Comparison of two types of ulnar component in type-5 Kudo total elbow arthroplasty in patients with rheumatoid arthritis

A LONG-TERM FOLLOW-UP

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The purpose of this study was to assess the long-term results (more than ten years) of two types of cemented ulnar component with type-5 Kudo total elbow arthroplasty in a consecutive series of 56 patients (60 elbows) with rheumatoid arthritis, and to compare the results in elbows above and below a Larsen grade IV.

There was no radiolucency around the humeral component. Patients in whom a metal-backed ulnar component and a porous-coated stem were used had better clinical results and significantly less progression of radiolucent line formation around the ulnar component. They also had a significantly better long-term survival than patients with an all-polyethylene ulnar component. The clinical results of arthroplasty using all-polyethylene ulnar components were inferior, regardless of the degree of joint destruction.

We conclude that the type-5 Kudo total elbow arthroplasty with cementless fixation of the porous-coated humeral component and cemented fixation of a metal-backed ulnar component is acceptable and well-tolerated by rheumatoid patients.

Improvements in design of total elbow replacements in the last 30 years have produced better functional results in patients with rheumatoid arthritis.¹

Because of problems with the type-4 Kudo prosthesis (Biomet, Swansea, UK),² which had been modified to decrease loosening of the humeral component of the type-3 design,³ a humeral component with a long porous stem, the type-5⁴ unlinked prosthesis (Biomet), was developed for cementless fixation. Two types of ulnar component are available. An all-polyethylene version with a short stem has the advantage of durability because of its thicker polyethylene layer. In addition, there is a component of the same shape which is made of high-density polyethylene, but with a metal-backed support and a titanium porous-coated surface. This uses the load-diffusing effect of the metal backing⁵ to prevent edge loading of the elbow from being transferred more directly to the bed around the ulnar component. However, the metal-backed component does not have optional locking systems for use when the ulnar component is not firmly fixed. The indications for its use without cement are limited to joints with good-quality bone stock.⁴ However, it has also been used with cement by many surgeons.⁶⁻⁹ It may be appropriate to use a cemented, metal-backed ulnar component for rheumatoid elbows of Larsen¹⁰ grade IV or

V, with advanced destruction of the joint, and the all-polyethylene component for elbows of Larsen grade III.

The aim of the present study was to assess the long-term results of the type-5 Kudo total elbow arthroplasty with cemented fixation of the metal-backed and all-polyethylene components in a consecutive series of patients with rheumatoid arthritis, and to compare the results in elbows above and below Larsen grade IV.

Patients and Methods

The study was approved by the institutional ethics committee, and informed consent was obtained from each patient. Of the 57 patients with rheumatoid arthritis¹¹ who had undergone total elbow arthroplasty with a type-5 Kudo prosthesis and were initially enrolled in the study, one had died. The remaining 56 patients (60 elbows) were followed up at a mean of 11.5 years (10 to 13). There were eight men and 48 women. The mean age at the time of the operation was 57 years (39 to 65). The mean duration of the rheumatoid disease and of elbow pain were 15 and 6 years, respectively. There were 32 right elbows and 28 left. All had Larsen grade III or worse. The operation was performed by one surgical team using either the metal-backed or the all-polyethylene ulnar component, randomly allocated,¹² a

Fig. 1

Photograph of a type-5 Kudo total elbow arthroplasty. The humeral component is made of cobalt-chrome alloy with half of the surface of the stem porous-coated with a plasma spray of titanium alloy and reinforcement of the junction of the humeral stem to the hollow cylinder, which has a porous-coated internal surface. The two types of ulnar component are shown, one made of high-density polyethylene with metal backing and a porous-coated stem, and one an all-polyethylene component.

method of unbiased allocation that ensures a balance between the two treatment groups with respect to suspected prognostic factors, namely Larsen grades IV or V and III.

Operative technique. Through a straight posterior midline incision, the fibrous arch proximal to the entry of the ulnar nerve at the cubital tunnel was released. A triangular-shaped flap with a distal base was raised in the triceps tendon. The head of the radius was excised. The radial and ulnar collat-

eral ligaments were transected to allow dislocation of the elbow joint and to gain satisfactory access to the interior of the joint. The orientation of the humeral and ulnar components and restoration of length were checked when the trial components were inserted into the prepared bed of bone in the humerus and ulna. The humeral component was then inserted without cement and with bone chips packed around it. The metal-backed or the all-polyethylene ulnar component (Fig. 1) was then cemented into place. The triceps tendon and the fascial layers were sutured meticulously. The ulnar nerve was transferred to an anterior subcutaneous position. After the operation the elbow was immobilised in 90° of flexion in a posterior splint for one week. Active and active-assisted exercises were then commenced.

Follow-up. The symptoms were assessed using the Mayo elbow performance score.¹³ The amount of radiolucency around the humeral and ulnar components was assessed, using the method previously described by Souter¹⁴ and Kudo and Iwano¹⁵ from four to six years after operation and at the time of the latest follow-up at ten to 13 years.

Statistical analysis. Statistical analysis was performed with one-way analysis of variance and the chi-squared test. Survivorship analysis using definite loosening and/or revision as the end point was by the method of Kaplan and Meier¹⁶ and the log rank test for statistical significance. The onset of pain and maximum radiolucency around the component were taken as evidence of definite loosening of the implant. All analyses were carried out using SPSS version 11.0 (SPSS Inc., Chicago, Illinois) with values of $p < 0.05$ being regarded as significant.

Table I. Clinical assessment of patients in the metal-backed (MB) and all-polyethylene (AP) groups

	Overall						Larsen grade IV or V ¹⁰						Larsen grade III ¹⁰					
	MB group			AP group			MB group			AP group			MB group			AP group		
	Pre-op	Post-op*	Post-op†	Pre-op	Post-op*	Post-op†	Pre-op	Post-op*	Post-op†	Pre-op	Post-op*	Post-op†	Pre-op	Post-op*	Post-op†	Pre-op	Post-op*	Post-op†
Number of elbows	30	30	30	30	29	26	19	19	19	19	18	16	11	11	11	11	11	10
Pain (points)																		
None (45)	0	20	12	0	20	6	0	13	8	0	12	4	0	7	4	0	8	2
Mild (30)	2	10	17	3	8	15	1	6	10	2	5	8	1	4	7	1	3	7
Moderate (15)	23	0	1	24	1	5	15	0	1	15	1	4	8	0	0	9	0	1
Severe (0)	5	0	0	3	0	0	3	0	0	2	0	0	2	0	0	1	0	0
Mean arc of movement in ° (points)	66	89	90	66	90	88	66	89	90	66	89	90	66	90	88	66	90	88
≥ 100 (20)	5	11	16	5	12	13	3	7	10	3	7	8	2	4	6	2	5	5
50 to 99 (15)	18	19	14	17	17	13	12	12	9	11	11	8	6	7	5	6	6	5
≤ 49 (5)	7	0	0	8	0	0	4	0	0	5	0	0	3	0	0	3	0	0
Stability (points)																		
Stable (10)	6	8	12	6	7	13	4	5	8	4	4	8	2	3	4	2	3	5
Moderately stable (5)	22	22	18	21	22	13	14	14	11	13	14	8	8	8	7	8	8	5
Grossly unstable (0)	2	0	0	3	0	0	1	0	0	2	0	0	1	0	0	1	0	0
Daily function (points)																		
Combing hair (5) 25	0	1	4	0	0	0	0	0	2	0	0	0	0	1	2	0	0	0
Feeding oneself (5) 20	0	12	14	0	12	10	0	8	9	0	7	6	0	4	5	0	5	4
Hygiene (5) 15	0	17	11	0	16	11	0	11	7	0	10	7	0	6	4	0	6	4
Putting on shirt (5) 10	28	0	1	27	1	5	18	0	1	17	1	3	10	0	0	10	0	2
Putting on shoes (5) 5	2	0	0	3	0	0	1	0	0	2	0	0	1	0	0	1	0	0
Mean total score (points)	42	81	79	43	80	72	42	81	79	43	80	71	43	80	79	43	80	74

* four to six years post-operatively

† ten to 13 years post-operatively

Table II. Radiographic assessment of patients in the metal-backed (MB) and all-polyethylene (AP) groups

	Overall series				Larsen grade IV or V ¹⁰				Larsen grade III ¹⁰			
	MB group		AP group		MB group		AP group		MB group		AP group	
	Post-operative*	Post-operative†	Post-operative*	Post-operative†	Post-operative*	Post-operative†	Post-operative*	Post-operative†	Post-operative*	Post-operative†	Post-operative*	Post-operative†
Number of elbows	30	30	29	29	19	19	18	16	11	11	11	10
Humeral component												
No radiolucent lines	30	30	29	26	19	19	18	16	11	11	11	10
Ulnar component†												
-	29	29	24	17	18	18	15	10	11	11	9	7
+	1	0	4	4	1	0	2	2	0	0	2	2
++	0	1	1	0	0	1	1	0	0	0	0	0
+++	0	0	0	5	0	0	0	4	0	0	0	1

* four to six years post-operatively

† ten to 13 years post-operatively

+ -, no radiolucent lines; +, radiolucent line in proximal portion only; ++, radiolucent line entirely surrounding mass of cement with a width of ≤ 1 mm; +++, radiolucent line entirely surrounding mass of cement and with a width of > 1 mm

Results

There were no differences before operation between the metal-backed and all-polyethylene groups in age, gender, the duration of the disease and elbow pain, the side involved, follow-up, levels of pain, range of movement, stability, function and the radiographic grade.

Clinical assessment (Table I). In the metal-backed group, pain decreased significantly ($p < 0.01$) after the operation. When last assessed, 12 elbows were pain free, 17 were mildly painful and one had moderate pain. The mean range of movement increased significantly ($p = 0.04$) compared with before operation. Instability was significantly ($p = 0.04$) corrected. There was significant improvement in daily function after ten to 13 years ($p < 0.01$) and in the Mayo score ($p = 0.007$) which had a mean of 79 points.

In the all-polyethylene group, pain had decreased significantly after operation at the intermediate ($p < 0.01$) and latest ($p < 0.05$) assessments. When last seen, six elbows were pain free, 15 were mildly painful, and five had moderate pain. There were significant improvements in movement ($p = 0.004$), stability ($p = 0.02$), and daily function at the latest assessment. The Mayo score was significantly increased at the intermediate ($p = 0.007$) and latest ($p = 0.02$) assessments, with a mean of 72 points at the latest follow-up.

The metal-backed group had a better clinical result than the all-polyethylene group for patients with Larsen grades IV or V and also for those with grade III.

Radiographic assessment (Table II). No humeral component showed evidence of loosening in either group. Only one ulnar component of the 30 elbows in the metal-backed group had developed a radiolucent line in the proximal portion at the intermediate assessment, and which entirely surrounded the cement with a width of ≤ 1 mm at the latest review.

The metal-backed group had less progression of radiolucent line formation around the ulnar component than the all-polyethylene group for patients with Larsen grades IV or V ($p = 0.04$ at the latest assessment) and also for those with grade III.

Fig. 2

Kaplan-Meier survivorship graph taking definite loosening and/or revision as the end-point, for the type-5 Kudo total elbow arthroplasty using the metal-backed or the all-polyethylene ulnar component in elbows with Larsen grades IV or V and III (MB, metal-backed; AP, all-polyethylene).

Survivorship. None of the patients in the metal-backed group but four of those in the all-polyethylene group required a revision for loosening of the ulnar component. Kaplan-Meier survival analysis with definite loosening indicated by pain and a prominent radiolucent line around the ulnar component and/or revision showed that survival of 100% at 13 years in the metal-backed group was significantly higher ($p = 0.04$) than the 72% (95% confidence interval (CI) 55 to 89) in the all-polyethylene group.

Three elbows with Larsen grade IV or V and one elbow with grade III changes in the all-polyethylene group required revision. A survival of 61% (95% CI 39 to 84) at 13 years for elbows in the all-polyethylene group with Larsen grade IV or V was the lowest. The survival for elbows in the all-polyethylene group with grade III changes was 80% (95% CI 55 to 105) at 13 years (Fig. 2).

Complications. In two patients, one of Larsen grade IV or V in the metal-backed group and one of grade III in the all-

polyethylene group, superficial infection was observed initially but there were no subsequent infections. Two elbows, one of Larsen grade IV or V in the metal-backed group and one of grade IV or V in the all-polyethylene group, had symptoms of ulnar neuritis before the operation, but these resolved after the operation. No evidence of compromise of the ulnar nerve or of dislocation was seen.

Discussion

Kudo et al⁴ found the clinical results of total elbow arthroplasty using the type-5 Kudo prostheses to be satisfactory at a mean follow-up of four years. However, Willems and DeSmet⁷ noted that despite initial excellent results, at a longer mean follow-up of five years, the results of Kudo types-4 and -5 prostheses in rheumatoid patients showed deterioration of outcome and increased loosening.

Previous follow-up studies of the type-5 Kudo prosthesis at a mean of six years showed that radiolucencies were seen around the metal-backed⁶ and all-polyethylene⁹ ulnar cemented components in 11% and 22% of cases, respectively. Loosening of the humeral component was not seen in either of these studies. The authors^{6,9} suggested that loosening of the all-polyethylene ulnar component would be expected to cause deterioration in the long-term outcome, although there have, to the best of our knowledge, been no long-term prospective randomised studies in which the results using the two types of ulnar component have been compared.

Our study has shown that the clinical results of arthroplasty using the all-polyethylene ulnar component were inferior, regardless of the degree of joint destruction, and worse for elbows with Larsen grade IV or V changes. There was no difference between the rate of complications in patients who underwent total elbow arthroplasty using the metal-backed ulnar component and those with an all-polyethylene prosthesis. Cementless fixation of the humeral component and cementing of the metal-back ulnar component gave good results. However, the all-polyethylene component should not be used, especially in rheumatoid patients with advanced destruction of the elbow joint.

It has been reported that total elbow arthroplasties (Kudo, Capitelcondylar, GSBIII, Liverpool, Norway, Roper-Tuke, Souter-Strathclyde) have high rates of complications such as infection, ulnar nerve injury, dislocation and fracture.¹⁷ In the present series, two elbows had an early superficial wound infection, but no other notable complications were seen.

Dehiscence and superficial infection of the posterior skin incision will occur because it is difficult to consistently achieve sufficient correction of an elbow flexion contracture with an unlinked surface-replacement prosthesis; with these, prevention of dislocation is achieved by lengthening of the joint segment. Exploration and anterior transposition of the ulnar nerve may be essential in preventing its compromise after total elbow arthroplasty. Correct orientation of the components and restoration of length, without preservation of the anterior oblique component of the ulnar

collateral ligament,³ are important in preventing dislocation. A structural feature of the Kudo prosthesis, which prevents mediolateral movement in the absence of the ulnar collateral ligament,⁴ might also be important.

It has been suggested that an elbow articulation is subjected to excessive edge loading because of the variation in the axes of flexion of the elbow.¹⁸ Hence, prevention of loosening of the humeral component might depend on the use of a long porous stem with a load-bearing effect,¹⁹ this might raise the possibility of stress shielding of the surrounding bone.

The low incidence of radiolucency around the metal-backed ulnar components might be explained by the higher ratio of elbows with Larsen grade III to those with grade IV or V, than in other studies^{6,7} and to the load-diffusing effect of the metal backing.⁵

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