Total elbow replacement using the Kudo prosthesis

CLINICAL AND RADIOLOGICAL REVIEW WITH FIVE- TO SEVEN-YEAR FOLLOW-UP

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Between 1993 and 1996, we undertook 35 Kudo 5 total elbow replacements in a consecutive series of 31 rheumatoid patients. A total of 25 patients (29 procedures) was evaluated at a mean follow-up of six years (5 to 7.5) using the Mayo Clinic performance index. In addition, all patients were assessed for loosening using standard anteroposterior and lateral radiographs.

At review, 19 elbows (65%) had either no pain or mild pain, ten (35%) had moderate pain and none had severe pain. The mean arc of flexion/extension was 94˚ (35 to 130) and supination/pronation was 128˚ (30 to 165).

A fracture of the medial epicondyle occurred during surgery in one patient. This was successfully treated with a single AO screw and a standard Kudo 5 implant was inserted. Postoperatively, there were no infections. One patient had a dislocation which was treated by closed reduction and five had neurapraxia of the ulnar nerve.

Radiologically, there was no evidence of loosening of the humeral component, but two ulnar components had progressive radiolucent lines suggestive of loosening. Two other ulnar components had incomplete and non-progressive radiolucent lines. With definite radiological loosening as the endpoint, the probability of survival of the Kudo 5 prosthesis at five years using the Kaplan-Meier method was 89%.

Although the early clinical results of total elbow replacements have been very encouraging, the high rate of complications, particularly aseptic loosening, has reduced enthusiasm for this procedure. More recently, modern designs have been shown to give more reliable results for relief from pain and preservation of movement of the elbow in the treatment of patients with advanced rheumatoid arthritis. Ten-year results are now available for linked prostheses such as the Coonrad-Morrey (Zimmer) and GSB 3 (Sulzer) implants.

The Kudo total elbow replacement, which is an unlinked prosthesis, was first inserted as an unstemmed surface replacement.1 The design of the implant has undergone several revisions since that time and in 1999 Kudo, Iwano and Nishino2 reported their experience with the Kudo 5 prosthesis with a mean follow-up of 3 years 10 months.

Our study represents the longest reported clinical follow-up of the Kudo 5 prosthesis. A minimum five-year evaluation has been carried out. Survivorship of the prosthesis has been assessed using loosening of the implant as the endpoint.

Patients and Methods

Since 1993, we have inserted 91 primary Kudo 5 total elbow arthroplasties with eight patients undergoing staged, bilateral procedures. Four replacements were for trauma with a further seven for osteoarthritis. The remaining 80 were undertaken for rheumatoid arthritis. We have identified 33 consecutive patients (37 elbow arthroplasties) with a minimum follow-up of five years. Two could not be traced and therefore 31 patients with 35 elbow arthroplasties have been evaluated and form the basis of this study.

All patients had radiological changes of Larsen grade IV or grade V3 and met the diagnostic criteria of the American Rheumatism Association.4 The indication for surgery was intractable pain leading to loss of function.

The mean age of the patients at the time of surgery was 60 years (37 to 79) with a mean length of postoperative follow-up of 6 years 2 months (5 to 7.5).

At review, all patients were assessed by the Mayo Clinic performance index (Table I).5 In addition, anteroposterior (AP) and lateral radiographs of the elbow were evaluated for position of the implant, the cement mantle, radiolucent lines, bone resorption and osteolysis (Fig. 1).

A life table was constructed and Kaplan-Meier survival analysis undertaken using definite radiological loosening.
and/or revision as the endpoint to give survival figures at five years.

**Operative technique.** All procedures in the study were undertaken or supervised by the senior author (DS). The posterior approach originally described by Bryan and Morrey\(^6\) was used initially, although more recently the implants have been inserted using the approach of Shahane and Stanley.\(^7\) This technique allows mobilisation of the ulnar nerve with its deep soft-tissue bed, but does not involve anterior transposition of the nerve. The medial and lateral collateral ligaments were released from their humeral attachments to allow soft-tissue balancing after insertion of the prosthesis. In addition, the radial head was resected and, if present, exuberant synovitis was excised.

After preparation of the bone, bone plugs were inserted into the humeral shaft and both components were implanted with Palacos cement inserted retrogradely using a cement gun.

After closure, the elbow was rested in a backslab in extension for four days before active mobilisation was begun. No splints or braces were used in the rehabilitation period to protect the soft tissues.

**Results**

Of the 31 patients initially identified for inclusion in the study, four had died and two were unavailable for review because of serious medical illness. The remaining 25 patients (29 elbows) underwent complete clinical and radiological assessment. There were five men and 20 women.

At review, ten elbows were free from pain, nine had mild pain and ten had moderate pain. No patient had severe pain.

The mean arc of flexion/extension was 94˚ (35 to 130) and that of pronation/supination 128˚ (30 to 165).

Function was assessed with regards to activities of daily living, in accordance with the Mayo Clinic performance index (Table I).

One patient sustained an intraoperative fracture of the medial condyle of the distal humerus during insertion of the implant. This was successfully stabilised using a single, small-fragment AO screw.
Postoperatively, five patients had neurapraxia of the ulnar nerve. This occurred in the early part of the study when experience was being gained with the prosthesis. In four, symptoms resolved within six months, but the remaining patient had persistent paraesthesiae in the distribution of the ulnar nerve.

Clinically, three elbows (three patients) had some valgus/varus instability (Fig. 2). One patient required a closed reduction of a dislocated prosthesis after a spontaneous dislocation while in bed, but had no further dislocations. The other two patients described their elbows as feeling slightly unstable, although this did not limit function.

Radiologically, no humeral component showed evidence of loosening. Two ulnar components had progressive wide lucent lines with bone resorption around the entire implant and migration of the ulnar stem (Fig. 3). The early postoperative radiographs of these elbows did not show any evidence of radiolucent lines. Two further ulnar components were noted to have incomplete radiolucent lines, which were present on the postoperative radiographs and did not appear to be progressive.

Correlation of the radiological and clinical findings showed that both elbows with radiological evidence of loosening were moderately painful on clinical assessment. These ulnar components were considered to be clinically and radiologically loose. It was not clear from the review why a further eight patients had moderate pain, except that this may be a feature of the generalised rheumatoid disease.

None of the patients have had revision surgery after their index procedure. The onset of pain and radiological evidence of progressive radiolucent lines were taken as evidence of loosening of the implant. Kaplan-Meier survival analysis with loosening as the endpoint showed survival of 89% at 81 months with an SEM of 79% to 99% (Fig. 4).

Discussion

Modern designs of total elbow replacement are either linked or unlinked. Both are popular. Of the linked designs, good long-term results have been reported for the Coonrad-Morrey and GSB prostheses.8-12 These studies are, however, from the centres where the prostheses were designed.
and published evidence from other centres to confirm the reproducibility of this experience is still awaited. The Kudo 5 prosthesis is an unlinked implant which has been shown by its designer to give good short-term results. The potential advantages of an unlinked resurfacing design include preservation of bone stock and a more anatomical articulation. Since the balance and stability of the artificial joint rely on the surrounding soft tissues rather than on the hinge of a linked implant, the theoretical risk of excessive torsional forces leading to aseptic loosening is also lower. There are, however, no published long-term outcomes of the Kudo 5 prosthesis. Our study has a minimum follow-up of five years and represents the longest reported experience with this prosthesis.

With respect to range of movement, both our results and those of Kudo et al2 are similar. With regard to relief from pain, in the study of Kudo et al2 all patients had either no or mild pain. Our results are less satisfactory with only 64% of patients falling into those groups, while 36% had moderate pain. Although levels of pain are always somewhat difficult to determine accurately, the difference in the results may represent the longer follow-up period of the patients in our study. In addition, the pain experienced by two of the patients could be related to the presumed loosening of the ulnar component.

It should be noted that the operative technique of Kudo et al2 did not involve cementing any humeral components, although 32 of the 43 ulnar components were cemented. By contrast, in our series both the humeral and ulnar components were cemented.

Humeral loosening was not observed in either study. Kudo et al2 had partial radiolucent lines around six cemented ulnar components with lucency around the entire ulnar component in one implant. We observed progressive lucent lines around two ulnar components with an additional two ulnar components having non-progressive radiolucent lines.

Loosening of total elbow replacements has been observed on the humeral side with the tip of the humeral component displacing anteriorly and the articulation posteriorly.13,14 The resultant forces on the articulation during flexion and extension (predominantly posteriorly directed) are thought to be responsible for this displacement. It is of interest that in both studies humeral loosening was not observed.

The aseptic loosening of the ulnar component seen in two patients in our study, together with the observation of ulnar radiolucent lines observed in both studies warrants discussion. It is possible that the loose components which we have observed are merely a feature of a longer follow-up. Alternatively, they may represent a characteristic pattern of aseptic loosening related to the design of the Kudo prosthesis.

We suggest that with modern elbow replacements, accurate positioning and fixation of the implant are associated with low rates of aseptic loosening. If orientation of the humeral component, with respect to either the position of the stem or the level of the articular axis in relation to the anatomical axis of movement, is incorrect, then loosening of the humeral component may be expected because of the resultant forces during flexion and extension. If humeral positioning and fixation are satisfactory then it is our view that a different pattern of loosening may occur resulting in loosening of the ulnar rather than the humeral component. Alternatively, it is possible that loosening of the ulnar component with the Kudo prosthesis may be related to the valgus tilt sometimes seen on postoperative radiographs. This loss of the normal ulnohumeral orientation is, we believe, associated with a risk of edge loading, wear and consequent loosening (Fig. 5).

Assessment of survival of the implant, using definite clinical and radiological evidence of loosening as the endpoint, gave a survival rate of 89% with a standard error of 79% to 99%. We believe that this is comparable to the results achieved with other unlinked implants.14-16

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


