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Differences in 30-day outcomes between inpatient and outpatient total elbow arthroplasty (TEA)

Andrew A. Furman, BS*, Alain E. Sherman, BS, Mark A. Plantz, BS, Guido Marra, MD, Matthew D. Saltzman, MD

Department of Orthopaedic Surgery, Northwestern University Feinberg School of Medicine, Chicago, IL, USA

Background: As the health care system in the United States shifts toward value-based care, there has been increased interest in performing total joint arthroplasty in the outpatient setting to optimize costs, outcomes, and patient satisfaction. Several studies have demonstrated success in performing ambulatory total knee and hip arthroplasty. The purpose of this study was to compare short-term outcomes and complications after total elbow arthroplasty (TEA) across the inpatient and outpatient operative settings.

Methods: The American College of Surgeons National Quality Improvement Program database was queried to identify 575 patients undergoing primary TEA using the Current Procedural Terminology code 24363. Of this sample, 458 were inpatient and 117 were outpatient procedures. Propensity score matching using a 3:1 inpatient-to-outpatient ratio was performed to account for baseline differences in several variables—age, sex, body mass index class, American Society of Anesthesiologists class, and various comorbidities—between the inpatient and outpatient groups. After matching, the rates of various short-term outcomes and complications were compared between the inpatient and outpatient groups.

Results: Inpatient TEA was associated with a higher rate of complications relative to outpatient TEA, including non-home discharge (14.9% vs. 7.5%, $P = .05$), unplanned hospital readmission (7.4% vs. 0.9%, $P = .01$), surgical complications (7.6% vs. 2.6%, $P = .04$), and medical complications (3.6% vs. 0.0%, $P = .04$).

Conclusion: Outpatient TEA has a lower short-term complication rate than inpatient TEA. Outpatient TEA should be considered for patients for whom such a discharge pathway is feasible. Future research should focus on risk stratification of patients and specific criteria for deciding when to pursue outpatient TEA.

Level of evidence: Level III; Retrospective Cohort Comparison using Large Database; Treatment Study

Keywords: Total elbow arthroplasty; outcomes; outpatient; ambulatory; complications; inpatient

Total elbow arthroplasty (TEA) was first developed in the 1970s to treat advanced degenerative changes of the elbow secondary to rheumatoid arthritis (RA).[17] Since then, the indications for this procedure have expanded to include osteoarthritis, post-traumatic arthritis, flail elbow, acute trauma, comminuted distal humerus fractures, hemophilic arthropathy, and reconstruction after tumor resection.[37] Over the past several decades, there has been a dramatic shift in the primary indication for TEA from RA to trauma, most of which represents the treatment of comminuted distal humerus fractures in elderly patients. According to the New York State Department of Health database from 1993 to 2006, the percentage of TEAs being

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*Reprint requests: Andrew A. Furman, BS, Feinberg School of Medicine, 420 E Superior St, Chicago, IL 60611, USA.

E-mail address: andrew.furman@northwestern.edu (A.A. Furman).

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performed for trauma increased from 43% to 69%, whereas the percentage of TEAs being performed for inflammatory arthritis decreased from 48% to 19%.[22] This change in primary indication for TEA has also been reported in international elbow replacement registries that show the current top 3 indications for TEA to be trauma/post-traumatic sequelae, osteoarthritis, and RA in respective order of frequency.[24,43]

This paradigm shift has had 2 primary drivers: (1) a better understanding and treatment of RA with disease-modifying antirheumatic drugs and biologics leading to slower progression of symptoms and joint destruction[39] and (2) an increasing incidence of comminuted distal humerus fractures in the elderly population.[2,32] In comparative studies of TEA vs. open reduction and internal fixation (ORIF) for the treatment of comminuted intra-articular distal humeral fractures in elderly patients, TEA has been shown to deliver superior outcomes and be the more cost-effective treatment.[20,21] Given these trends and the aging population, there will be significantly increased demand for TEA in the coming years.[16,40]

As the United States health care system shifts from a fee-for-service model to value-based care and bundled payments, there has been increased interest in performing primary total joint arthroplasty (TJA) in the outpatient setting in order to improve surgical outcomes, optimize costs, and increase patient satisfaction.[7,18] Since the late 2000s, numerous studies have demonstrated that total knee arthroplasty, total hip arthroplasty, and total shoulder arthroplasty can be safely performed in the outpatient setting with equivalent or superior outcomes to those performed on an inpatient basis.[3-6,8,9,14,18,19,25,26,28,34,35] Subsequent studies have demonstrated that properly transitioning TJA to the outpatient setting is associated with significant cost savings.[10,41,44]

Despite the extensive literature comparing inpatient vs. outpatient outcomes for other TJA procedures, there have been no comprehensive studies that have analyzed the risk of postoperative complications between TEA performed in the inpatient and outpatient settings. Given that TEA is performed for a diverse set of indications, including trauma and inflammatory arthritis, and that operative volumes will continue to grow with the aging population, more research into this area is warranted. The objective of this study was to compare 30-day postoperative complications for primary TEA performed in the inpatient and ambulatory settings using a population-based dataset.

Materials and methods

This is a propensity score–matched retrospective cohort study of short-term complication rates after TEA performed in the inpatient vs. outpatient setting.

Overview of data extraction and variables of interest

The American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) is a national multi-institution research program designed to collect data on various surgical procedures for quality improvement purposes. Its design and data collection methods have been previously described and validated.[15,38] Over 700 institutions participate in the program, spanning academic medical centers, community hospitals, and independent surgical centers. Data are collected by clinical reviewers who must undergo standardized training and annual recertification to participate. Inter-rater reliability has been reported to be excellent, with an overall agreement rate of 98.4% for all measured variables.[1] The database has specifically been used to examine orthopedic surgical outcomes of the upper extremity in the past, including TEA.[30,31,33]

Data for this study were retrospectively queried from the ACS-NSQIP Participant User Files for years 2007 through 2017. The Current Procedural Terminology code 24363 was used to identify all patients who underwent primary TEA in the dataset (N = 575). The ACS-NSQIP ''inpatient/outpatient'' variable, which relies on individual hospital definitions and reporting, was used to identify surgical setting. The length of hospital stay was not used to determine inpatient or outpatient status. Of the primary TEA cases, 458 were inpatient, whereas 117 were performed in an outpatient setting.

All variables were defined according to the User Guide for the 2017 ACS-NSQIP Participant Use Data File. Patient demographic and lifestyle factors included gender, age, race/ethnicity, body mass index (BMI) class, smoking status within the past year, and American Society of Anesthesiologists (ASA) classification. Comorbidities analyzed were hypertension requiring medication, diabetes mellitus, chronic obstructive pulmonary disease, congestive heart failure, bleeding disorders, and steroid use for a chronic condition. Primary indication for TEA (ie, osteoarthritis, RA, trauma/fracture, device failure, or other arthropathy) was also reported. Thirty-day postoperative outcomes were assessed: surgical site infection, wound dehiscence, anemia requiring transfusion, urinary tract infection (UTI), pneumonia, deep venous thrombosis (DVT)/thrombophlebitis, pulmonary embolism, stroke or cerebrovascular accident, myocardial infarction, cardiac arrest, unplanned intubation, systemic sepsis, septic shock, return to operating room, non-home discharge (eg, rehabilitation center, skilled or acute care facility), unplanned reoperation, unplanned readmission likely related to TEA, and mortality.

Propensity score matching and statistical analysis

Propensity score matching was performed to minimize the impact of selection bias in the creation of inpatient and outpatient TEA groups. This approach uses individual patient data to match each outpatient case to a demographically and comorbidly similar inpatient case. Propensity score matching has been previously employed to examine the comparative complication rates of inpatient and outpatient total hip arthroplasty and total knee arthroplasty using ACS-NSQIP data.[29] Patients were matched according to gender, race/ethnicity, age, BMI class, smoking, hypertension, diabetes, chronic obstructive pulmonary disease, congestive heart failure, bleeding disorders, steroid use, ASA

class, and indication for TEA using a balanced, nearest-neighbor approach and 3:1 inpatient-to-outpatient ratio. Cases for which no matches were found were excluded from analysis. The propensity score–matched groups were compared at baseline using *t*, χ^2, and Fisher's exact tests. After matching, χ^2 and Fisher's exact tests were used to compare the inpatient and outpatient TEA groups for outcome variables of interest. All data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA). The criterion for statistical significance was set at $\alpha = 0.05$ for all inferential tests.

Results

The propensity score algorithm successfully matched 331 inpatient TEA cases to 114 outpatient cases. Three outpatient cases, for which no inpatient matches were found, were excluded from the sample, yielding a match rate of 97.4%. The propensity score–matched groups were found to be statistically equivalent with regard to sex, age, BMI, comorbidities, ASA class, and TEA-related diagnosis (Table I). The only difference that was found to be statistically significant was patient race/ethnicity ($P = .004$), with the outpatient group having a greater proportion of white patients (80.7% vs. 69.5%, $P = .02$). The inpatient was also more likely to have cases with unknown or unreported patient race (15.7% vs. 4.4%, $P = .002$).

Inpatient TEA procedures were associated with significantly increased risk of hospital readmission (7.4% vs. 0.9%, $P = .01$) and non-home discharge (14.9% vs. 7.5%, $P = .05$) when compared with outpatient TEA procedures (Table II). There were no statistically significant differences between the TEA groups with regard to return to operating room (OR) (3.3% vs. 1.8%, $P = .31$), postdischarge reoperation (2.9% vs. 1.9%, $P = .73$), and mortality (0.3% vs. 0.0%, $P = .74$).

Overall, patients undergoing inpatient TEA were significantly more likely to have postoperative complications than their outpatient counterparts (10.3% vs. 2.6%, $P = .01$). This trend was consistent for both surgical complications (7.6% vs. 2.6%, $P = .04$) and medical complications (3.6% vs. 0.0%, $P = .04$). Specifically, inpatient TEA cases were significantly more likely to experience the surgical complication of bleeding requiring transfusion (4.5% vs. 0.9%, $P = .05$). Pneumonia, reintubation, pulmonary embolism, UTI, cerebrovascular accident, DVT, systemic sepsis, and septic shock events consistently occurred more frequently in the inpatient group but, individually, did not achieve statistical significance.

Table I Patient demographics

	Inpatient (n = 331)	Outpatient (n = 114)	*P* value
Sex			.63
Male	71 (21.5)	22 (19.3)	
Female	260 (78.5)	92 (80.7)	
Race/Ethnicity			.004*
Asian	7 (2.1)	0 (0.0)	
Black or African American	17 (5.1)	8 (7.0)	
Hispanic	8 (2.4)	7 (6.1)	
White	230 (69.5)	92 (80.7)	
Other	17 (5.1)	2 (1.8)	
Unknown/Not reported	52 (15.7)	5 (4.4)	
Age (yr)	64.1 ± 13.5	65.3 ± 12.2	.39
BMI (kg/m^2)	29.3 ± 7.1	29.1 ± 7.3	.80
Comorbidities			
Diabetes	47 (14.2)	14 (12.3)	.61
Smoking	42 (12.7)	10 (8.8)	.26
COPD	15 (4.5)	6 (5.3)	.75
Congestive heart failure	3 (0.9)	1 (0.9)	>.999
Hypertension	166 (50.2)	58 (50.9)	.89
Chronic steroid use	66 (19.9)	27 (23.7)	.40
Bleeding disorder	0 (0.0)	0 (0.0)	–
ASA class			.83
Class 1 (no disturbance)	12 (3.6)	4 (3.5)	
Class 2 (mild disturbance)	126 (38.1)	49 (43.0)	
Class 3 (severe disturbance)	186 (56.2)	59 (51.8)	
Class 4 (life threatening)	7 (2.1)	2 (1.8)	
Diagnosis			.98
Osteoarthritis	79 (23.9)	25 (21.9)	
Rheumatoid arthritis	51 (15.4)	19 (16.7)	
Trauma/Fracture	107 (32.3)	40 (35.1)	
Device failure	14 (4.2)	4 (3.5)	
Other arthropathy	25 (7.6)	9 (7.9)	
Unknown	55 (16.6)	17 (14.9)	

BMI, body mass index; *COPD*, chronic obstructive pulmonary disease; *ASA*, American Society of Anesthesiologists.
Data are presented as n (%) unless otherwise specified.
* Statistically significant.

Discussion

We investigated the comparative safety and efficacy of performing TEA in the outpatient setting compared with the inpatient setting using the ACS-NSQIP database and a propensity score–matched design. Patients undergoing outpatient TEA had significantly fewer complications relative to patients in the propensity score–matched inpatient control group. There was a statistically significant absolute risk reduction in the outpatient group of 7.7% for overall complications, representing a relative risk reduction of 74.8% over the inpatient controls. In addition, rates of postoperative bleeding requiring transfusion were significantly lower in the outpatient group. Notably, no ambulatory TEA patients experienced medical complications. The potential reasons for this finding are multifactorial and may include surgeon selection of healthier patients in the outpatient group, less vigilant identification of medical complications in

Table II Comparison of complication rates between inpatient and outpatient cohorts

	Inpatient (n = 331)	Outpatient (n = 114)	*P* value
Non-home discharge	41 (14.9)	8 (7.5)	.05*
Mortality	1 (0.3)	0 (0.0)	.74
Return to operating room	11 (3.3)	2 (1.8)	.31
Readmission	20 (7.4)	1 (0.9)	.01*
Reoperation	8 (2.9)	2 (1.9)	.73
Overall complications	34 (10.3)	3 (2.6)	.01*
Surgical complications	25 (7.6)	3 (2.6)	.04*
Surgical site infection	9 (2.7)	1 (0.9)	.46
Dehiscence	2 (0.6)	1 (0.9)	>.999
Bleeding	15 (4.5)	1 (0.9)	.05*
Medical complications	12 (3.6)	0 (0.0)	.04*
Pneumonia	3 (0.9)	0 (0.0)	.57
Reintubation	2 (0.6)	0 (0.0)	.55
Pulmonary embolism	3 (0.9)	0 (0.0)	.57
Urinary tract infection	1 (0.3)	0 (0.0)	>.999
Cerebrovascular accident	1 (0.3)	0 (0.0)	>.999
Cardiac arrest	0 (0.0)	0 (0.0)	–
Myocardial infarction	0 (0.0)	0 (0.0)	–
Deep venous thromboembolism	1 (0.3)	0 (0.0)	>.999
Systemic sepsis	3 (0.9)	0 (0.0)	.57
Septic shock	1 (0.3)	0 (0.0)	>.999

Data are presented as n (%).
* Statistically significant.

the outpatient setting, or less exposure to nosocomial infection.

Interest in performing TEA as an outpatient procedure is first seen in the literature in 2006 when Ilfeld et al[23] published a prospective case report looking at postoperative pain management in 3 patients. From an analgesic perspective, this study demonstrated the feasibility of converting TEA into an ambulatory procedure by using a portable infusion pump to deliver a continuous infraclavicular nerve block as a part of a multimodal ambulatory regimen. In 2018, Stone et al[42] published a retrospective case series that assessed 90-day outcomes—including complications, readmissions, and reoperations—in 28 patients who underwent same-day discharge after primary TEA. This study reported a 90-day major complication rate of 7.1%, a reoperation rate of 3.5%, and a readmission rate of 3.5% in patients who had TEA in the ambulatory setting. They compared these rates with those published in inpatient studies and came to the conclusion that same-day discharge after TEA is a safe and viable option for a carefully selected group of patients when combined with attentive follow-up.[22,27] In comparison to Stone et al, our study showed lower rates of complications (2.5% vs. 7.1%), reoperation (1.9% vs. 3.5%), and readmission (0.9% vs. 3.5%) after outpatient TEA. However, given the differences in follow-up period (30 days vs. 90 days), we are unable to say if these lower rates truly reflect better outcomes within our outpatient cohort.

Our study supports the conclusion of Stone et al, namely that ambulatory TEA is a safe and viable alternative to inpatient TEA for a subset of patients. Our study further suggests that the safety profile of ambulatory TEA is superior to that of inpatient TEA in appropriately selected patients. The former study was a prospective case series with no inpatient control, as all 28 patients underwent TEA in the ambulatory setting. By using a larger, population-based cohort of 575 patients who underwent TEA in both inpatient and outpatient settings, we were able to use a retrospective propensity score–matched design to directly compare outcomes by operative setting while controlling for confounding demographic and comorbidity variables. This approach allowed us to more effectively isolate operative setting as the explanatory variable driving the changes in medical and surgical 30-day outcomes. In addition, the large ACS-NSQIP sample provided the power necessary to conclude differences in complication rates between cohorts with statistical significance. Although the Stone et al study described outcomes from 1 surgeon at an academic medical center, the geographic and institutional breath of data collection sites included in ACS-NSQIP extends the external validity of the present investigation beyond those of single-center studies.

There are a few important limitations to our study. First, as with any database study that is retrospective in nature, our analysis was limited by the variables reported by ACS-NSQIP. This database was created to catalog common complications across all major surgical procedures, which precludes the collection of procedure-specific metrics. As such, certain TEA-specific complications, such as dislocation, ulnar neuropathy, and periprosthetic fracture, were not captured. Second, there may be inconsistencies in how ‘‘outpatient’’ surgery was defined. In this study, we elected to use the institutional designations provided to NSQIP to classify surgeries as outpatient. Other studies have used the hospital length of stay of 0 days to define outpatient surgery.[29] TEAs that were designated as ‘‘outpatient’’ may have documented lengths of stay greater than 0 due to errors in data collection or may represent true prolongations in stay due to voluntary or mandated observational stays resulting from a patient’s failure to meet institution-specific discharge criteria. Third, only 30-day outcome measures are reported by ACS-NSQIP; the database is primarily used for short-term complications and does not provide any information regarding mid-term or long-term outcomes and, thus, likely under-represents the true rate of complications. Fourth, given the inherent infrequency of certain postoperative complications (eg, UTI, DVT), some outcomes that were not found to be statistically significant could be due to type II error secondary to insufficient power. Fifth, there is potential for selection bias when determining which patients should undergo outpatient TEA based on variables

not included in the dataset despite the use of propensity score matching. Nonetheless, we were able to consistently show lower rates of medical and surgical complications in the outpatient group relative to our propensity score–matched inpatient control group. Based on these findings, TEA appears to be safe to perform in the ambulatory setting and likely has an improved safety profile in select patients.

The demonstrated safety and efficacy of outpatient TEA will likely have an impact on clinical decision making as the health care system continues to move toward risk- and value-based contracting. Medicare diagnosis-related group payment rates for TEAs range drastically depending on the setting of the procedure. The average 2016 Medicare diagnosis-related group payment rates for TEAs performed in the inpatient, hospital outpatient, and ambulatory surgical setting were $14,246, $10,537, and $7886, respectively, while physician Current Procedural Terminology codes were constant across operative location.[11-13] Even greater variability in reimbursement rates by operative setting can be expected within the private insurance market.[36] Given that most TEA procedures are performed in the Medicare population and that the popularity of Medicare Managed Care Plans continues to grow, it is anticipated that more provider groups will engage in risk- and performance-based insurance contracting.[33] In addition to improving patient outcomes and satisfaction with surgery, providers and insurers would be able to deliver more cost-effective care by properly stratifying and assigning their patients to the appropriate surgical setting.

Conclusion

This study demonstrated that performing TEA in the ambulatory setting results in lower rates of 30-day complication when compared with inpatient TEA. As cost pressures continue to rise and demand for this procedure grows, moving appropriate TEAs to the outpatient setting appears to be an effective tool to deliver safer, higher quality care in a more cost-effective manner. Future research dedicated to developing criteria for patient selection and optimizing postoperative pain management and physical rehabilitation protocols for patients undergoing TEA in the ambulatory setting would be of great value.

Disclaimer

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