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ORIGINAL ARTICLE

Linked semiconstrained and unlinked total elbow replacement in juvenile idiopathic arthritis: a case comparison series with mean 11.7-year follow-up

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Background: Few series report the results of total elbow replacement (TER) in patients with juvenile idiopathic arthritis (JIA). Most report the use of a linked implant. There are theoretical benefits to using an unlinked prosthesis, and thus we report our experience of the clinical benefit and survivorship of both this implant and a linked semiconstrained prosthesis.

Methods: There were 21 elbows replaced in 14 JIA patients (12 women and 2 men; 14 unlinked, 7 linked). Mean age at surgery was 39.5 years (range, 26-52 years). Mean clinical follow-up was 11.7 years (range, 5.4-17.6 years).

Results: Reoperation, including implant revision, was required in 9 elbows (42.9%). Using revision as an end point, survivorship was 95% (95% confidence interval [CI], 74%-99%) at 5 years and 68% (95% CI, 45%-86%) at 10 years. The 10-year survival was 70% (95% CI, 40%-89%) for the unlinked group and 69% (95% CI, 28%-94%) for the linked group. The need for bilateral TER was found to be a risk factor for revision within 10 years of primary surgery (6/11 vs. 0/7 elbows; $P = .037$). The rate of aseptic loosening seen on radiographs was high in the unlinked group (12/14, 85.7%), but many of these patients continue to function well without need for revision.

Conclusion: Both the unlinked Kudo 5 and linked Coonrad-Morrey prostheses for TER can provide benefits in the long-term for most patients with JIA. The need for bilateral TER in this group is associated with higher rate of revision at 10 years.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

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Juvenile idiopathic arthritis (JIA) is defined as persistent arthritis of unknown etiology that begins before the age of

The subjects of this retrospective study of anonymized existing data were all UK NHS patients who had surgery in a single institution. NHS Research and Ethics Committee approval was deemed not necessary according to NHS Health Research Authority criteria.

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16 years, persists for at least 6 weeks, and cannot be explained by any other cause. It is the most common chronic rheumatologic disease in children, with an incidence of 1 per 10,000 every year.¹ The elbow is affected in 20% to 70% of patients, manifesting as pain, swelling, and stiffness eventually leading to severe joint destruction, soft tissue contractures, and abnormalities of growth.¹ Before advancements in disease-modifying medications, patients traditionally required multiple elbow operations throughout their

lifetime, with options including synovectomy with or without radial head excision, interposition arthroplasty, and total elbow replacement (TER).²⁰ Although functional outcomes of TER in inflammatory arthritis are thought to be as good as in non-inflammatory arthritis, the juvenile group is thought to do comparatively worse because of the usual early requirement for replacement and aggressive nature of the disease.^{8,12} Furthermore, arthroplasty can be technically difficult in these patients as they often have small and variably shaped osseous anatomy as well as significant soft tissue contracture.⁶ Such changes are due to the effect of an active inflammatory arthritic process on the growing skeleton that makes the juvenile idiopathic disease different from adult inflammatory arthritis when a normal skeleton has developed before the onset of the disease.¹⁵

To our knowledge, there are only 2 published series reporting the results of TER in patients with JIA exclusively, and both originate from the Mayo Clinic (Rochester, MN, USA).^{4,5} Baghdadi et al recently reported long-term follow-up of 24 patients (29 elbows) using a linked semiconstrained prosthesis.⁴ Sixteen years earlier, Connor and Morrey first reported the outcome of TER in 19 patients (24 elbows) with JIA. Whereas the majority of patients in this series received a linked semiconstrained design, an unlinked resurfacing-type implant was used in 6 elbows.⁵ Dennis et al also reported the results of 6 unlinked TERs in a subset of patients with JIA as a part of a larger series of patients with rheumatoid arthritis.⁷ We believe that these 2 studies remain the only published experience of using unlinked TER in JIA to date.

The purpose of this study was to report our experience of TER in this complex group of patients, with emphasis on the results of an unlinked design.

Materials and methods

We identified consecutive patients with JIA who underwent TER at our institution from 1997 to 2007 through our arthroplasty database. The decision to proceed to TER was based on pain, limited movement, or elbow instability prohibiting normal daily function, combined with Larsen grade 4 or 5 changes on plain radiography.¹¹ Where there was sufficient bone and soft tissue support, the unlinked Kudo 5 prosthesis (Biomet UK Ltd, Swindon, UK) was used (unlinked group). In elbows with significant bone loss, potential soft tissue compromise, and instability, the semiconstrained Coonrad-Morrey prosthesis (Zimmer, Warsaw, IN, USA) was used (linked group). All preoperative radiographs were then templated, and if necessary, smaller customized implants were requested from the manufacturer to account for small skeletal stature. All procedures were performed by the senior author.

Operative technique

The patient was placed in the lateral decubitus position. A posterior midline skin incision was made and Newcastle approach performed.³ The radial head (if present) was resected, and the ulnar nerve was decompressed within the cubital tunnel and within the

2 heads of flexor carpi ulnaris up to the level of the first motor branch and protected throughout the procedure but not transposed. Soft tissue releases were performed to gain adequate access, including release of the medial collateral ligament in its entirety irrespective of which type of implant was being inserted. The intramedullary canal of the humerus and ulna was identified, opened using a burr, and expanded with a malleable plastic sucker to prevent breach of the potentially thin and fragile cortical bone. Once the intramedullary canal was satisfactorily exposed, it was enlarged carefully with a burr together with solid and flexible metal reamers. Trial components were inserted, checking specifically for range of movement, tracking, and stability. Bone plugs were used as cement restrictors, and antibiotic-loaded cement was routinely inserted using a cement gun with a delivery system that accommodated the small intramedullary canals present in this group of patients. Postoperatively, a nocturnal thermoplastic extension splint was used for 4 weeks, with patients encouraged to perform active flexion during the day.

Data collection

Retrospective review of data routinely collected in our arthroplasty database was undertaken. Pain score, range of movement, function, stability, complications, and Mayo Elbow Performance Score (MEPS)¹⁴ were recorded preoperatively and then on a yearly basis postoperatively until latest follow-up or time of revision. A MEPS below 60 represents poor function, 60 to 74 is fair, 75 to 89 is good, and above 90 is excellent. In the instances in which a patient has moved away from our area, telephone consultation is routinely employed at our institution. When they were available, radiographs from the most recent clinic visit were assessed for signs of loosening, instability, fracture, and bushing wear (linked implants only).

Statistical analysis

Survivorship analysis was carried out by the Kaplan-Meier method, and survival probability estimates were compared between unlinked and linked groups using a nonstratified log-rank test. Preoperative and postoperative MEPS were compared using Student *t*-test. Comparison revision rates for patients with bilateral and unilateral disease as well as for those who did and did not have prior surgery were analyzed using Fisher exact test. A result was considered statistically significant when $P < .05$.

Results

There were 21 TERs performed in 14 patients (12 men, 2 women; [Table I](#) and [Supplementary Table I](#)). The dominant elbow was replaced in 10 of 21 cases. The mean age at diagnosis of JIA was 7 years (range, 4-13 years), whereas the mean age at TER was 39.5 years (range, 26-52 years). Nine patients (14 elbows) were included in the unlinked group and 5 patients (7 elbows) in the linked group, meaning that the proportion of patients who had bilateral TER was greater in the unlinked group (5/9 vs. 2/5). Of 21 elbows, 9 had undergone previous surgery (7 fascia lata interposition arthroplasty and 2 radial head excision plus synovectomy),

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