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Original research

Revision Total Knee Arthroplasty Is Associated With Significantly Higher Opioid Consumption as Compared With Primary Total Knee Arthroplasty in the Acute Postoperative Period

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ABSTRACT

Background: There is a scarcity of studies investigating narcotic use after revision total knee arthroplasty (TKA). We compared immediate postsurgical narcotic consumption after revision TKA and primary TKA.
Methods: A single-institution database was used to identify patients who underwent revision TKA or primary TKA between 2016 and 2019. Morphine milligram equivalents (MMEs) were calculated to discern narcotic usage, and pain visual analog score was also used.
Results: A total of 7342 cases were identified: 88.65% primary TKA and 11.35% revision TKA. Opioid consumption for the first 24 hours postoperatively was significantly higher for the revision TKA group (133.1 MMEs vs 56.14 MMEs, $P < .0001$), as well as for the 24- to 48-hour time period. The visual analog pain scores were also higher for the revision TKA group.
Conclusion: The revision TKA group had a higher opioid requirement, most significant during the first 24 hours postoperatively, and expressed more pain in the acute postoperative period.

Introduction

Optimal strategies to minimize opiate consumption and improve postoperative pain management for total knee arthroplasty (TKA) continue to raise significant interest. As opioid use in the United States has now reached a level where it is called an epidemic [1], more attention is being paid to prescribers and what we are prescribing. This is especially true for orthopaedic surgeons, who are some of the highest volume prescribers of narcotics, [2-4] and opioid prescriptions after orthopaedic procedures are one of the leading causes of long-term opioid use [5,6].

With the focus on opioid use, a considerable amount of attention has gone into deriving new opioid-sparing or reduced opioid pain management programs to follow total joint arthroplasty. These opioid-sparing protocols have become very effective at reducing narcotic consumption and improving function after primary total knee arthroplasty (pTKA), including at our own institution [7-11]. But while multiple studies have described pain management plans to reduce opioid consumption after pTKA, there has been minimal investigation into whether the consumption of opioids after revision TKA (rTKA) is comparable with pTKA and whether these multimodal pain plans are able to be translated to rTKA in the acute postoperative period. rTKA procedures are technically more demanding and can involve greater soft-tissue and osseous manipulation than primary procedures. As the number of rTKA is expected to continue to rise [12,13], it is important that we understand how to best care for these patients. In this study, we sought to determine whether immediate postsurgical opioid use was different between rTKA and pTKA.

Material and methods

Data source

A single-institution total joint arthroplasty database was used to identify patients who underwent a pTKA or rTKA from 2016 to 2019

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from all surgeons operating at 1 academic medical center (20 surgeons performing pTKA and/or rTKA). These patients were identified based on those who had 2020 Current Procedural Terminology codes 27447 (primary total knee) and 27487 (revision total knee). Data were collected from our institution's electronic data warehouse prospectively. This study was exempt from institutional review board approval based on institutional guidelines.

Outcomes of interest

We collected information regarding surgical procedure, patient age, gender, American Society of Anesthesiologists scores, discharge disposition, surgical time, and length of stay. Surgical time was derived from the time of incision and time of closure documented in the electronic medical record and calculating the difference between the two. Discharge disposition was stratified by homebound or nonhomebound. Pain score is documented in electronic medical record during the patients' hospitalization using the visual analog pain (VAS) scale, and this was recorded for the 0- to 12-hour postoperative period and the 12- to 24-hour postoperative period. Inclusion criteria included patients aged 18 years and older who had undergone TKA and rTKA for all causes, including infection. Exclusion criteria included patients who had undergone bilateral TKA. Conversion TKAs were classified based on how they were billed by the Current Procedural Terminology code, primarily as pTKA, as no separate code exists. Morphine milligram equivalents (MMEs) were calculated for each patient based on opioid consumption for 0-24 hours, 24-48 hours, and the entire hospitalization. This calculation was based on conversion factors described by the Centers for Disease Control and Prevention and the American Pain Society [14-16]. The Activity Measure for Post-Acute Care (AMPAC) scores were calculated for each patient for their first 24 hours postoperatively to monitor physical therapy process. This score has been previously validated for use in the postoperative setting [17]. At our institution, all patients are prescribed the same initial pain protocol postoperatively unless they are on narcotics preoperatively in which case their home pain regimen is ordered. The standard pain protocol consists of standing tramadol, high-dose acetaminophen, and meloxicam as well as nonmedicinal pain control with ice and elevation. There is also a breakthrough as-needed oxycodone ordered. If this is deemed to be insufficient for the patient's pain control postoperatively based on the patient's pain scale, then the narcotics offered to the patient are increased gradually until there is adequate pain control. In addition, there is routine usage of periarticular blocks performed by the surgeon. During the collection period of this study, there was a shift from using Marcaine (Pfizer, New York, NY) to liposomal bupivacaine and then back to Marcaine. This was applicable to both pTKA and rTKA. In our pain protocols during the study period, there was no routine use of adductor canal blocks or other anesthesiologist-administered nerve blocks.

Statistical analysis

A binary variable was created to identify pTKA vs rTKA. For categorical variables, χ^2 analysis was used to determine statistically significant differences between groups, whereas the Student *t* test was used for numerical variables (SAS, Cary, NC). *P* values <0.05 were considered statistically significant.

Results

Characteristics of the study population

A total of 7342 cases were identified that met inclusion and exclusion criteria: 88.65% pTKAs (6509) and 11.3% rTKAs (833). There were some statistically significant differences between these 2 groups. The patients who underwent rTKA were older than the patients who underwent pTKA (66.03 vs 64.13 years; $P < .001$) and had a higher percentage of men in the cohort (39.38% vs 31.60%; $P < .0001$). In addition, patients who underwent rTKA had a higher ASA score than the patients who underwent pTKA (class 3, 51.44% vs 46.47%; $P < .001$). There was a statistically significant difference in the makeup of race between the 2 groups ($P < .001$). There was also a statistically significant difference in body mass index between the 2 groups, with the rTKA group having a slightly higher body mass index (33.14 vs 32.61; $P = .0267$). (Table 1)

Outcome regarding opioid consumption

In each time period measured, the rTKA group consumed significantly more opioids than the pTKA group. In the 0- to 24-hour postoperative time period, the rTKA group consumed 133.1 MMEs vs 56.14 MMEs in the primary group ($P < .0001$). In the next 24 hours, 24-48 hours postoperatively, the rTKA group consumed 58.05 MMEs vs 43.45 MMEs in the primary group ($P < .0001$). Finally, the total MMEs for the encounter were significantly higher for the rTKA group than for the pTKA group (292.3 vs 136.5, $P < .0001$). (Table 2)

Secondary outcomes

The rTKA group had a significantly higher length of stay than the pTKA group (3.54 days vs 2.48 days, respectively; $P < .0001$) and also had a significantly lower rate of discharge to home (76.23% vs 83.04%, respectively; $P < .0001$). The rTKA pain score was higher than the pTKA score at both the 0- to 12-hour time period (3.64 vs 2.58, respectively; $P < .0001$) and the 12- to 24-hour time period (5.3 vs 5.0, respectively; $P = .0500$). Both the rTKA and pTKA groups expressed a higher pain score at the 12- to 24-hour time period than the 0- to 12-hour time period. There was no significant difference in the AMPAC score for the hospital stay between the 2 groups (18.78 vs 18.76, $P = .8576$) (Table 2).

Discussion

Our study demonstrates that patients after rTKA have a significantly higher opioid requirement than patients having undergone pTKA. At our own institution, we have demonstrated that an opioid-sparing pain protocol can decrease narcotic utilization in pTKA and improve postoperative function, but this success has not

Table 1
Demographics of the revision TKA (rTKA) cohort compared with those of the primary TKA (pTKA) cohort.

Demographic	rTKA	pTKA	
Sample size	833	6509	
Age	64.13 (9.69)	66.03 (9.58)	***P* < .0001**
BMI	33.14 (6.96)	32.61 (6.40)	***P* = .0267**
% Male	39.38%	31.60%	***P* < .0001**
Race			
White	57.26%	54.57%	***P* < .0001**
Black	22.33%	20.03%	
Asian	2.40%	4.33%	
Other	18.01%	21.06%	
ASA status			
Class 1	2.16%	1.65%	***P* < .0001**
Class 2	42.31%	49.31%	
Class 3	51.44%	46.47%	
Class 4	4.09%	2.41%	

BMI, body mass index; TKA, total knee arthroplasty.
Significant *P* values are given in bold.

Table 2
Outcomes of the rTKA cohort compared with outcomes of the pTKA cohort.

Outcome	rTKA	pTKA	
Surgical time	133.0 ± 52.59	102.6 ± 29.9	***P* < .0001**
LOS (days)	3.54 ± 3.07	2.48 ± 1.52	***P* < .0001**
Home discharge (%)	76.23%	83.04%	***P* < .0001**
Total MME	292.3 ± 454.8	136.5 ± 232.8	***P* < .0001**
MME 0-24 hours	133.1 ± 197.7	56.14 ± 91.71	***P* < .0001**
MME 24-48 hours	58.05 ± 80.87	43.45 ± 46.00	***P* < .0001**
Pain score 0-12 hours	3.64 ± 2.3	2.58 ± 1.90	***P* < .0001**
Pain score 12-24 hours	5.30 ± 1.78	5.0 ± 1.70	***P* = .0500**
AMPAC raw score	18.78 ± 3.85	18.76 ± 3.44	*P* = .8576

AMPAC, Activity Measure for Post-Acute Care; LOS, length of stay; MME, morphine milligram equivalent; pTKA, primary total knee arthroplasty; rTKA, revision total knee arthroplasty.
Significant *P* values are given in bold.

been translated to rTKA in the immediate postoperative period [11]. This is especially true in the initial 24-hour postoperative period, during which the rTKA group used 2.4 times more opioids that the pTKA group. In the subsequent 24 hours, the patients who underwent rTKA only used 1.33 times more opioids than the pTKA group. Thus, the multimodal pain protocols that have been effective for patients who underwent pTKA [7-9] do not appear to be as effective for our patients who underwent rTKA. By the second day, the differences in opioid requirements are less pronounced, suggesting that the opportunity for improved pain control is in the immediate postoperative period. This is also reflected in the VAS pain scales recorded, where the difference between the rTKA and pTKA groups is larger in the first 12 hours compared with the subsequent 12 hours.

The AMPAC raw score is not statistically different between the 2 groups. Because the AMPAC reflects the physical therapy performed during the entire hospitalization, this just shows that the 2 groups are able to progress to a similar point in therapy before discharge. However, because the rTKA groups on average had a longer length of stay, it does not allow for a day-by-day comparison. As there is considerable evidence to support that poorly controlled acute postoperative pain can lead to delayed recovery time and prolonged duration of opioid use [18], we should focus on the acute postoperative period after rTKA as a target to improve our pain programs.

Multiple studies have looked at how opioid use affects TKA outcomes and rates of revisions, but there has been minimal research previously into opioid use associated with rTKA. It has been shown that opioid-naïve patients who underwent pTKA had a lower revision rate than those using narcotics preoperatively and that the more opioids used preoperatively correlated with an increasing revision rate [14-16,19,20]. In addition, preoperative opioid use has been shown to be linked to worse clinical outcomes, including poorer postoperative pain control, higher deep vein thrombosis rates, and longer length of stay [17,21,22]. The negative impact of both preoperative and postoperative opioid use has been shown in multiple studies, which highlights that opioid use is associated with worse outcomes, longer length of stay, higher complications, and higher rates of in-hospital morbidity and mortality after TKA [23-29]. Singh and Lewallen [30] found that younger patients and those with a diagnosis of depression were at higher risk for continued opioid use after rTKA. The harmful effects of opioids on the outcomes of patients who underwent pTKA have been well displayed in these multiple studies, but this study identified the fact that we still do not have adequate control over pain in the acute postoperative setting after rTKA surgery. We believe it is important to now focus on how to minimize preoperative opioid administration in these patients. Grant et al [31] found retrospectively that the use of a adductor canal block equalized the 48-hour opioid consumption between patients who underwent pTKA and rTKA. Although this was a small, retrospective study, we believe this offers a promising technique to improve acute postoperative pain control after rTKA and is worth studying in a large prospective study.

There were several limitations to our study. It was a retrospective study, which allows for selection bias or information bias to be introduced into the study. Given that the revision surgeries have more heterogeneity than primary surgeries, there is more variability in this group as compared with the pTKA group. We did not explore which types of revisions (both components vs polyethylene liner only and revision for infection vs for instability) were less responsive to the current opioid-sparing pain protocol. As the exposure required to perform a rTKA is more substantial than that for the pTKA, we would expect that any of the variations of rTKA require more extensive pain control. An additional limitation is that we did not collect whether the patients had preoperatively been on opioids, which may have influenced postoperative opioid requirements in both groups. But, we feel that this may not be as big of a factor as may have been thought, for by the second 24 hours postoperatively, there was more similarity in opioid consumption between the 2 groups. This does suggest an area of further study. Finally, we did not investigate whether the type of anesthesia used for surgery was associated with differences in postoperative opioid consumption. At our institution, short-acting spinal anesthesia is used for 92% of our primary total joints. The protocol for our rTKA is to use spinal anesthesia as the first-line anesthesia, but the anesthesia providers dose the patient in accordance with the estimated procedure duration [32].

Conclusions

There has been considerable importance placed at institutions, including ours, on minimizing narcotic use and implementing opioid-sparing protocols for patients undergoing TKA. Our study shows that these protocols may not be generalizable to our patients who underwent rTKA in the acute postoperative period. The patients who underwent rTKA experience more pain and have a higher narcotic requirement. Further research is needed into better methods to control pain for our revision patients postoperatively, including nerve blocks, additional doses of steroids, intravenous acetaminophen, ibuprofen injections, more robust periarticular injections, ketamine, and cryoanalgesia [33-38]. These adjuncts have been studied with respect to primary total joint arthroplasty, but we feel that they may also be effective in treating patients who underwent rTKA who may not be adequately treated with low-dose opioid protocols. Finding improved methods to minimize the acute pain and narcotic use in patients who underwent rTKA will help us to facilitate recovery and to prevent long-term opioid use.

Conflict of interest

Ran Schwarzkopf, MD, MSc, reports royalties from Smith and Nephew, paid consultancy for Smith and Nephew and Intellijoint; stock or stock options in Gauss Surgical and Intellijoint; research support from Smith and Nephew and Intellijoint; medical/orthopaedic publications in *Journal of Arthroplasty* and *Arthroplasty Today*; and a board member/committee appointment for AAHKS and AAOS. William J. Long, MD, FRCSC, reports royalties from Ortho Development, Micropot, and J&J; speakers bureau/paid presentations for ConvaTec, Think Surgical, and Pacira; paid consultancy for TJO, DePuy, Ortho Development, Microport, Johnson and Johnson, Think Surgical, ConvaTec, and Pacira; research support from Think Surgical and KCI; royalties, financial, or material support from Elsevier; medical/orthopaedic publications in *Journal of*

Arthroplasty and *The Knee*; and a board member/committee appointment for AAOS ICL Hip. All other authors declare no potential conflicts of interest.

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