The Kudo 5 total elbow replacement in the treatment of the rheumatoid elbow

RESULTS AT A MINIMUM OF TEN YEARS

Between September 1993 and September 1996, we performed 34 Kudo 5 total elbow replacements in 31 rheumatoid patients. All 22 surviving patients were reviewed at a mean of 11.9 years (10 to 14). Their mean age was 56 years (37 to 78) at the time of operation. All had Larsen grade IV or V rheumatoid changes on X-ray. Nine (three bilateral replacements and six unilateral) had died from unrelated causes. One who had died before ten years underwent revision for dislocation.

Of the 22 total elbow replacements reviewed six had required revision, four for aseptic loosening (one humeral and three ulnar) and two for infection. Post-operatively, one patient had neuropraxia of the ulnar nerve and one of the radial nerve. Two patients had valgus tilting of the ulnar component.

With revision as the endpoint, the mean survival time for the prosthesis was 11.3 years (95% confidence interval (10 to 13)) and the estimated survival of the prosthesis at 12 years according to Kaplan-Meier survival analysis was 74% (95% confidence interval 0.53 to 0.91).

Of the 16 surviving implants, ten were free from pain, four had mild pain and two moderate. The mean arc of flexion/extension of the elbow was 106° (65° to 130°) with pronation/supination of 90° (30° to 150°) with the joint at 90° of flexion. The mean Mayo elbow performance score was 82 (60 to 100) with five excellent, ten good and one fair result.

Good long-term results can be expected using the Kudo 5 total elbow replacement in patients with rheumatoid disease, with a low incidence of loosening of the components.

Modern designs of total elbow replacement (TER) are either linked1-3 or unlinked4-6 with some having the ability to be inserted in either capacity, the so-called convertible prostheses.7-8 Although all modern prostheses reduce pain and improve function, the long-term outcomes are less clear with few peer-reviewed reports in the literature.1,9,12

Gill and Morrey1 published their experience of the Coonrad-Morrey linked TER (Zimmer, Warsaw, Indiana) in rheumatoid patients with a follow-up of ten to 15 years and Gschwend et al9 described the long-term results of the GSB III linked prosthesis. More recently, Tanaka et al10 have recorded their experience with the unlinked Kudo 5 (Biomet UK Ltd, Swindon, United Kingdom) prosthesis with a mean follow-up of 11.5 years, and Aldridge et al11 have published their survival analysis of the Coonrad/Coonrad-Morrey prosthesis at ten to 31 years. These long-term studies, however, are from orthopaedic units where the prostheses were developed and as such may not be representative of results achieved elsewhere.

In order to determine whether our experience of the Kudo 5 TER in the treatment of end-stage rheumatoid arthritis of the elbow was consistent with that reported by Kudo himself, we have retrospectively reviewed all our patients with a minimum follow-up of ten years. We used revision for any reason as the endpoint to analyse the survival of the implant in the 22 patients.

Patients and Methods

Between September 1993 and September 1999 we performed 34 Kudo 5 TERs on a consecutive series of 31 rheumatoid patients. At a minimum follow-up of ten years nine patients (three with bilateral replacements and six with unilateral) had died from unrelated causes leaving 22 surviving patients. There were 20 women and two men with a mean age at the time of TER of 56 years (37 to 78). All underwent a clinical and radiological review. Each was independently assessed by a surgeon who had not been involved in the initial procedure (FQ, KPD). All the patients had a radiological grade of IV or V according to the criteria of

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Larsen, Dale and Eek\textsuperscript{13} and met the diagnostic criteria of the American Rheumatism Association.\textsuperscript{14} The indication for surgery was intractable pain and to loss of function. There were no exclusion criteria.

At a mean follow-up period of 11.9 years (10.0 to 14.0) clinical review was undertaken using the Mayo elbow performance score,\textsuperscript{15} and anteroposterior (AP) and lateral radiographs were taken to determine failure of the implant.

A life-table was constructed and a Kaplan-Meier survival analysis performed using revision for any cause as the endpoint.

**Operative technique.** All TERs were performed or supervised by the senior author (DS). A posterior triceps reflecting approach was used initially,\textsuperscript{16} but was then modified to allow decompression of the ulnar nerve without anterior transposition.\textsuperscript{17} This change was instituted as the senior author felt that there was less risk of ulnar nerve complications with simple decompression and anterior transposition.

Bony preparation of the humerus and ulna was undertaken as described by Tanaka et al.\textsuperscript{10} The collateral ligaments were only released to achieve soft-tissue balancing so that when the trial components were inserted the elbow could be flexed and extended without instability. If released they were not routinely repaired. Plugs prepared from the resected bone were inserted into the humeral shaft as a cement restrictor. Cement restriction was not used in the ulna. The humeral and metal-backed ulnar components were then sequentially inserted with Palacos cement (Heraeus Medical GmbH, Wehrheim, Germany) using a cement gun.

Post-operatively, the elbow was rested in an above-elbow backslab in extension for four days followed by active mobilisation. No splints or braces were used.

**Results**

We were unable to obtain data relating to the nine patients who died, partly because of the interval between death and the time of the review. In addition, in 2004 our institution changed computer systems and the records and radiographs of patients who had already died at that time had been destroyed.

However, we could identify the date of death and cross check this against the date of the TER in order to determine if the implant had been revised. Using this approach we were able to identify one patient who had undergone a revision for dislocation.

The details and Mayo performance scores of the 22 patients reviewed are shown in Table I. Of the 16 surviving arthroplasties, ten elbows were free from pain, four had mild pain and two moderate. The mean arc of flexion/extension was 106° (65° to 130°) and pronation/supination was 90° (30° to 150°) with the elbow at 90° of flexion. The mean Mayo Elbow Performance score was 82 (60 to 100) with five excellent, ten good and one fair result.

Survival analysis was determined for the 22 patients with revision for any cause as the endpoint. The mean survival time was 11.3 years (95% confidence interval (CI) 10 to 13) and the estimated survival of the prosthesis of 12 years according to Kaplan-Meier was 74% (95% CI 0.53 to 0.91) (Fig. 1).

<table>
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<th>Case</th>
<th>Gender</th>
<th>Age (yrs)</th>
<th>Follow-up (mths)</th>
<th>Side</th>
<th>Range of flexion/extension (°)</th>
<th>Pain</th>
<th>Mayo score</th>
<th>Revision</th>
<th>Time to failure (mths)</th>
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Complications. Six patients had a revision procedure, in three for ulnar and in one for humeral aseptic loosening, and in two for infection. The mean time to revision was 6.3 years (1.0 to 11.0). All the revision procedures were performed using the Coonrad-Morrey arthroplasty and, with the exception of the infected cases, were undertaken as a one-stage procedure. The two patients with infection were revised in two stages. Stage one involved removal of the implant and all of the cement together with the insertion of antibiotic beads. In stage two these were removed and the revision prosthesis inserted.

Post-operatively one patient had a neuropraxia of the ulnar nerve and another had a neuropraxia of the radial nerve. This patient was thin and we suspect that the neuropraxia may have resulted from pressure on the nerve by the tourniquet. Both recovered within six months of surgery. There were no dislocations.

Radiological analysis. The radiographs of 12 patients were considered to be satisfactory with no evidence of loosening or valgus tilting (Fig. 2). Progressive radiolucent lines (measured on serial radiographs) > 1 mm wide were seen around one humeral (Fig. 3) and three ulnar components (Fig. 4). All of these patients had a revision procedure. Two patients had incomplete non-progressive radiolucent lines on the ulnar side of the joint which had remained unchanged since the time that the initial post-operative radiographs had
been taken. Valgus tilting of the ulnar component was present in two of the three TERs which underwent revision and at operation this was thought to be due to wear of the high-density polyethylene of the ulnar component. In addition, valgus tilting was noted on two further AP radiographs (Fig. 5). At the time of review these patients were relatively asymptomatic, but have been under continuing review. They are currently not awaiting revision.

Discussion
In a comprehensive review of TER in the English-language literature Little, Graham and Carr,18 noted that of 3618 implantations the mean weighted follow-up was only 60 months. As such the long-term outcome of TER is unclear with few peer-reviewed reports in the literature. When long-term outcome studies have been published,1,9-12,19 most have been at institutions where the prostheses were developed.

Gschwend et al9 using the GSB linked prosthesis reported survival of the implant of 87.7% at a mean follow-up of 13.5 years. Similar excellent results with linked arthroplasties have been reported by Gill and Morrey1 using the Coonrad-Morrey TER with a follow-up of ten to 15 years and by Aldridge et al11 who reported a survival analysis of the Coonrad/Coonrad-Morrey prosthesis of ten to 31 years.

Unlinked prostheses have also been reported to give good results with a number of studies reporting a survival of the Souter-Strathclyde prosthesis (Stryker UK, Newbury, United Kingdom) of five to ten years.4,5,12,19,20 Khatri and Stirrat4 using revision as the endpoint reported a survival of 75% at nine years while van der Lugt et al5 gave a survival rate of 77% at ten years. Trail et al20 reported a survivorship of 87% at 12 years after the insertion of 186 Souter-Strathclyde prostheses. They noted that 75% of the 24 revisions in their study were for humeral problems.

There are, however, fewer reports in the literature of the outcome of the Kudo TER.6,10,21-26 Little et al26 compared the outcome of the Kudo prosthesis with that of the Souter-Strathclyde and the Coonrad-Morrey implants at a follow-up of between 61 and 68 months. They found that all three implants had similar functional results in terms of relief from pain and range of movement and that, despite the Coonray-Morrey prosthesis having a linked mechanism, it
did not have an increased risk of loosening. More recently a two-centre study of the Kudo 5 arthroplasty with a follow-up of two to 11 years suggested very encouraging functional results with survival of 86% of the implant at 100 months. Our own study with a follow-up of ten to 14 years, gives a survival of 74% at 12 years and suggests progressive failure with time. The results from both these studies, unfortunately, do not match those from the institution where the arthroplasty was developed.

Tanaka et al\textsuperscript{10} reported the long-term results of the Kudo type 5 TER and compared the outcome of all-polyethylene cemented ulnar component with that of the metal-backed cemented ulnar component. They found a survival rate of 100% at 13 years of the metal-backed ulnar component compared with only 72% with the all-polyethylene prosthesis (p = 0.04).

Our study showed a mean survival time of 11.3 (95% CI 10 to 13) years with a Kaplan-Meier survival analysis of 74% (95% CI 0.53 to 0.91). This difference in outcome compared with that obtained by Tanaka et al\textsuperscript{10} may be due to either minor differences in surgical technique or simply represents the differences which can be expected when surgery is performed by an implant designer compared with a regular TER user.

It should be noted that in our study three of the four revisions performed for aseptic loosening had loose ulnar components. This pattern of loosening is in contrast to that seen with early designs of TER in which humeral loosening was the cause of failure. The proximal tip of the humeral prosthesis classically migrated anteriorly with the axis moving posteriorly. This loosening pattern occurred as the result of the predominantly posteriorly-directed joint resultant force during flexion and extension of the elbow. The humeral component of the Souter-Strathclyde prosthesis migrates with external rotation with an anterior and varus tilt.\textsuperscript{28}

There seems recently, however, to have been a shift in the pattern of aseptic loosening from the humeral to the ulnar component.\textsuperscript{6,11,13} This may in part be due to more accurate positioning of the humeral component such that the anatomical axis of movement is more closely replicated, but may also be related to the design of modern humeral prostheses. The early designs of TER achieved fixation of the humeral component either by having a humeral articulation which fitted over the remnant of the distal humerus or by the use of an intramedullary stem. In both situations, with or without the use of cement, there was essentially only one feature of the humeral design which helped to resist posteriorly-directed forces during flexion and extension. The modern linked and unlinked implants with the longest follow-up and lowest rates of humeral loosening have two methods of humeral fixation, stem and distal articular cover (Kudo, GSB) or stem and anterior flange (Coonrad-Morrey). The Souter-Strathclyde humeral prosthesis has small flanges which fit within the distal humerus and an intramedullary stem of variable length.

It would appear that an appropriate design and positioning of the humeral component are essential to reduce the risk of aseptic loosening. However, even if these criteria are met the risk does not appear to be eliminated. The increased frequency of loosening of the ulnar component which we and others have observed\textsuperscript{6,11,13} suggests that with a well-positioned and well-fixed humeral component the loosening forces are transmitted from the humeral to the ulnar side of the joint resulting in failure of the ulnar component. An explanation for this observation has recently been advanced by Cheung and O’Driscoll\textsuperscript{29} who identified pistoning of the ulnar component as a cause of loosening of the Coonrad-Morrey prosthesis. This same principle may also be the explanation for loosening of the ulnar component with other prostheses. They stated that to reduce the risk of this complication it is important to trim coronoid and olecranon osteophytes.\textsuperscript{29}

Our experience suggests that good long-term results with a low incidence of loosening of the humeral and ulnar components can be expected when the Kudo 5 TER is used to treat rheumatoid disease of Larsen grade IV or grade V.\textsuperscript{13} We would advise particular care when inserting both the trial and definitive components in order to be certain that there is no anterior impingement on flexion of the elbow or posterior impingement with extension. If this is not avoided pistoning of the ulnar component may occur with loosening of the implant.

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


