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ORIGINAL ARTICLE

Retrospective Study

Subsequent total joint arthroplasty: Are we learning from the first stage?

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Abstract

BACKGROUND

With the increasing incidence of total joint arthroplasty (TJA), there is a desire to reduce peri-operative complications and resource utilization. As degenerative conditions progress in multiple joints, many patients undergo multiple procedures.

AIM

To determine if both physicians and patients learn from the patient's initial arthroplasty, resulting in improved outcomes following the second procedure.

METHODS

The institutional database was retrospectively queried for primary total hip arthroplasty (THA) and total knee arthroplasty (TKA). Patients with only unilateral THA or TKA, and patients undergoing same-day bilateral TJA, were excluded. Patient demographics, comorbidities, and implant sizes were collected at the time of each procedure and patients were stratified by first *vs* second surgery. Outcome metrics evaluated included operative time, length of stay (LOS), disposition, 90-d readmissions and emergency department (ED) visits.

RESULTS

A total of 642 patients, including 364 undergoing staged bilateral TKA and 278 undergoing bilateral THA, were analyzed. There was no significant difference in demographics or comorbidities between the first and second procedure, which were separated by a mean of 285 d. For THA and TKA, LOS was significantly less for the second surgery, with 66% of patients having a shorter hospitalization (P <

0.001). THA patients had significantly decreased operative time only when the same sized implant was utilized (P = 0.025). The vast majority (93.3%) of patients were discharged to the same type of location following their second surgery. However, when a change in disposition was present from the first surgery, patients were significantly more likely to be discharged to home after the second procedure (P = 0.033). There was no difference between procedures for post-operative readmissions (P = 0.438) or ED visits (P = 0.915).

CONCLUSION

After gaining valuable experience recovering from the initial surgery, a patient's perioperative outcomes are improved for their second TJA. This may be the result of increased confidence and decreased anxiety, and it supports the theory that enhanced patient education pre-operatively may improve outcomes. For the surgical team, the second procedure of a staged THA is more efficient, although this finding did not hold for TKA.

Key Words: Staged total joint arthroplasty; Asynchronous total joint arthroplasty; Subsequent total joint arthroplasty; Contralateral total joint arthroplasty; Perioperative outcomes

Core Tip: In this study, we investigated if surgeons and patients learn from their initial arthroplasty experience, resulting in improved outcomes following their second procedure. We showed that the second procedure of staged total hip arthroplasty has a shorter operative time, likely due to increased precision in implant sizing. However, this was not seen in total knee arthroplasty. After gaining valuable experience recovering from the initial surgery, a patient's perioperative outcomes are improved for their second total joint arthroplasty with shorter length of stay and similar discharge to facility or increased change of discharge to home.

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INTRODUCTION

The incidence of total hip arthroplasty (THA) and total knee arthroplasty (TKA) has increased dramatically, and this trend is expected to continue[1-6]. With expansion of indications, increased longevity of implants resulting in younger patients receiving arthroplasty, and patient satisfaction with these operations, it is becoming more common for patients to undergo arthroplasty of the second side when degenerative conditions progress in the contralateral hip and knee[7,8]. Patients may initially present with symptoms bilaterally and degenerative changes may progress on the contralateral side due to increased activity and time, or they may notice the pain more after the replaced side has recovered from surgery, and those with multiple joints may have higher satisfaction[7,8]. A series of 156 patients undergoing their first TKA published in 1994 reported a 37% rate of second side TKA at 7 year follow up if the other knee was arthritic at presentation and 5% if the knee was initially normal but symptoms and radiographic changes became apparent over the next 5 years[9]. Another series of 185 total knee patients eventually underwent contralateral TKA 43% of the time and this was has high as 93% if they had moderate or severe symptoms and radiographic arthritis[10]. Another series of 332 patients with primary TKA and 132 patients with primary THA reported that by 8 years, the incidence of contralateral TKA was 4% and contralateral THA 8%[8].

Despite the frequency of staged bilateral total joint arthroplasty (TJA), there is a paucity of published data on outcomes and perioperative factors comparing the second side to the first. Much of the literature is focused on whether to do simultaneous bilateral compared to staged or optimal duration[11] between stages with a focus on complications and cost effectiveness[12-29] or patient reported outcome measures (PROMs)[30-33]. However, the topic of staged subsequent arthroplasties has been mentioned in registry studies[21,23] and poses statistical challenges including immortal time bias and competing risk models[7,34,35]. In addition, some studies have demonstrated that the second THA is more similar to a unilateral THA in terms of outcome and survival[36]. Outcomes after the second stage TJA have not been thoroughly studied, with available data on operative efficiency gains particularly sparse. The purpose of this study was to determine if surgeons and patients learn from their initial arthroplasty experience, resulting in improved outcomes following their second procedure. We hypothesized there would be decreased operative time, length of stay (LOS), and discharges to skilled nursing facilities (SNF), as well as fewer 90-d emergency department (ED) visits and readmissions due to surgical team efficiency and patient expectations and preparedness for recovery.

MATERIALS AND METHODS

An institutional TJA database was retrospectively reviewed for all primary THA and TKA procedures between January 2014 and August 2017 using current procedural technology codes 27130 and 27447, respectively, resulting in 6637 procedures. Patients were included if their bilateral THA or TKA were staged on different dates, with both procedures occurring during the study period at the investigating institution. Patients were excluded if index arthroplasty was performed at an outside institution, if TJA was completed as same-day bilateral procedures, or if they were undergoing revision TJA. Patients were also excluded if the second TJA procedure was performed on a different joint from the first (that is, THA followed by subsequent TKA). The combination of these criteria led to the formation of a study group of patients who underwent primary bilateral TJA in subsequent fashion.

Patient demographics including age, sex, body mass index, and American Society of Anesthesiologists score were collected in addition to intraoperative data including operative time, anesthesia type, and implant type and sizes. Patients were stratified by first *vs* second procedure for data analysis. Outcome metrics evaluated included operative time, LOS, disposition, 90-d ED visits, and 30-d and 90-d readmissions. Statistical analysis was performed using IBM SPSS Statistics, version 24 (IBM Corp., Armonk, NY) and Wizard Pro for Mac (E. Miller, Chicago, IL). Continuous data were not normally distributed and were analyzed with Mann Whitney and are presented as median (lower quartile, upper quartile). Categorical data were analyzed with chi squared test and are presented as count (percent). A P value < 0.05 was considered statistically significant.

RESULTS

There were 1284 TJA operations performed on 642 patients, including 364 undergoing staged bilateral TKA and 278 undergoing staged bilateral THA included in this study. There was no significant difference in demographics (Table 1) or comorbidities between the first and second procedure, which were separated by a mean of 285 d [299 d (range 34-1235 d) for knees and 268 d (range 35-1267 d) for hips].

Table 2 compares outcome measures for the second joint compared to the first. THA patients had significantly decreased median operative time (102 *vs* 96 min, P = 0.011) and subgroup analysis demonstrated this to be the case only when the same sized implant was utilized. For the 278 bilateral THA patients, the stem type and size was the same in 65.5% (182 patients) and the cup type and size was the same in 66.5% (185 patients). For patients with the same stem size, the operating room (OR) time was more likely to be shorter (P = 0.025) and for patients with the same cup size, the OR time was more likely to be shorter (P = 0.001). However, there was no significant difference in OR time if the stem size (P = 0.210) or cup size (P = 0.910) were different.

For THA and TKA, LOS was significantly less for the second surgery, with 424 of the 642 patients (66%) having a shorter hospitalization (P < 0.001). At discharge, 93.3% of patients had the same disposition for both procedures with 504 discharged to home, 93 discharged to SNF, 2 discharged to rehabilitation facility. However, when a change in disposition was present, patients were significantly more likely to be discharged to home after the second procedure: 25 patients who went to SNF after their first procedure were discharged to home after their second procedure, while 12 patients who went home after the first procedure were discharged to SNF after the second (P = 0.033). Other changes of disposition included 2 rehab to home, 2 SNF to rehab, 1 rehab to SNF, and 1 home to expired in-hospital. There was no difference between procedures for post-operative readmissions (P = 0.438) or ED visits (P = 0.915).

DISCUSSION

A large percentage of patients who undergo TJA have pathology affecting the contralateral hip or knee which can progress over time and become sufficiently symptomatic and refractory to conservative therapy to warrant a second side TJA. Surgical efficiency improved on the second side for hips but was unchanged for knees. Of note the operative time was identical for TKA but was 6 min faster on the second side for THA. This is statistically significant (P = 0.011), and we would argue clinically significant in a healthcare environment where OR time is very costly. Further subgroup analysis demonstrates that this improved efficiency on the second side holds only when the same implant types and sizes as the first side are used. For the 278 bilateral THA patients, the stem type and size was the same in 65.5% (182 patients) and the cup type and size was the same in 66.5% (185 patients). For patients with the same stem size or cup size, the OR time was more likely to be shorter. However, if the stem or cup sizes utilized were different, there was no difference in OR time.

While same day bilateral TJA has been performed, many surgeons advocate recovering from the first side prior to proceeding on the other side, and many patients have degenerative joint disease at different stages when they present. With the patients' first-hand experience from the first side, postoperative expectations for pain and rehabilitation are well established. Furthermore, the medical care team including physical therapists and discharge planners may have additional insight to a patients' expected recovery needs and discharge from the hospital may occur sooner and to a different location—home rather than SNF, because of patients' comfort level. Our results were similar to another single institution study which had an increase from 69% to 74% of discharge home after first and second stage bilateral TKA but did not statistically compare this increase as their comparison was to simultaneous bilateral[12].

Surgical efficiency may be improved due to already knowing the implant sizes from the contralateral side, eliminating some uncertainty associated with a standard preoperative template. The explanation for this statistically significantly increased efficiency for THA may be due to increased confidence in starting reamer size for hips closer to the final

Table 1 Demographic data for arthroplasty patients based on procedure number

	First procedure	Second procedure	*P* value
Arthroplasty (n = 1286)			
Age (yr)	65.0 (58.0, 71.0)	66.0 (58.0, 72.0)	0.185
BMI (kg/m^2)	30.5 (26.6, 34.9)	30.4 (26.5, 35.1)	0.920
Female sex	362 (56.4)	362 (56.4)	1.000
ASA 1 or 2	373 (58.1)	370 (57.6)	0.865
Total knee arthroplasty (n = 728)			
Age (yr)	66.0 (61.0, 72.0)	67.0 (62.0, 73.0)	0.218
BMI (kg/m^2)	31.3 (27.4, 35.7)	31.5 (27.5, 36.0)	0.878
Female sex	210 (57.7)	210 (57.7)	1.000
ASA 1 or 2	193 (53.0)	192 (52.7)	0.941
Total hip arthroplasty (n = 556)			
Age (yr)	62.0 (54.0, 69.0)	62.0 (54.0, 70.0)	0.468
BMI (kg/m^2)	28.9 (25.5, 33.4)	29.2 (25.7, 33.0)	0.734
Female sex	152 (54.7)	152 (54.7)	1.000
ASA 1 or 2	180 (64.7)	178 (64.0)	0.859

Continuous data are presented as median (lower quartile, upper quartile). Categorical data are presented as count (percent). BMI: Body mass index; ASA: American Society of Anesthesiologists.

acetabular cup size and reduced need to repeat trial attempts.

A prior review reported improved ability to reduce leg length discrepancy and more accurate cup position in bilateral THA on the second side when performed in a simultaneous compared to staged fashion[18]. The present study suggests that benefit may also exist when the second side is done as a subsequent surgery. Knee pre-operative planning at our institution generally consists of using software to template cuts for the distal femur and the tibial cut and this may not be improved as much by knowledge of the other side. Other researchers have shown that postoperative medical complications or surgical site infections after the first THA or TKA are associated with recurrence of these complications with the contralateral procedure[37,38].

As with any study of this type there are important limitations to consider. Despite a large cohort of patients, ED return and readmissions are relatively rare events, making it difficult to detect clinically significant differences. This research was performed at a large tertiary referral academic medical center, and it is possible the results may be different in other practice settings due to factors like consistency of OR staff, presence of trainees including medical students, residents, and fellows, and level of complexity of cases. Of note, in this study, both sides were operated on at the same institution and the beneficial effect may be diminished if the subsequent surgery is performed by another surgeon at a different institution. We did not report perioperative variables such as blood loss and postoperative pain, due to limitations of our electronic database. Lastly, this study is not a direct comparison of simultaneous bilateral TJA to staged TJA, so conclusions regarding superiority of one technique will require additional research.

Several studies have focused on patient perceptions of functional improvement. Gazendam *et al*[33] showed that PROMs and reporting minimally clinically important difference after the first THA is predictive of a similar response on the second contralateral THA[33]. The importance of patient counseling is critical, and surgeons should avoid making assumptions about patients' expectations. Poultsides *et al*[39] showed that patients expectations had only a fair to moderate correlation between their first and second of staged TJA[39]. This seems to be particularly key in TKA. Multiple reviews have shown that the second TKA has significantly worse PROMs than the first[40,41] even in patients who were satisfied overall, and in patients who reported dissatisfaction with one of their TKAs, there was 50% greater risk of dissatisfaction at 1 year with the second TKA. However, from an objective surgical course and recovery perspective, our study demonstrates that operative time for THA, LOS, and postoperative discharge disposition can be anticipated for patients undergoing the second side TJA.

CONCLUSION

In conclusion, the second side of a staged THA is more efficient in terms of operative time, likely due to increased precision in pre-operative planning to account for implant sizing and possibly matched leg length discrepancy when the other side has already been replaced. Interestingly, this pattern was not observed for TKA. After gaining valuable

Table 2 Patient outcomes for arthroplasty patients based on procedure number

	First procedure	Second procedure	*P* value
Arthroplasty (*n* = 1284)			
OR time (min)	99.0 (86.0, 119.0)	96.0 (86.0, 113.0)	0.039
Length of stay (d)	2.26 (1.40, 3.14)	2.09 (1.28, 2.41)	< 0.001
Discharge to SNF	120 (18.7)	106 (16.5)	0.305
90-d ED return	48 (7.5)	47 (7.3)	0.915
90-d readmission	19 (3.0)	24 (3.7)	0.438
30-d readmission	14 (2.2)	15 (2.3)	0.851
Total knee arthroplasty (*n* = 728)			
OR time (min)	97.0 (85.0, 118.0)	97.0 (86.0, 113.0)	0.654
Length of stay (d)	2.3 (2.09, 3.19)	2.21 (1.33, 2.47)	< 0.001
Discharge to SNF	82 (22.5)	72 (19.8)	0.364
90-d ED return	23 (6.3)	30 (8.2)	0.318
90-d readmission	8 (2.2)	9 (2.5)	0.806
30-d readmission	7 (1.9)	7 (1.9)	1.000
Total hip arthroplasty (*n* = 556)			
OR time (min)	102.0 (88.0, 121.0)	96.0 (85.0, 112.0)	0.011
Length of stay (d)	2.21 (1.36, 2.48)	1.38 (1.23, 2.32)	< 0.001
Discharge to SNF	38 (13.7)	34 (12.2)	0.530
90-d ED return	25 (9.0)	17 (6.1)	0.199
90-d readmission	11 (4.0)	15 (5.4)	0.422
30-d readmission	7 (2.5)	8 (2.9)	0.794

Continuous data are presented as median (lower quartile, upper quartile). Categorical data are presented as count (percent). SNF: Skilled nursing facilities; ED: Emergency department; OR: Operating room.

experience recovering from the initial surgery, a patient's perioperative outcomes are improved for their second TJA, and this is likely attributable to the experience of the first procedure and reduction in anxiety. This may be the result of increased confidence, decreased anxiety, and supports the theory that enhanced patient education pre-operatively may improve outcomes. This information can be used to counsel patients who are considering bilateral TJA or who have already had one side replaced and are considering the second side.

ARTICLE HIGHLIGHTS

Research background

The volume of total joint arthroplasty is increasing rapidly and measures to decrease complications, increase efficiency and minimize resource utilization are important considerations.

Research motivation

The motivation for this project was to investigate if patients and surgeons learned or improved upon measures from the initial arthroplasty in subsequent contralateral procedures.

Research objectives

Our primary outcomes examined were operative time, length of stay, discharge disposition and 90-d emergency department visits and admissions. Length of stay was statistically significantly shorter. Total hip arthroplasty (THA) patients had a shorter operative time when the same implant sizes were utilized. There was no difference in 90-d hospital utilization.

Research methods
We utilized retrospective institutional database review for data collection and univariable analyses to compare cohorts.

Research results
Our results show that the second side of staged THA performed had shorter operative time, but there was no difference in total knee arthroplasty (TKA). There were no differences in postoperative hospital utilization. There was a shorter length of stay after the second procedure.

Research conclusions
This study reveals that patients had a shorter hospital stay after the second total joint arthroplasty (TJA) and operative time was statistically significantly shorter for the contralateral THA, but no difference was noted in TKA. This study seems to show that there is a benefit to pre and postoperative counseling in patient hospital stay and clinical course, and that there is a similar rate of postoperative hospital visits after the first and second TJA.

Research perspectives
Future studies may examine patient reported outcomes and experience of pain after first and second total joint arthroplasty, as well as if implant type or bearing type may affect patient reported outcomes or outcomes.

FOOTNOTES

Author contributions: Wu CJ revised the manuscript; Penrose C performed the data collection and drafted manuscript; Ryan SP performed data collection and analysis and drafted manuscript; Bolognesi MP, Seyler TM, and Wellman SS designed the study and provided guidance; All authors approved the final manuscript.

Institutional review board statement: Institutional review board approval was obtained prior to initiation of the study.

Informed consent statement: Consent is waived per the Duke Institutional Review Board for this retrospective review study.

Conflict-of-interest statement: Colin Penrose and Christine Jiang Wu report no conflicts. Sean Patrick Ryan reports research support from Zimmer Biomet and Smith & Nephew, outside the submitted work. Michael Paul Bolognesi reports royalties from Total Joint Orthopaedics and Zimmer Biomet, stock options from Amedica, research support from Depuy Synthes, Exactech, PCORI, and financial support from Smith & Nephew, DJO, and Acelity, and research support from KCI, outside of this work. Thorsten Markus Seyler reports paid consultant work from Total Joint Orthopedics, Smith & Nephew, Heraeus Medical, and Peptilogics, research support from Zimmer Biomet, Royalties from Pattern Health, publishing royalties from Lippincott Williams & Wilkins, and IP royalties from Restor3d, outside the submitted work. Samuel Secord Wellman reports research support from Zimmer Biomet and DePuy Synthes, stock options from Joint Development, LLC, research support from Medacta, Smith & Nephew, Stryker, and royalties from Joint Orthopedics, outside the submitted work.

Data sharing statement: Per the institutional review board, consent was not obtained but the data are de-identified and risk of identification is low.

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