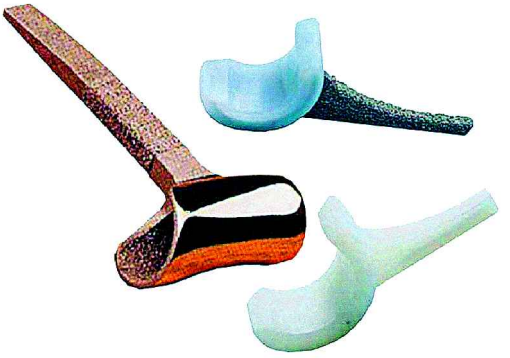
Radiolucent lines were seen around the proximal part of the ulnar component in 18/26 elbows. Although progressive in 1 patient only, this is a matter of concern, indicating that this component may be the weak part of the Kudo prosthesis.

■

The Kudo prosthesis is the commonest implant used in Sweden (Rahme et al. 2001). This non-constrained prosthesis has been improved considerably since its introduction in 1972 (Kudo et al. 1980, 1999, Kudo and Iwano 1990). It permits translation, motion in varus and valgus angulations and slight axial rotation. Types 1 and 2 were surface-replacement prostheses without a stem, but in type 3, a stem was added to the humeral component. All types were implanted with cement.

In this series, type 4 (introduced in 1988) and 5, with a porous-coated stem, were used when the humeral component could be inserted without cement. The difference between types 4 and 5 is that the former is an all-titanium prosthesis while the latter consists of cobolt-chromium alloy and half of the stem is porous-coated with a titanium alloy. The ulnar component is metal-backed or all-polyethylene and the same is true of type 4 and 5 versions of the prosthesis (Figure). An uncemented ulnar component is available, but I did not use it in this series.

I report the medium-term results of the first 30 Kudo prostheses implanted in patients with rheumatoid arthritis.



The Kudo type 5 elbow prosthesis. The humeral component with half of the stem porous-coated. The 2 different ulna components, metal-backed or all-polyethylene.

Patients and methods

From 1992 to 1998, I implanted 30 Kudo elbow prostheses in 28 patients with rheumatoid arthritis. I had no prior experience of elbow arthroplasties, which means that the study includes the learning curve.

22 of these patients were women and 6 men with a mean age of 63 (50–85) years. The elbows were in stages 3–5, according to Larsen et al. (1977) (Table 1).

Surgical technique

The operations were done under general anesthesia with the patient in the lateral position and the arm supported on a padded rest. A posterior approach was used in all cases. The ulnar nerve was decompressed in all cases and transposed in 2. The ulnar collateral ligament was divided or partially removed (when ossified) and the elbow dislocated to provide a wide exposure of the joint. The radial head was resected when present.

The humeral component was oriented in the coronal plane by placing a wire on the posterior cortex 35 mm proximal to the medial epicondyle. This represents the isometric plane for extension and flexion (Blewitt and Pooley 1994). In 4 elbows, one of the condyles was deficient and replaced by a bone graft shaped like the radial head. The humeral component was inserted without cement in 6 cases, partially cemented below the condyles in 22 and fully cemented with antibiotic cement in 2. The decision whether to cement, partially cement or implant the humeral component uncemented was based on the fixation achieved intraoperatively. At the beginning of the series, 5 type 4 humeral components were used, the remaining 25 were type 5 humeral prostheses. The ulnar component was aligned parallel to the subcutaneous border of the ulna. The ulnar component was cemented in all cases. 5 of the components were all-polyethylene and 25 metal-backed. The soft tissue was carefully reconstructed, but no attempt was made to resuture the ulnar collateral ligament.

A wound drain was inserted before closure. A plaster back splint at 60 degrees of flexion was applied before releasing the tourniquet. Prophylactic antibiotics were given for 1–3 days.

Postoperative rehabilitation

The drain was removed on the 1st postoperative day. On the 4th postoperative day, the plaster was replaced by a removable splint and passive extension and active flexion exercises, 3–4 times daily, were started. The splint was retained for 2–4 weeks in the daytime, depending on the stability achieved during surgery, and another 2 weeks at night. Supervised physiotherapy was continued until a reasonable range of motion was achieved.

Follow-up

Patients were followed with a standardized protocol preoperatively, postoperatively, at 6 weeks, 4 months, 1 year, 3 years, 5 years and at a final follow-up for this study. 3 patients (7, 11, 18) were revised before the 3-year follow-up and 1 had died (26), leaving 26 elbows with a mean follow-up of 60 (29–103) months.

Pain on activity, pain at rest (VAS scale), activity of daily living, range of motion, pro-and supination, stability and the patient's satisfaction were recorded. The users of the Kudo prosthesis in Scandinavia and England have created a new score which I used. The maximum score is 100 points, representing an almost normal elbow joint (Table 2).

Radiographs were taken at all follow-ups. A radiologist unaware of the clinical results interpreted the latest available radiographs. A shift in the position of the component or a radiolucent line more than 2 mm around the whole component was regarded as definitive loosening.

Results

Peroperative complications

One patient (21) had a preoperative fracture through the medial column that was stabilized with a lag screw. The fracture healed uneventfully without compromising the result.

In 2 cases (7, 22), the all-polyethylene ulnar component did not adhere to the cement. The cement was removed and the component replaced by a cemented metal-backed component during the index operation. Case 2 had an excellent result while case 7 was revised (see below).

Table 1. Characteristics of the patients

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	F	62	103	III	1	1	–	60	82	75	30–115	30–115	55–110	0	2	2	2	–	–		
2	F	66	37	IV	1	3	–	47	100	92	25–120	15–140	20–135	0	2	2	1	–	–		Early dislocation [1]
3	M	78	54	III	1	3	–	42	93	61	35–130	25–130	40–155	0	2	2	2	–	–		Died
4	F	50	101	III	1	3	–	50	93	93	10–115	25–135	35–140	1	1	1	1	–	–		
5	M	65	99	IV	2	3	–	52	85	75	30–140	45–135	45–155	2	2	0	1	–	–		
6	F	59	99	V	1	3	–	39	100	95	40–130	30–135	45–150	2	2	2	1	–	+		
7	M	67	24	IV	2	3	1	54	86		35–150	60–135		2	2			–	–		Revised.[2] Died
8	M	63	97	IV	2	3	–	71	90	95	60–110	45–120	55–140	1	1	2	1	–	–		
9	F	53	96	V	2	3	–	44	93	95	60–100	60–130	40–145	0	2	2	1	–	–		Mobilization.
10	F	56	93	IV	2	3	–	55	98	94	30–140	30–150	30–150	2	2	2	1	–	–		Reoperated [3]
11	F	78	15	V	2	3	–	59	78		35–140	30–130		2	2			–	–		Revised.[4] Died
12	F	57	86	III	2	3	–	56	98	100	30–120	15–135	20–150	2	2	2	1	–	–		Mobilization.
13	M	65	80	III	2	3	–	76	93	100	40–130	20–140	20–140	2	2	2	1	–	–		
14	F	53	60	IV	2	1	–	47	73	68	30–80	40–90	20–90	1	1	1	2	–	–	RIAP	
15	F	60	60	V	2	2	–	25	90	90	25–85	50–120	45–135	0	1	1	1	–	–	RIAP	
16	F	65	59	III	2	2	–	49	93	96	40–140	30–140	35–150	2	2	2	1	–	–		
17	F	51	36	IV	2	3	–	66	98	98	45–120	35–130	35–145	2	2	2	1	–	–		
18	F	78	13	IV	2	3	–	58	100		0–145	20–150		2	2			–	–		Fracture.[5] Ulna rev.
19	F	69	50	IV	2	2	–	44	97	98	30–135	20–145	25–150	2	2	2	1	–	–		
20	F	67	36	IV	2	3	–	35	88	91	40–135	35–140	30–150	2	2	2	1	–	–		
21	F	85	33	IV	2	3	2	34	90	93	60–135	55–135	60–145	1	1	2	1	–	–		
22	F	53	38	V	2	3	1	58	95	90	35–95	20–135	20–140	2	2	2	1	–	–		
23	F	53	43	IV	2	2	–	70	90	93	45–140	55–145	55–155	1	2	2	1	–	–		
24	F	69	37	IV	2	3	–	54	90	100	5–140	18–145	20–150	1	1	2	1	+	–		
25	F	51	34	IV	2	3	–	83	98	98	30–125	25–135	30–140	1	2	2	1	–	–		
26	F	73	4	III	2	3	–	64			60–140			2				+			Died [6]
27	M	63	35	V	2	3	–	37	83	90	30–135	25–140	40–150	2	2	2	1	–	–	CRR	
28	F	63	36	IV	2	3	–	33	95	98	35–110	40–140	35–140	1	2	2	1	–	–		
29	F	62	35	III	2	2	–	54	90	91	0–140	15–150	30–150	2	2	2	1	–	–		
30	M	65	29	IV	2	2	–	47	90	86	20–140	25–145	25–145	1	2	0	1	–	–	CRR	

A Patient
B Sex
C Age
D Months of follow-up
E Stage, using Larsen's classification
F Humeral prosthesis
  1 Type 4
  2 Type 5
G Cementation technique
  1 Both components cemented
  2 Ulna cemented, humerus uncemented
  3 Ulna cemented, humerus cemented below condyles
H Peroperative complications
  1 Ulnar component did not adhere to the cement
  2 Fissure in the medial column
I Preoperative score
J Score at 1 year
K Score at last follow-up
L Range of motion preop
M Range of motion at 1 year
N Range of motion at last follow-up
O Pro-supination preop
  0 < 60° together
  1 Both pro- and supination between 30–60°
  2 Both pro- and supination > 60°
P Pro-supination at 1 year
Q Pro-supination at last follow-up
R Patient satisfaction
  1 Satisfied
  2 Uncertain
  3 Dissatisfied
S Symptoms from the ulnar nerve 6 weeks after surgery
T Symptoms from the ulnar nerve at last follow-up
U Previous surgery
  RIAP Resection interposition arthroplasty
  CRR Caput radii resection
V Notes
  [1] Declines further follow-ups
  [2] Revised after 33 months.
  [3] Reoperated for early infection
  [4] Revised after 35 months.
  [5] Periprosthetic fracture after 34 months.
  [6] Died before 1-year follow-up

Early postoperative complications

One patient (2) had a dislocation on the day after surgery. The elbow was reduced and put in plaster for 3 weeks, after which the elbow was stable. At the 3-year follow-up, the patient had a well functioning elbow, but declined to attend further follow-ups.

One patient (7) damaged his wound after a fall from a wheelchair ramp 1 week after implantation

Table 2. Scoring system

Variable	Score	Points
Pain on activity	No pain	20
	Mild pain	17
	Moderate pain	10
	Severe pain	3
	Severe pain, constant analgesics	0
Pain at rest	VAS scale	0–20
Eating	No disability	5
	Moderate disability	3
	Severe disability	0
Reaching perineum	No disability	5
	Moderate disability	3
	Severe disability	0
Combing hair	No disability	5
	Moderate disability	3
	Severe disability	0
Washing the axillas	No disability	5
	Moderate disability	3
	Severe disability	0
Flexion	> 120°	15
	105°–120°	10
	90°–105°	5
	< 90°	0
Extension defect	0°–20°	5
	20°–40°	3
	> 40°	0
Stability	Stable	10
	Unstable	0
Pro-/supination	Both > 60°	10
	Both between 30°–60°	5
	< 60° together	0

Maximum score 100 points

of the prosthesis. He developed a wound infection and later a low-grade deep infection of the prosthesis and a periprosthetic ulnar fracture. The implant had to be removed 2.8 years after implantation and he remained without a prosthesis.

Another patient (10) developed a joint infection 2 weeks postoperatively. She was reoperated on immediately with lavage and suture of the extension apparatus, that had broken. The prosthesis was retained. Oral antibiotics were given for 4 years. At follow-up 8 years postoperatively, the prosthesis was functioning well with no signs of loosening.

2 cases (8, 12) underwent mobilization under anesthesia 3 weeks after surgery.

2 patients had slight ulnar symptoms preoperatively, both resolved after surgery. 2 patients had numbness in the little and ring fingers at the 6-week follow-up. The one with more severe symptoms and reduced 2-point discrimination died before the 1-year follow-up; in the other patient, the symptoms had disappeared at the last follow-up (3 years after surgery). 1 patient (6) had developed permanent numbness and an increase in 2-point discrimination (10 mm) in the ring and little fingers several years after implantation (Table 1).

Late complications

Apart from case 7, there was 1 revision for mechanical loosening of both components in a patient (11) with mutilating changes preoperatively and 1 revision of the ulnar component (18) after a periprosthetic ulnar fracture because of a fall. She was reoperated on with a long stem ulnar component and the ulna was plated and bone-grafted. The fracture healed and she is now pleased with her elbow.

Clinical results

Clinical results were available at the 1-year follow-up for all but patient 26, who had died (Table 1). 26 of the remaining 29 elbows were followed an average of 60 (29–103) months postoperatively, since 3 were excluded because of revision (7, 11, 18). At this follow-up, 21 patients (23 elbows) were satisfied and 3 were uncertain about the result. The reasons why they were not fully satisfied were stiffness in 2 (1, 14) and pain in 1 (3).

The arch of motion increased by an average of 14 degrees. The mean extension deficit was unchanged (35 degrees). Preoperatively, pronation and supination together were below 60 degrees in 5, between 30–60 degrees in 9 and above 60 degrees in 16 elbows. The corresponding figures at the final follow-up were 2, 3 and 21 elbows. The preoperative score averaged 52 (25–83) and was 91 (61–100) at the last follow up. 5 patients had mild pain during activity, but only 1 (3) had pain at rest and moderate pain during activity at the last follow-up. Activities of daily living were markedly improved in all 24 patients (26 elbows) (Table 3).

Radiographic results

At the last follow-up, among the 27 humeral com-

Table 3. Activity of daily living (ADL) in 24 patients (26 elbows)

	Disability preoperatively			Disability at last follow-up		
ADL	Severe	Moderate	None	Severe	Moderate	None
Combing hair	14	7	5	7	2	17
Eating	6	12	8	3	1	22
Reaching perineum	9	14	3	4	5	17
Washing opposite axilla	7	6	13	2	5	19

Table 4. Radiolucent lines (in mm) around the components at the last follow-up

A	B	C	D	E	F
1	>2	>2	1	1	SIP
2	0	0	0	1	
3	0	0	0	1	
4	0	0	0	<1	
5	0	0	0	0	
6	0	0	0	0	
7	–	–	–	–	R, D
8	0	0	<1	1	
9	1.5	<1	<1	<1	
10	0	0	0	1	
11	–	–	–	–	R, D
12	0	0	0	<1	
13	0	0	1	1	
14	0	0	1	2	
15	0	0	0	1	
16	0	0	0	0	
17	0	0	0	<1	
18	0	0	–	–	UR
19	0	0	0	<1	
20	0	0	0	<1	
21	0	0	1.5	<1	
22	2	1	<1	<1	
23	1	0	0	<1	
24	0	0	0	0	
25	0	0	0	0	
26	–	–	–	–	D
27	0	0	0	0	
28	0	0	0	0	
29	0	0	0	0	
30	0	0	0	1	

A Patient
B Lines around humeral stem
C Lines around condylar part of humeral component
D Lines around ulnar stem
E Lines around proximal part of the ulnar component
F Notes
SIP Shift in position
R Revised
UR Ulnar component revised
D Died

ponents that were not revised, radiolucent lines were seen around the stem in 4 patients and around the condyles in 3. 1 had definitive loosening (1) and 1 had progressive radiolucent lines (22) without definitive loosening, but the patient had slight pain during activity.

Radiolucent lines around the stem of the ulnar component were found in 7 cases and around the proximal part of the ulna in 18 (Table 4).

Discussion

Good results following elbow arthroplasty in the rheumatoid patient can be achieved with nonconstrained (Pöll and Rozing 1991, Ewald et al. 1993, Risung 1997, Kudo et al. 1999) and semiconstrained implants (Gill and Morrey 1998, Gschwend et al. 1999). Constrained elbow prostheses have been plagued with a high rate of loosening problems while nonconstrained implants have been associated with dislocation, ulnar nerve palsy, infection and wound problems (Ferlic 1999).

The Kudo prosthesis is one of the most commonly used nonconstrained elbow prostheses. In 1999, 35/70 implanted elbow prostheses, reported to the Swedish Elbow Arthroplasty Register, were Kudo prostheses (Rahme et al. 2001). Kudo himself has presented the results of the different generations of his prosthesis in patients with rheumatoid arthritis (Kudo et al. 1980, Kudo and Iwano 1990, Kudo et al. 1999). In addition to his reports, only a few others have been published (Verstrecken et al. 1998).

My series of 30 elbows included 3 revisions and 1 radiographic loosening not requiring revision. 2 of the revisions were related to a fall on the operated elbow. 1 patient sustained an ulnar fracture 2 years after implantation and 1 patient a wound rupture 1 week after implantation leading to an infected prosthesis. In the third reoperated patient,

we found mutilating changes preoperatively, probably too severe for the implant.

Radiolucent lines were found around the proximal ulnar cement-bone interface in two thirds of the elbows. Most of the lines were not progressive and 1 mm or less, but this is a matter of concern. The ulnar component seems to be the weakest part of the Kudo prosthesis, for 3 reasons: 1) the high percentage of radiolucencies, 2) 2 all-polyethylene components did not adhere to the cement, and 3) the polyethylene layer on the metal-backed component is thin (3 mm).

Loosening of the humeral component is commonest with the Souter-Strathclyde elbow prosthesis (Sjöden et al.1995), but in my series of Kudo prostheses, only 1 definitive case of loosening was seen among the unrevised patients. Revisions were attributed to loosening of both components in 2 cases and to the ulnar component in 1.

I have used a posterior approach and always visualized the ulnar nerve so as to avoid damaging it during surgery. Only 2 patients developed postoperative ulnar nerve neuropathy, 1 was transient and the other patient died before the 1-year follow-up, but still had symptoms at the 4-month follow-up. In a series in which a lateral approach had been used, the rate of ulnar palsy was much higher (Ewald et al. 1993, Ljung et al. 1995), probably because of unrecognized traction on the nerve and thermal injury during cementation.

Dislocation has been a problem in nonconstrained prostheses (Ferlic 1999). Only 1 of my patients dislocated although the ulnar collateral ligament had been excised. Much attention has been paid to balancing the soft tissue and minimal resection of bone to gain stability. Since orientation of the components and restoration of length are essential for stability, I have developed a humeral jig with saw-blocks to simplify insertion of the humeral component.

The functional results were good and activities of daily living improved markedly. All patients who are still alive have a well-functioning implant and most of them stated that they “never thought of their elbow”.

No funds have been received to support this study.

I thank Fredrik Breitholz for help with the data register and Lars Wikblad for interpreting the radiographs.

Blewitt N, Pooley J. An anatomic study of the axis of elbow movement in the coronal plane: Relevance to component alignment in elbow arthroplasty. J Shoulder Elbow Surg 1994; 3: 151-8.

Ewald F C, Simmons E D, Sullivan J A, Thomas W H, Scott R D, Poss R, Thornhill T S, Sledge C B. Capitellocondylar total elbow replacement in rheumatoid arthritis. Long-term results. J Bone Joint Surg (Am) 1993; 75: 498-507.

Ferlic D C. Total elbow arthroplasty for treatment of elbow arthritis. J Shoulder Elbow Surg 1999; 8: 367-78.

Gill D R J, Morrey B F. The Coonrad-Morrey total elbow arthroplasty in patients who have rheumatoid arthritis. A ten- to fifteen-year follow-up study. J Bone Joint Surg (Am) 1998; 80: 1327-35.

Gschwend N, Scheier N H, Baeher A R. Long-term results of the GSB III elbow arthroplasty. J Bone Joint Surg (Br) 1999; 81: 1005-12.

Kudo H, Iwano K. Total replacement with a non-constrained surface-replacement prosthesis in patients who have rheumatoid arthritis. J Bone Joint Surg (Am) 1990; 72: 355-62.

Kudo H, Iwano K, Watanabe S. Total replacement of the rheumatoid elbow with a hingeless prosthesis. J Bone Joint Surg (Am) 1980; 62: 277-85.

Kudo H, Iwano K, Nishino J. Total elbow arthroplasty with a nonconstrained humeral component inserted without cement in patients who have rheumatoid arthritis. J Bone Joint Surg (Am) 1999; 81: 1268-80.

Larsen A, Dale K, Eek M. Radiographic evaluation of rheumatoid arthritis and related conditions by standard reference films. Acta Radiol 1977; 18: 481-91.

Ljung P, Jonsson K, Rydholm U. Short-term complications of the lateral approach for non-constrained elbow replacement. Follow-up of 50 rheumatoid elbows. J Bone Joint Surg (Br) 1995; 77: 937-42.

Pöll R G , Rozing P M. Use of the Souter-Strathclyde total elbow prosthesis in patients who have rheumatoid arthritis. J Bone Joint Surg (Am) 1991; 72: 1227-33.

Rahme H, Jacobsen M B, Salomonsson B. The Swedish elbow register and the Swedish shoulder arthroplasty register. Two new Swedish arthroplasty registers. Acta Orthop Scand 2001; 72: 107-12.

Risung F. The Norway elbow replacement. Design, technique and results after nine years. J Bone Joint Surg (Br) 1997; 79: 394-402.

Sjöden G O J, Lundberg A, Blomgren G A. Late results of the Souter-Strathclyde total elbow prosthesis in rheumatoid arthritis. 6/19 implants loose after 5 years. Acta Orthop Scand 1995; 66: 391-4.

Verstrecken F, De Smet L, Westhovens R, Fabry G. Results of the Kudo elbow prosthesis in patients with rheumatoid arthritis: a preliminary report. Clin Rheumatol 1998; 17: 325-8.