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ORIGINAL ARTICLE

Risk factors for reoperation after total elbow arthroplasty

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Background: Total elbow arthroplasty (TEA) is a treatment option for arthritic conditions of the elbow and for complex distal humerus fractures in the elderly. Complications are common, however, and rates of survivorship vary. The goal of this study was to describe the factors associated with reoperation and revision after TEA.

Methods: We retrospectively reviewed primary TEAs performed at 2 tertiary academic medical centers. We identified 102 primary TEAs in 82 patients by 9 surgeons. The average age of the patients was 61 years. Female patients represented 81% of TEAs performed. The mean follow-up was 6.1 years. The principal diagnosis was inflammatory arthritis in 63 patients (62%), acute trauma or post-trauma in 28 (27%), and primary osteoarthritis in 9 (8.8%).

Results: The rate of reoperation was 41% (42 of 102). The median time to the first reoperation was 1.8 years. The percentage of elbows that had 1 or both components revised was 30% (31 of 102). The most common indication for reoperation was component loosening (17). Six elbows were treated definitively with resection arthroplasty, and 1 was revised to an elbow fusion. The rate of implant revision was 27% for inflammatory arthritis, 11% for osteoarthritis, and 57% after trauma. Trauma-related TEA was more likely to undergo additional reoperation (odds ratio, 4.3; $P = .008$) and implant revision (odds ratio, 3.4; $P = .031$).

Conclusion: Revision surgery with implant revision after primary TEA is common. Trauma-related TEA often leads to additional procedures.

Level of evidence: Level IV; Case Series; Treatment Study

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Keywords: Elbow arthroplasty; total elbow; complications; rheumatoid arthritis; revision elbow arthroplasty; elbow arthritis

The work was performed at the Hand and Upper Extremity Service, Department of Orthopedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts.

The Institutional Review Board at Massachusetts General Hospital approved this study under protocol #2009P001019/MGH. A waiver of informed consent was granted.

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Total elbow arthroplasty (TEA) is a surgical treatment option for arthritic conditions of the elbow and for complex distal humerus fractures in the elderly. Our understanding of TEA survivorship comes primarily from retrospective case series generally from a single institution. TEA survival rates vary among reports from 72%[10] to 94%[5] at 5 years, depending on the indication for surgery. A primary diagnosis of osteoarthritis[6] or post-traumatic arthritis,[7,10] use of an unlinked prosthesis,[8] and younger age at time of surgery[2] are associated with increased complication rates.

Database studies complemented with selective chart review allow evaluation of a larger number of patients, which yields statistical advantages over smaller case series in evaluating outcomes such as reoperation. Database studies may have greater external validity because they capture the result experienced by all the patients treated by any surgeon in a given institution or institutions rather than a series of patients treated by a select group of surgeons as the results reflect the experience of many patients treated by various surgeons.

The goal of this study was to describe our institutional experience with TEA. We studied the primary null hypothesis that there are no factors independently related to reoperation after primary TEA. We also studied secondary questions examining the rate of revision surgery and the number of reoperations after primary TEA.

Methods

We used *Current Procedural Terminology* codes 24361 and 24363 for "elbow arthroplasty with prosthetic replacement" to identify all patients who underwent primary TEA between September 1991 and July 2015. The database spanned 2 tertiary academic medical centers and affiliated community hospitals in 1 major metropolitan area. The final study cohort consisted of 102 primary TEAs performed in 84 patients by 11 attending surgeons. Eighteen patients had bilateral TEAs; 37 patients had one on the right and 29 patients had one on the left. Exclusion criteria consisted of patients younger than 18 years and pregnant women, neither of which resulted in patient exclusion. Medical records were manually reviewed to confirm the diagnosis, surgical treatment, and occurrence of reoperation.

We collected data from the medical records on factors that could be related to reoperation, including age at the time of treatment, sex, race, smoking history, and comorbidities. We also recorded the initial diagnosis, indication for reoperation, type of prosthesis (semiconstrained vs. unconstrained), number of revisions, and time from index TEA to reoperation or revision. Reoperation was defined as any surgical procedure performed on the elbow after primary TEA. Revision was defined as any reoperation that involved the removal or replacement of ulnar or humeral components after primary TEA. The primary outcome of interest was reoperation after primary TEA. The decision for reoperation was based on the discretion of the surgeon and patient.

Statistical analysis

We calculated the rate of reoperation as a percentage of the total number of TEAs performed. Descriptive statistics were used to report the rate and time between primary TEA and reoperation. We reported categorical variables as frequencies and percentages and continuous variables as mean and standard deviation (SD) or median and interquartile range (IQR), depending on the normality of the data. In exploratory bivariate analysis, a Fisher exact test was used to compare the distribution of categorical variables among patients who did and did not have a reoperation, and 2-tailed independent samples Student *t*-tests were used to compare the means of continuous variables among both groups. Variables that demonstrated a near-significant relationship ($P < .10$) with reoperation in bivariate analysis were then entered into a multivariable logistic regression model to identify factors that were independently associated with reoperation. We calculated odds ratios (ORs) and 95% confidence intervals (CIs) for the included variables and reported *P* values. A *P* value of $< .05$ was considered statistically significant. All statistical analyses were performed using Stata 13 (StataCorp LP, College Station, TX, USA).

Patient characteristics

The average age of the patients at the time of the index procedure was 61 years (SD, 12; range, 27-84 years). Female patients represented 81% of TEAs performed. The mean follow-up was 6.1 years (SD, 5.4; range, 0-24 years). In 22 patients, follow-up was <1 year. The principal diagnosis was inflammatory arthritis in 63 elbows (62%), including 2 elbows with psoriatic arthritis. Twenty-eight (27%) were performed in acute traumatic or post-traumatic settings. Primary osteoarthritis was the indication in 9 (8.8%) and hemophilia in 2 (2.0%) elbows.

Results

Reoperation and revision

The overall rate of reoperation was 41% (42 of 102). Of those, 26 (25%) initially were component revisions, whereas 8 elbows (7.8%) had at least 1 reoperation before component revision for infection (n = 2), olecranon bursitis (n = 2), compartment syndrome (n = 1), ruptured triceps tendon (n = 1), scar contracture (n = 1), and seroma (n = 1) (Table I). The remaining 8 elbows (7.8%) had reoperation without the need for subsequent revision; 3 of those had 2 or more washouts for infection, 2 had excision of heterotopic ossifications, 2 had ulnar nerve release, and 1 had adhesiolysis of a scar contracture.

The median time to the first reoperation in all these elbows was 2.0 years (IQR, 0.4-7.0 years). Reoperation was, on average, indicated earlier in post-traumatic elbows (median, 1.9 years; IQR, 0.5-5.3 years) compared with elbows with inflammatory arthropathy (median, 5.2 years; IRQ, 0.4-10 years), although not statistically significant ($P = .35$ by Mann-Whitney *U* test). The percentage of elbows that had 1 or both components revised was 30% (31 of 102), whereas 3 TEAs required bushing exchange (Table I). The median time to component revision was 6.0 years (IQR, 3.9-6.9 years) in all elbows. Six TEAs had component revision within 1 year. In post-traumatic elbows, the median time to revision was 2.8 years (IQR, 1.5-5.5 years) compared with 7.0 years (IQR,

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