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ORIGINAL ARTICLE

Total elbow arthroplasty for primary osteoarthritis

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Background: Primary osteoarthritis of the elbow is a less common indication for total elbow arthroplasty (TEA). Higher complication rates in younger, active patients may offset short-term improvements in pain and function. The purpose of this study was to determine pain relief, functional outcomes, complications, and survival of TEA in this population.
Methods: Between 1984 and 2011, 20 consecutive TEAs were performed for primary elbow osteoarthritis. Two patients died before the 2-year follow-up. Mean age at surgery was 68 years (range, 51-85 years). Outcome measures included pain, motion, Mayo Elbow Performance Score, satisfaction, complications, and reoperations. Mean follow-up was 8.9 years (range, 2-20 years).
Results: Three elbows sustained mechanical failures. Complications included intraoperative fracture (n = 2), wound irrigation and débridement (n = 1), bony ankylosis (n = 1), humeral loosening (n = 1), humeral component fracture (n = 1), and mechanical failure of a radial head component (n = 1). Fifteen elbows without mechanical failure were examined clinically. Pain improved from 3.6 to 1.5 ($P < .001$). Range of motion remained clinically unchanged ($P > .05$), with preoperative flexion contractures not improving. Mayo Elbow Performance Scores were available for 13 elbows without mechanical failure, averaging 81.5 points (range, 60-100 points); these were graded as excellent (n = 5), good (n = 2), and fair (n = 6). Subjectively, all patients without mechanical failure were satisfied.
Conclusion: TEA represents a reliable surgical option for pain relief in patients with primary osteoarthritis. However, restoration of extension is not always obtained, indicating that more aggressive soft tissue releases or bony resection should be considered. Complications occurred in a large number of elbows, but mechanical failure was low considering the nature of this population and the length of follow-up.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Total elbow; total elbow arthroplasty; primary osteoarthritis; young; active; complications

Total elbow arthroplasty (TEA) has been reported to provide pain relief and improved function in patients with end-stage arthritis of various causes. In the early years of elbow arthroplasty, most patients undergoing this procedure were affected by inflammatory arthritis. With the widespread use of disease-modifying antirheumatic drugs and the adoption of expanded indications for elbow arthroplasty, most arthroplasties are currently performed for other indications, mainly post-traumatic osteoarthritis, distal humeral fractures, and nonunions.[4,7]

Primary osteoarthritis of the elbow is a relatively common condition likely associated with overuse of the joint over an extended time. It is much more prevalent in men, and most patients are involved in manual labor and lift weights

The Mayo Clinic Institutional Review Board approved this study (IRB 07-007944).

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repetitively.[16] The primary complaints of patients initially presenting with primary osteoarthritis is often loss of motion and impingement pain at the extremes of motion. Frequently there is little or no pain in the midarc of flexion.

In these early stages, primary osteoarthritis of the elbow can be treated successfully with osteophyte removal and capsulectomy.[1] However, a subset of patients continues to degenerate and eventually develop pain through the midarc of motion that may not respond well to even multiple attempts at osteocapsular arthroplasty. In these circumstances, elbow arthroplasty is an alternative option, especially in the older patient. TEA in this population represents less than 1% of preoperative diagnoses in large studies of patients with mixed diagnoses.[5,6,10]

Patients must be willing to accept the activity limitations of a TEA, which is not uniformly the case in this population. Thus, the performance of TEA in these patients remains concerning. TEA has the potential to provide pain relief and improved function but could also be associated with a high rate of mechanical failure in the typical patient who develops primary osteoarthritis and has a higher baseline activity level than the historic inflammatory patient.

Owing to the rarity of the diagnosis and reluctance to implant a TEA in this active population, reports on outcomes after TEA for primary osteoarthritis are limited to 3 studies in the English literature, including a previous case series of 5 elbows from our institution.[3,9,14] Two other small case series each report 11 elbows with primary osteoarthritis with a mean follow-up of 68 and 57 months, respectively.[3,14] Larger studies are needed to examine this population and determine the roll of TEA in the treatment of primary elbow osteoarthritis. We aim to expand on our previous case series and review our experience over a 27-year period with TEA for primary osteoarthritis with a minimum 2-year follow-up to assess pain relief, functional outcomes, complications, and the revision rate in this population.

Methods

Patients

Between January 1, 1984, and December 31, 2011, 1305 TEAs were performed at our institution. Of these, 20 (<1%) were performed in patients for primary elbow osteoarthritis. Two patients died before the 2-year follow-up, leaving 18 elbows (90% of the overall cohort; 7 men, 11 women) with a mean age at the time of surgery of 68 years (range, 51-85 years) that had been monitored for a minimum of 2 years or until reoperation. The mean follow-up for these 18 elbows was 8.9 years (range, 2-20 years).

Patients were indicated for TEA when their pain included the midarc of motion, pain with resisted flexion and extension, and pain at rest and at night. Imaging showed characteristic findings of primary elbow osteoarthritis with hypertrophic marginal osteophytosis affecting the ulnohumeral joint and an absence of inflammatory changes. Conservative measures before TEA had failed in all patients, with 5 undergoing a previous débridement procedure (4 open, 1 arthroscopic) before arthroplasty. One additional patient underwent an isolated ulnar nerve transposition before TEA without débridement.

Efforts were made to preserve the native elbow in young active patients until symptoms could no longer be tolerated. Patients had to be willing to accept the activity limitations of a TEA before the operation was scheduled, which was more common in women despite the disease being more common in men.

Surgical procedures

Seven subspecialty practicing surgeons performed the index procedure, with more than half of the procedures performed by one of the senior author's surgeons (B.F.M.). All surgeons performed TEA as a part of their routine practice. Surgery was performed using a Bryan-Morrey triceps-reflecting approach in 17 elbows and a triceps split in 1 elbow. The ulnar nerve was transposed in an anterior subcutaneous pocket in 13 elbows; 2 additional elbows had undergone prior ulnar nerve transposition. Implants used included the Coonrad-Morrey system (Zimmer, Warsaw, IN, USA) in 14 elbows, the Latitude system (Tornier, Minneapolis, MN, USA) in 3 elbows, and the Pritchard system (DePuy, Warsaw, IN, USA) in 1 elbow, depending on surgeon preference.

Implants were fixed with antibiotic-loaded cement (18 of 18) and linked (17 of 18). An extensive capsulectomy was performed in 7 elbows in an effort to gain full intraoperative range of motion without having to excessively shorten the distal humerus. Intraoperative range of motion obtained at the end of the procedure included mean extension of 6° (range, 0°-30°) and mean flexion of 137° (range, 130°-145°). Postoperative heterotopic ossification prophylaxis was not routinely used.

The operative arm was splinted in full extension for 2 to 7 days postoperatively, depending on the state of the extensor mechanism and soft tissue envelope. Patients were instructed postoperatively to refrain from lifting more than 2 pounds repetitively and 10 pounds rarely with a single lift. The radial head was maintained in 17 elbows because there was no significant malalignment or impingement. One elbow treated with a Latitude prosthesis underwent concurrent radial head replacement because of existing arthritic changes.

Evaluation

All patients were assessed prospectively at regular intervals through our institutional joint database. Pain, active range of motion, and other elements of the Mayo Elbow Performance Score (MEPS) are obtained at the clinical follow-up or by a validated letter questionnaire or telephone interview at 1, 2, and 5 years, and every 5 years thereafter.[2] This information was collected retrospectively along with a record review to identify previous surgical procedures, complications, and reoperations. Sufficient information was available to calculate the MEPS at most recent follow-up for 13 of the 15 elbows without mechanical failure.

Preoperative radiographs were available for all elbows and were evaluated for cartilage loss, bony erosion, carrying angle deformities, and subluxation. Cartilage loss was assessed as partial (thinned joint space) or complete (bone-on-bone articulation). Bony erosion was classified as being present if the native architecture of the elbow had been disrupted beyond complete loss of the cartilage space. Postoperative radiographs were available for 94% of the elbows at a mean follow-up of 6.9 years (range, 0.9-20 years). Radiographs were performed in 1 elbow with mechanical failure before revision at 0.9 years, with the remainder of elbows all having follow-up of greater than 2 years.

Radiographs were examined to assess radiolucent lines, humeral bone graft union, and bushing wear. The humeral cement mantle was assessed as adequate when cement was present past the tip with less than a 1-mm line at the bone cement interface, marginal if cement was present past the tip with less than a 2-mm line, and inadequate if cement did not pass the tip of the prosthesis or a line was present greater than 2 mm.[13] Radiolucent lines were assessed by comparing the immediate postoperative x-ray images to the most recent, as described by Ramsey et al.[15] Bushing wear was classified as none, partial, or complete, as described by Morrey et al.[12]

Statistical methods

Descriptive statistics are reported as means with the range for continuous measures and number with percentage for discrete variables. A paired *t* test was used to compare preoperative vs. postoperative changes in pain and range of motion. The same analyses were performed for elbows with radiographic follow-up of 1 year or until reoperation. Statistical significance for all tests were set at an α level of .05. Kaplan-Meier survival curves were plotted to assess implant survival.

Results

Complications and reoperation

Complications occurred in 9 of the 18 elbows studied. Minor complications occurred in 7 elbows and did not require a return to the operating room or alteration of postoperative rehabilitation. Intraoperative fractures occurred in 2 elbows. The first was a nondisplaced fracture of the medial column treated with circumferential #2 FiberWire (Arthrex, Naples, FL, USA). The fracture united with no adverse clinical consequences. The second intraoperative fracture affected the proximal ulna and led the surgeon to switch to a long-stemmed ulnar component.

Cellulitis developed in 2 patients. One elbow was treated with a 10-day course of oral antibiotics with no further concerns for infection at the 4-year follow-up. The second elbow required débridement of an uncomplicated stitch abscess in the office and did not require antibiotics. Massive heterotopic ossification developed in 1 elbow leading to pain-free ankyloses. A hematoma developed in a fourth elbow 2 months after the operation secondary to medical anticoagulation. This was aspirated, and the patient was clinically doing well 7 years postoperatively. One elbow had complete bushing wear at follow-up, but the patient did not wish to undergo reoperation.

Three patients experienced major complications that required a return to the operating room. In 1 patient, who had sustained an intraoperative ulna fracture as outlined above, the radial head component of the prosthesis subsequently disengaged 11 months postoperatively, requiring open removal with retention of the ulnohumeral implants. One elbow sustained a medial condyle fracture around a loose humeral stem 10 years after the index arthroplasty and underwent a revision of the humeral component with retention of the ulnar component. One patient, with persistent wound drainage, returned to the operating room 2 months after TEA for a formal irrigation and débridement. Drainage was determined to be secondary to nonabsorbable sutures beneath the skin. It did not track deep, and the patient was doing well 5 years postoperatively.

At the most recent follow-up, 3 elbows were determined to have mechanically failed. These included the patient with the periprosthetic humeral fracture and the elbow with the dislodged radial head. One additional patient with complete bushing wear was considered to have failed mechanically despite electing to forgo revision surgery. The estimated survival, free of reoperation for any cause, was 89.4% (95% confidence interval, 66%-97%) at 10 years.

Clinical results

Three patients were determined to have mechanical failures and were eliminated from clinical analysis. TEA resulted in statistically significant improvements in pain; the mean pain subscore of the MEPS was 3.6 preoperatively and 1.5 at the most recent follow-up ($P < .001$). However, pain was rated as moderate in 2 elbows for unexplained reasons. The mean preoperative range of motion was from 34° of extension to 121° of flexion (mean arc of motion, 87°). At the final follow-up, range of motion averaged 25° of extension to 130° of flexion (mean arc of motion, 105°). Pronation and supination averaged 55° and 60°, respectively, before surgery and averaged 74° and 69°, respectively, at the most recent follow-up. None of these differences in motion reached statistical significance ($P > .05$).

According to the MEPS (information available for 13 of 15 patients), results were graded as excellent in 5 elbows, good in 2, and fair in 6. Reasons for the fair result included persistent pain in 6 elbows, with associated poor motion in 3. Subjectively, 100% (15 of 15) of the patients were satisfied with the procedure.

A subgroup of 8 elbows with preoperative flexion contractures of ≥30° was compared with 7 elbows without. The groups were similar in preoperative pain ($P > .05$). At follow-up, both groups averaged a lack of 25° of full extension ($P > .05$). In fact, no correlation was found between intraoperative motion and postoperative motion. Postoperative flexion contractures developed in 4 of 5 patients with full intraoperative extension. Conversely, 3 of 6 patients with intraoperative contractures regained full extension. Therefore, intraoperative motion was not a reliable prognostic indicator in this cohort of patients.

Radiographs

All 18 elbows were identified to have preoperative cartilage loss, with 6 being considered partial and 12 complete. Six elbows had osseous erosion, with 5 of these being isolated to the ulna and 1 involving both the radiocapitellar and

ulna-trochlea joint. No elbows had articular deformities, marked malalignment, or evidence of preoperative subluxation.

Postoperative radiographs were available for 16 of 18 elbows. The cement mantle about the humerus was graded as "A" in 15 elbows, and 1humeral component had an inadequate cement mantle that did not extend past the tip. At the most recent follow-up, 4 elbows had progressive lucent lines around the humeral component. These were graded as type 2 (n = 3) and type 5 (n = 1). Two elbows had progressive lucencies around the ulnar component, both type 2. Therefore, only 1 elbow was considered to have radiographic evidence of loosening (isolated humeral component). Five elbows had partial bushing wear, with 1 having complete bushing wear at 10 years postoperatively. The average follow-up time in the group with no bushing wear was 7.5 years (range, 0.9-20 years) compared with 6.5 years (range, 2-10 years) in the 5 elbows with partial bushing wear. The bone graft placed behind the flange was united in all but 3 elbows. Heterotopic ossification was visualized in 4 elbows and was considered mild in 3 elbows and severe in 1, leading to ankylosis.

Discussion

Primary osteoarthritis of the elbow typically develops in active men with a history of manual labor and repetitive weight lifting over time. When symptoms are severe enough to require surgical intervention, most patients respond well to osteophyte removal with capsulectomy or osteocapsular arthroplasty. However, a small subset of patients with more extensive cartilage damage do not respond well to débridement procedures. Surgical treatment of this subset of patients is challenging. Indications for replacement at our institution focused on midarc pain, an older patient, patients in whom conservative interventions had failed, and patients who were willing to comply with postimplant functional restrictions. Finally, those with nearly full clinical ankyloses, not felt to be amenable to a débridement procedure, were offered joint replacement.

Elbow arthroplasty has the potential to provide pain relief and improved function but at the expense of an anticipated high rate of complications with younger ages and increased activity level. Because primary elbow osteoarthritis affects less than 2% of the population and elbow arthroplasty is considered for very few individuals with this diagnosis,[4,8] there is paucity of information in the literature regarding the outcome of TEA in primary osteoarthritis. However, this information would be critical for counseling those patients considered for elbow arthroplasty.

The results of our study indicate that elbow arthroplasty does provide pain relief to these individuals as a group. However, mechanical implant failure was documented in 3 elbows (17%) and moderate polyethylene wear in 5 elbows (29%). In addition, elbow arthroplasty failed to significantly improve motion in these patients, partly because their preoperative range of motion was not severely compromised and partly because of incomplete restoration of extension, as well as the development of massive heterotopic ossification in 1 elbow.

Postoperative flexion contractures were common, with only 5 elbows achieving full extension. Seven had flexion contractures of ≥30°. When studying this group, neither preoperative range of motion nor intraoperative range of motion was predictive of a postoperative flexion contracture ($P > .05$). Documentation of intraoperative capsulectomy or distal humeral shortening also did not predict better postoperative motion ($P > .05$). Previous studies have demonstrated similar findings in pain relief but suboptimal restoration of motion in elbows with unlinked prostheses (21 of 22).[3,10] Naqui et al[14] and Espag et al[3] reported improvements in the flexion arc of 38° and 40°, respectively, which is substantially more than our population, with a mean arc of motion improvement of 18°. Half of this was gained in extension. It is possible that these patients are prone to soft tissue contractures even after treatment of the arthritic articular surfaces. Early mobilization and therapy might be beneficial to prevent loss of motion.

Revision for implant failure was lower than expected. One reoperation was required because of failure of a radial head component, which some may argue was caused by design issues. No ulnar component was considered loose or revised for mechanical failure. Only 1 elbow was reoperated on for fracture about the humeral component in the setting of a known loose humeral component. This is consistent with previous reports: Naqui et al[14] reported no revisions, and Espag et al[3] reported a single revision for aspect loosening. Polyethylene wear was more of an issue, with 1 instance of severe wear and 5 more elbows with radiographic evidence of wear. It should be noted that the mean age of our patient population was 68 years, reflecting the fact that elbow arthroplasty is reserved for the older patient.

Some have recommended interposition arthroplasty to address the joint surface in patients with end-stage arthritis not considered ideal candidates for elbow arthroplasty because of age and activity level. Larson and Morrey[11] reported the results of Achilles interposition arthroplasty in a mixed group of individuals with rheumatoid arthritis and other etiologies. Although the subjective satisfaction rate approached 90% in this experience, the rate of satisfactory MEPS was low, and the reoperation rate was higher than in the study group reported here. This prompted the authors to consider interposition as a "salvage" procedure for primary osteoarthritis of the elbow.

Our study has a number of strengths. To our knowledge, this represents the largest series of TEAs for primary osteoarthritis considering this is an uncommon indication, and most patients were monitored for a long time. However, there are a number of weaknesses, including the retrospective nature of the study. Owing to the rarity of the diagnosis, these procedures had been performed over a 28-year period, with a lack of uniformity in surgical technique. However, all surgeons were in a subspecialty practice and performed TEAs as a routine part of their practice.

Because the average age of the patients included in this study was 68 years and not every patient with mechanical

failure underwent reoperation, these results cannot be extrapolated to younger patients with primary osteoarthritis, and they underestimate the true potential rate of reoperation. In addition, more women than men were willing to accept the limitations of a TEA, thus increasing their representation in the study despite the disease being more common in men.

Another limitation is that not all patients underwent x-ray imaging at the final clinical follow-up. We routinely ask all patients to have x-rays performed, but a number of patients, who are not having subjective complaints about their elbow, forgo these x-rays because of the cost to them personally. Therefore, these elbows may possibly have had signs of mechanical wear or loosening despite a lack of subjective symptoms at the final follow-up.

Currently in our practice, we still attempt at all costs to recommend débridement procedures (osteophyte removal and capsulectomy) to most patients with primary elbow osteoarthritis, even when there is radiographic evidence of joint narrowing. However, some patients with severe damage to the articular cartilage, pain at rest, and midarc pain are considered for elbow arthroplasty if they are older and willing to comply with restrictions. Pain relief seems to be reliable and durable. Lack of full extension at follow-up was not predicted by preoperative extension and indicates that surgeons should pay more attention to full restoration of motion in the operating room by use of more aggressive soft tissue releases and, possibly, even nonanatomic placement of the implants that take into account the dynamic forces across the joint with proximal placement of the humeral component to help gain extension.

Conclusion

TEA is reliable for providing pain relief for primary osteoarthritis of the elbow. Restoration of extension is not always obtained, indicating that more aggressive soft tissue releases or bony resection may need consideration. Preoperative counseling remains critical, and patients should be willing to accept the activity limitations after TEA.

Disclaimer

B.F.M. has received royalties for a period of time for the Coonrad-Morrey elbow prosthesis. All other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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