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The outcome of total elbow arthroplasty in juvenile idiopathic arthritis (juvenile rheumatoid arthritis) patients

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Background: Elbow prosthetic replacement in patients with juvenile idiopathic arthritis (JIA) can be complicated and technically challenging. Thus, we sought to evaluate the clinical benefit and the prosthetic longevity of primary semiconstrained linked total elbow arthroplasty (TEA) performed to treat these patients.
Methods: Between 1983 and 2005, 29 elbows in 24 patients (20 women and 4 men) had been replaced because of JIA. The mean age was 37 years (range, 24-68 years). Because of underlying deformity, the implant contour was modified for 9 elbows (31%) and a customized implant was inserted in 5 elbows (17%). The mean follow-up duration was 10.5 years (range, 4.6-20.1 years).
Results: During the follow-up period, 8 elbows underwent reoperation, including 6 (21%) that underwent implant revision. At most recent follow-up, 22 elbows (76%) subjectively had a satisfactory overall functional result. The mean Mayo Elbow Performance Score was 78 points (range, 50-100 points), with 18 elbows graded as having an excellent or good result. Compared with preoperative range of motion, the mean extension-flexion arc improved from 65° ± 44° to 89° ± 35° ($P = .01$), mean flexion improved from 113° ± 23° to 126° ± 26° ($P = .02$), and mean extension improved from 48° ± 25° to 37° ± 26° ($P = .08$). By use of the Kaplan-Meier survivorship method, the rate of TEA survival from any revision was 96.4% (95% confidence interval, 89.8%-100%) and 79.9% (95% confidence interval, 65.1%-97.5%) at 5 years and 10 years, respectively.
Conclusion: Primary TEA for JIA patients is technically challenging and frequently requires implant modification or custom designs. These patients might have high complication and revision rates. However, most benefit from the intervention for a long term.
Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Juvenile idiopathic arthritis; total elbow arthroplasty; semiconstrained linked design; outcomes

Juvenile idiopathic arthritis (JIA; formerly called juvenile rheumatoid arthritis [JRA]) is a devastating multifactorial disease with underlying genetic and environmental factors. Patients present with distinct patterns and clinical features. The disease shows different patterns of presentation that start before the age of 16 years and persists for at

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least 6 weeks in the absence of a known etiology. These patterns include systemic arthritis, oligoarthritis (≤4 joints), and polyarthritis (>4 joints).[19] The aggressive nature of the disease with multiple-joint involvements and soft-tissue damage may necessitate joint replacement during the early decades of a patient's life. The elbow might be involved with the disease, and the damage can be extensive. Patients typically complain of persistent pain and progressive loss of motion. Total elbow arthroplasty (TEA) in these patients can be technically difficult and challenging because of unusual deformity, small anatomy, a narrowed medullary canal, severe stiffness, and soft-tissue contracture.[4,5,8] TEA is not commonly performed for arthritis associated with JIA. It is usually indicated when the medical treatment fails to halt the disease progression and the patient has considerable pain and functional disability. Connor and Morrey[4] reported on 24 elbows with JIA that underwent TEA with the use of linked and unlinked designs. To our knowledge, no other series in the English-language literature have described the outcome of TEA in JIA patients with a special emphasis on the linked design.

The purpose of this study was to determine the clinical results and implant longevity in patients who were treated with a primary semiconstrained linked TEA for end-stage JIA.

Materials and methods

We queried the joint registry at the Mayo Clinic[1] and identified a total of 52 elbows that underwent TEA for end-stage JIA with the use of semiconstrained linked prostheses. We included in our study patients who underwent primary replacement and patients who had an established JIA diagnosis in their medical records. The diagnosis of the JIA had been made according to the formerly described principles.[2,17] After we applied our inclusion and exclusion criteria, 29 elbows in 24 patients constituted our study cohort. A group of these patients have been reported on in the literature as part of other series for different research purposes.[3,4,16] However, each of these patients was independently reassessed to specifically determine the clinical benefit and the survival rate in patients who underwent primary TEA using the linked design for end-stage JIA.

Patient characteristics, the presence of pain, and range of motion were obtained through patients' records before and after the arthroplasty. The operative technique (implant design, fixation technique, and implant modification) and intraoperative range-of-motion assessment were recorded. Additional operations including revision with component exchange were also reviewed.

At our institution, the follow-up was carried out at regular intervals. It was performed twice during the first year, at 2 years, at 5 years, and then every 5 years. Patients had been requested to complete a standardized elbow questionnaire and have radiographs obtained. The questionnaire included components of the standardized Mayo Elbow Performance Scoring system. The Mayo Elbow Performance Score (MEPS) was calculated at the most recent clinical evaluation using the questionnaire. The results were graded as excellent, good, fair, or poor according to this system.[14]

Radiographs were assessed before the replacement and graded regarding the severity of joint destruction[4] as follows: grade I, no radiographic changes except periarticular osteopenia; grade II, narrowing of the joint space with intact joint architecture; grade III, joint architecture alteration, whether mild (A) or moderate (B); grade IV, gross destruction of the joint; and grade V, ankylosis.

Radiographs were also evaluated immediately after the replacement for the cementing technique,[15] which was considered adequate, marginal, or inadequate. The cementation was considered adequate when the radiolucent zone at the bone-cement interface was less than 1 mm wide and the cement extended past the tip of the prosthesis. It was considered marginal when the radiolucent zone at the bone-cement interface was 2 mm wide and the cement extended past the tip of the prosthesis or when the radiolucent zone at the bone-cement interface was less than 2 mm wide and the cement did not extend past the tip of the prosthesis. It was considered inadequate when the radiolucent zone at the bone-cement interface was 2 mm wide or greater and the cement did not extend past the tip of the prosthesis.

At most recent follow-up, anteroposterior radiographs were evaluated for component loosening[18] and bushing wear.[12,18] The component loosening was evaluated by comparing the immediate postoperative radiographs with the latest radiographs. The progressive radiolucency was graded as follows: none; type I, a radiolucent line less than 1 mm wide that involved less than 50% of the bone-cement interface; type II, a radiolucent line at least 1 mm wide that involved less than 50% of the bone-cement interface; type III, a radiolucent line more than 1 mm wide that involved at least 50% of the bone-cement interface; type IV, a radiolucent line more than 2 mm wide around the entire bone-cement interface; or type V, a radiolucent line more than 2 mm wide around the entire bone-cement interface with shifting of the component.

The bushing wear was evaluated on the most recent anteroposterior radiograph.[12,18] Two intersecting lines were drawn: One was parallel to the yoke of the humeral component, and one was parallel to the medial or lateral articular surface of the ulnar component. An angle of intersection greater than 7° indicates changes in the bushings due to wear or plastic deformation. An angle greater than or equal to 10° indicates mild to moderate bushing wear.

Operative technique

The size and shape, as well as other anatomic deformities, make TEA a challenging procedure in patients with JIA. Preoperative planning is imperative. The surgeon should consider having specialized tools available, such as extra-small ulnar and humeral components, small cannulated flexible reamers, and large plate benders and diamond-tipped burs for implant modification. The humeral and ulnar intramedullary canals are characteristically narrow and may be obliterated by cortical bone especially the ulna (Fig. 1). The canal is carefully identified with a high-speed burr and entered using a flexible guide pin. If the canal is obliterated, a new canal must be created using a high-speed end-cutting burr. The canals are then sequentially reamed using small, flexible reamers placed over the guide pins. In patients with severe soft-tissue contracture or bony ankylosis, extra steps are required to gain adequate exposure and restore a reasonable range of motion. If there is bony ankylosis of the joint, a small osteotome or microsagittal saw may be needed to create a joint space in which to work (Fig. 2). Often, a plane of normal tissue can be identified either anterior or posterior, and then, the joint line is re-created using this as the starting point. If severe soft-tissue contracture