The Journal of Arthroplasty xxx (2016) 1–5

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Navigated vs Conventional Total Knee Arthroplasty: Is There a Difference in the Rate of Respiratory Complications and Transfusions?

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ARTICLE INFO

Article history:
Received 26 November 2015
Received in revised form
7 March 2016
Accepted 22 March 2016
Available online xxx

Level of Evidence:
Level II
prognostic study

Keywords:
computer-assisted surgery
navigation
total knee arthroplasty
NSQIP database
transfusions
respiratory complications

ABSTRACT

Background: Proponents of navigation in total knee arthroplasty (TKA) report lower rates of systemic embolization and perioperative bleeding compared to conventional TKA given that breeching the intramedullary canal is not required.

Methods: We queried the National Surgical Quality Improvement Program to compare perioperative respiratory complications and transfusions between navigated and conventional TKA. We identified 2008 patients who underwent navigated TKA. These patients were matched 4:1 to a control group of 8026 patients.

Results: Conventional TKA resulted in similar odds of having a respiratory complication compared to navigated TKA (odds ratio = 1.35, P = .44). However, conventional TKA was found to be an independent predictor for requiring a transfusion perioperatively (odds ratio = 1.90, $P < .001$).

Conclusion: Use of navigation in TKA results in less perioperative transfusions but has no influence on the rate of respiratory complications.

The initial objectives of computer-assisted surgery in total knee arthroplasty (TKA) were to improve the accuracy and alignment of the femoral and tibial components while providing additional information about soft tissue balancing [1]. The ultimate goal of navigated TKA was to improve implant longevity. Despite radiographic evidence of improved alignment [2,3] and lower revision rates with use of navigation [4,5], only 3.2% of knee arthroplasties were performed using navigation in the United States between 2008 and 2010 [6]. Possible reasons for a low adoption of navigation include additional costs, increased surgical time, lack of training with navigation, and the absence of better functional outcomes or long-term survival [7-9].

Proponents of navigation TKA also claim other theoretical advantages over conventional TKA such as a decrease in systemic embolization and perioperative bleeding given that breeching the intramedullary canal to insert alignment guides is not required during navigation [10,11]. Recent randomized controlled trials have shown fewer systemic fat emboli after navigated TKA when measured by transesophageal echocardiography and transcranial ultrasonography [10,12]. However, it remains unknown whether this theoretical increase in systemic fat emboli results in clinically important differences in respiratory complications during conventional TKA. One possible explanation is that these studies are too small and underpowered to detect clinically important differences.

The question surrounding reduced perioperative blood loss after navigated TKA also remains controversial. Recent studies have shown less intraoperative blood loss, lower calculated hemoglobin loss, and less drainage in patients undergoing computer navigation TKA compared to conventional TKA [13-15]. However, these studies included only a small sample size and failed to show any difference in transfusion requirements postoperatively.

Each author certifies that all investigations were conducted in conformity with ethical principles of research.

This work was performed at the Jewish General Hospital, Montreal, Canada.

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.03.051.

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http://dx.doi.org/10.1016/j.arth.2016.03.051
0883-5403/

The primary objective of this study was to compare the rate of respiratory complications between navigated and conventional TKA within the first 72 hours postoperatively using a large administrative database. The secondary objective was to assess the rate of perioperative transfusions within the first 72 hours after surgery as a clinically relevant surrogate for perioperative bleeding. Our hypothesis is that the type of surgical procedure (navigated vs conventional) is not an independent predictor for either perioperative respiratory complications or transfusion requirements after primary, unilateral TKA.

Patients and Methods

We analyzed the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from January 1, 2011 to December 31, 2013. This registry is nationally validated and risk adjusted [16]. NSQIP prospectively collects patient data including preoperative baseline demographics, surgical variables, and 30-day postoperative complications from more than 650 North American hospitals [17]. Data collection methods have been previously reported in detail [18].

Patients were identified using Current Procedural Terminology (CPT) codes corresponding to conventional (CPT: 27447) and navigated TKA (CPT: 27447 and CPT: 20985). Only elective, primary, unilateral TKA were included in this study. All cases involving major ligament reconstructions, bilateral procedures, revisions, and emergency procedures were excluded. Furthermore, patients who had missing baseline data were excluded from the study.

A total of 2008 patients undergoing primary, unilateral navigated TKA were identified. These patients were then matched using a 4:1 ratio to a control group undergoing conventional TKA during the same study period according to age, gender, and American Society of Anesthesiologists score. A nearest neighbor matching technique was chosen to identify the matches in both groups according to a greedy matching algorithm. This allows patients in the navigated group to be sorted according to their estimated propensity score and matches each patient to 4 “nearest neighbour” patients in the conventional TKA group [19]. This created a matched control group of 8026 patients treated with conventional TKA.

A perioperative respiratory complication was defined by the presence of at least one of the following complications during the procedure or within 72 hours postoperatively: pulmonary embolism, unplanned intubation, or failure to wean from a ventilator. NSQIP does not differentiate between thromboembolic and fat embolism. Consequently, we decided to include all types of embolism in our analysis because we did not want to underestimate the rate of respiratory complications and because it is sometimes difficult to differentiate between thromboembolic and fat embolisms in the clinical setting.

The perioperative transfusion rate was calculated based on the number of patients receiving at least one transfusion of blood products during the operation or in the first 72 hours after surgery. Transfusions beyond 72 hours were excluded because these were thought to be unrelated to the type of surgery being performed. Thirty-day postoperative complications were also recorded.

Statistics

Baseline variables and unadjusted postoperative complications were analyzed using a Fisher's exact test for binary variables and Pearson's chi-square test for categorical variables. Continuous data were assessed using a 2-tailed unpaired *t*-test. Continuous variables are reported as mean ± standard deviation and categorical variables as absolute values and frequencies using percentages. Variables that had greater than 5% missing values were excluded from the analysis.

Multivariable logistic regression models were performed to assess the independent effect of a patient's type of surgery (navigated vs conventional TKA) on the risk of having a perioperative respiratory complication or being transfused while controlling for all other risk factors. The initial model included all baseline demographic variables from Table 1 as these were considered to be confounders in the relationship between the type of surgery and respiratory complications. Additional models were then created by excluding variables that were believed to be unlikely true confounders. The stability of each model was examined by comparing the −2 Log L, chi-square likelihood ratio and Akaike information criterion to earlier models. A separate multivariable logistic regression model was performed for respiratory complications and transfusion rates. Odds ratios (ORs) and 95% CI were used to report the independent effect of each risk factor included in the final model. A P value <.05 (2 tailed) was considered to be statistically significant. Statistical analyses were performed using SPSS (SPSS 22.0, IBM Inc, Somers, NY).

Results

A total of 10,034 patients were included in this study: 2008 patients treated with navigated TKA and 8026 patients with conventional TKA. The preoperative characteristics of the patients in both groups are shown in Table 1. Baseline patient demographics and comorbidities were overall similar between the navigated and

Table 1
Patient Baseline Demographics and Operative Characteristics for Navigated and Conventional TKA.

Patient Demographics and Operative Characteristics	Navigated (N = 2008)	Conventional (N = 8026)	*P* Value
Patient demographics			
Age (y) (±SD)	67.32 ± 9.87	66.35 ± 9.82	<.001
Male gender (%)	743 (37)	2970 (37)	.999
Preoperative comorbidities			
BMI (kg/m^2) (±SD)	32.38 ± 6.65	32.83 ± 7.05	.009
Diabetes mellitus (%)	369 (18.4)	1397 (17.4)	.310
Hypertension (%)	1392 (69.3)	5418 (67.5)	.122
Smoking (%)	154 (7.7)	707 (8.8)	.11
COPD (%)	95 (4.7)	282 (3.5)	.011
Congestive heart failure (%)	9 (0.4)	21 (0.3)	.172
Dialysis (%)	3 (0.1)	11 (0.1)	1.000
Corticosteroids use (%)	57 (2.8)	274 (3.4)	.210
Bleeding disorder (%)	47 (2.3)	193 (2.4)	.929
Preoperative laboratory values			
Hematocrit (%)	40.6 ± 4.08	40.56 ± 4.01	.734
BUN (±SD)	18.1 ± 6.92	18.14 ± 6.87	.798
Creatinine (mg/dL) (±SD)	0.91 ± 0.42	0.91 ± 0.44	.968
INR (±SD)	1.04 ± 0.25	1.03 ± 0.22	.025
aPTT (±SD)	29.41 ± 4.28	29.10 ± 4.56	.035
WBC (±SD)	7.17 ± 2.11	7.03 ± 2.21	.019
Platelets (±SD)	247.34 ± 67.82	244.59 ± 66.74	.107
PT (±SD)	12.66 ± 1.56	11.75 ± 2.44	<.001
Operative characteristics			
General anesthesia (%)	1469 (73.2)	4527 (56.4)	<.001
Regional anesthesia (%)	539 (26.8)	3499 (43.6)	
ASA classification (%)			.999
ASA 1-no disturbance	31 (1.5)	122 (1.5)	
ASA 2-mild disturbance	1036 (51.6)	4144 (51.6)	
ASA 3-severe disturbance	908 (45.2)	3631 (45.2)	
ASA 4-life threatening	33 (1.6)	129 (1.6)	
Postop length of stay (d)	3.08 ± 1.19	3.22 ± 1.52	<.001
Operation time (min)	93.3 ± 32.59	93.7 ± 33.35	.625

aPTT, activated partial thromboplastin time; ASA, American Society of Anesthesiologists; BMI, body mass index; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; INR, international normalized ratio; PT, prothrombin time; SD, standard deviation; TKA, total knee arthroplasty; WBC, white blood cell.