Resident Involvement in Arthroscopic Knee Surgery Is Not Associated With Increased Short-term Risk to Patients

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Background: Whether resident involvement in surgical procedures affects intra- and/or postoperative outcomes is controversial.

Purpose/Hypothesis: The purpose of this study was to compare operative time, adverse events, and readmission rate for arthroscopic knee surgery cases with and without resident involvement. We hypothesized that resident involvement would not negatively affect these variables.

Study Design: Cohort study; Level of evidence, 3.

Methods: A retrospective review of the prospectively maintained National Surgical Quality Improvement Program was performed. Patients who underwent arthroscopic knee surgery between 2005 and 2012 were identified. Multivariate Poisson regression with robust error variance was used to compare the rates of postoperative adverse events and readmission within 30 days between cases with and without resident involvement. Multivariate linear regression was used to compare operative time between cohorts. Because of multiple statistical comparisons, a Bonferroni correction was used, and statistical significance was set at \( P < .004 \).

Results: A total of 29,539 patients who underwent arthroscopic knee surgery were included in the study, and 11.3% of these patients had a resident involved with the case. The overall rate of adverse events was 1.62%. On multivariate analysis, resident involvement was not associated with increased rates of adverse events or readmission. Resident cases had a mean 6-minute increase in operative time \( (P < .001) \).

Conclusion: Overall, resident involvement in arthroscopic knee surgery was not associated with an increased risk of adverse events or readmission. Resident involvement was associated with only a mean increased operative time of 6 minutes, a difference that is not likely to be clinically significant. These results support the safety of resident involvement with arthroscopic knee surgery.

Keywords: knee; arthroscopy; resident; training; NSQIP; safety

Arthroscopic knee surgery is a fundamental and commonly performed procedure within the field of orthopaedic surgery. For example, arthroscopic partial meniscectomy alone is the most commonly performed orthopaedic procedure in the United States. In addition to the frequency with which it is performed, arthroscopic knee surgery is well-tolerated with an overall low complication rate. Per the Accreditation Council for Graduate Medical Education (ACGME) orthopaedic sports medicine milestones, meniscal tear and anterior cruciate ligament (ACL) tears are the only required core competences related to knee arthroscopic surgery.

One of the goals of the core competency procedures of the ACGME is to prepare orthopaedic surgery trainees to become independent practitioners via a system of graduated responsibility. However, a consequence of this system is concern regarding patient safety, coupled with the external pressures of operating room time and cost efficiency. Previous studies have investigated the impact of resident involvement on adverse outcomes and readmissions after spine surgery, total joint arthroplasty, and shoulder arthroscopy.

The purpose of the current study was to use a large national data set to compare operative time, adverse events, and readmission for arthroscopic knee surgery cases with and without resident involvement. Our hypothesis was that operative time, adverse events, and readmissions would not significantly differ between arthroscopic surgeries...
knee surgery cases with and without a resident involved in the performance of the procedure.

METHODS

Data Source

Per institutional policy, the current study did not require approval by an ethics review board. Data for this study were obtained from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). The ACS-NSQIP is a database that has become widely used in the orthopaedic literature to analyze outcomes after surgery. It contains information from >300 hospitals, and demographics, comorbidities, hospital data, and postoperative data are gathered. The full methodology of the data-collection process used by the ACS-NSQIP is described elsewhere. Briefly, patients are identified prospectively and randomly sampled at eligible hospitals. Clinical data are collected for the entire 30-day postoperative period, regardless of discharge status within this time.

Data Collection

Patients who underwent arthroscopic knee surgery between 2005 and 2012 were identified in the ACS-NSQIP database using Current Procedural Terminology codes 29866, 29867, 29868, 29873, 29874, 29875, 29876, 29877, 29879, 29880, 29881, 29882, 29883, 29884, 29885, 29886, 29887, 29888, and 29889. These codes were based on the precedent of previous studies of arthroscopic knee surgery in the ACS-NSQIP data set. Additionally, resident involvement in surgical procedures is poorly captured in the ACS-NSQIP after 2012, so although data from later years are available, only data through the end of 2012 were used. To control for differing magnitudes of procedures and possible accessory incisions, a “major” arthroscopic procedure was defined as osteochondral autograft, osteochondral allograft, meniscal transplant, ACL reconstruction, or posterior cruciate ligament reconstruction. Patients undergoing nonselective surgery or those with incomplete perioperative data were excluded from this study.

The ACS-NSQIP database includes sex, age, height, and weight. Body mass index was calculated from each patient’s height and weight. A history of smoking was defined as the use of tobacco products within the past year. Hypertension was defined as a chart diagnosis of hypertension with the patient currently taking antihypertensive medication. A history of diabetes is recorded as 1 of 3 groups in the database: insulin-dependent diabetes mellitus, non-insulin dependent diabetes mellitus, or no diabetes. American Society of Anesthesiologists class ≥3 corresponds to severe systemic disease. History of chronic obstructive pulmonary disease and congestive heart failure as well as the number of operative levels were also available in the database.

The ACS-NSQIP also includes a variable specifying whether a resident was scrubbed into a surgical case. Thus, for the purposes of this study, resident involvement has been simply defined as whether a resident scrubbed into the surgical case.

Outcomes

The ACS-NSQIP records intra- and postoperative data in a standardized fashion, including operative time, the occurrence of postoperative adverse events within 30 days, and readmission within 30 days.

Operative time was the time in minutes from the opening incision to the end of wound closure. The occurrence of a serious adverse event (SAE) was defined as the occurrence of any of the following: death, coma >24 hours, ventilator >48 hours, unplanned intubation, stroke/cerebrovascular accident, thromboembolic event (deep venous thrombosis or pulmonary embolism), cardiac arrest, myocardial infarction, acute renal failure, sepsis, septic shock, return to the operating room, deep surgical site infection, or organ/system infection. The occurrence of a minor adverse event (MAE) was defined as a superficial surgical site infection, urinary tract infection, pneumonia, progressive renal insufficiency, or wound dehiscence. Any adverse event was defined as the occurrence of any SAE or MAE. Groups were compared in terms of any adverse event, SAEs, and MAEs as well as individual adverse events.

Readmission was defined as a patient having an unplanned hospital admission to the index facility or another facility after the initial postoperative discharge. As the ACS-NSQIP began collecting readmission data...
beginning in 2011, only patients who underwent surgery from 2011 and 2012 were included in the readmission analysis.

Statistical Analysis

Statistical analyses were conducted using Stata Version 13.1 (StataCorp). All demographic and comorbidity variables were compared between procedures with and without resident involvement using chi-square analysis. Operative time, a continuous variable, was compared between groups using bivariate and multivariate linear regression to control for patient characteristics. Adverse events and readmission were compared between groups using bivariate and multivariate Poisson regression with robust error variance. All demographic and comorbidity variables were compared between procedures with and without resident involvement. Patients whose surgeries were performed by residents were generally younger (P < .001), had lower body mass index (P < .001), and had lower rates of medical comorbidities such as diabetes (P = .001) and chronic obstructive pulmonary disease (P = .044). American Society of Anesthesiologists class was also less in resident cases (P < .001). The rate of hypertension was higher in resident cases (P < .001).

The overall rates of adverse events were 1.62% and 1.64% without and with a resident present, respectively (Table 3). The most common adverse event was a return to the operating room (0.64%), followed by surgical site infection (0.48%) and thromboembolic events (0.46%). On multivariate analysis (Table 4), resident involvement was not associated with increased rates of any severe adverse event (P ≥ .004 for all) (Table 3). In regards to minor adverse events, resident involvement was only associated with higher need of blood transfusion (RR = 4.5, P = .004).

The mean ± SD operative time was 43 ± 41 and 57 ± 48 minutes without and with a resident present, respectively (Table 5). The association of resident involvement with operative time was next explored with bivariate and multivariate linear regression. On multivariate analysis,
resident cases had a mean increase in operative time ($P < .001$) of 6 minutes.

**DISCUSSION**

The present study found that resident involvement in arthroscopic knee surgery was not associated with increased risk of overall adverse events or readmission rate; however, resident involvement was associated with a mean increased operative time of 6 minutes.

Several published studies utilized the NSQIP database to assess the impact of resident involvement on intra- and postoperative morbidity and mortality in general surgical, orthopaedic spinal, and joint arthroplasty surgery.7,10,13,14,16,19 Kothari et al17 demonstrated that resident participation was associated with significantly longer operative times for 1136 patients undergoing adult spinal deformity surgery and, as a likely result of this, was an independent predictor of overall morbidity, wound complication, intra- and postoperative transfusion, and length of stay >5 days. By contrast, Haughom et al14 reported a higher incidence of postoperative sepsis in cases with resident involvement but lower transfusion rates despite greater operative time with total knee arthroplasty surgery in 24,529 cases. Haughom et al14 also noted lower transfusion rates in 13,109 cases of total hip arthroplasty despite resident involvement. Our study did not show increased rates of the aforementioned adverse events attributed to resident involvement; however, the rate of blood transfusion was significantly higher in the group of patients who underwent knee arthroscopy with a resident present. This final finding contrasts the results of the 2 studies by Haughom et al13,14 that showed lower transfusion rates despite resident involvement in total hip arthroplasty cases.

Schoenfeld et al19 evaluated 43,343 cases from the NSQIP database to determine the role of residents’ participation in general with orthopaedic surgery cases. The authors included only ACL reconstruction in their analysis of arthroscopic procedures. They found that a mild to moderate risk for complications was noted after resident involvement in arthroplasty procedures but that no such association was present with the amputation, spine, sports medicine, or hand-related orthopaedic procedures. Edelstein et al9
provided a similar analysis and found an association between resident involvement and lower risks for perioperative complications and mortality. However, for analysis, these previous studies were limited by combining relatively morbid procedures, such as hip fracture surgery, with procedures associated with lower morbidity, such as arthroscopic knee surgery.

The present study found no increased rates of overall adverse events and readmission. The rates of these events are generally considered to be very low, and patient-related risk factors for increased adverse events after knee arthroscopy procedures have been previously described, including advanced age, chronic steroid use, and chronic systemic disease. The findings of the present study are encouraging for resident training and important to convey to patients seeking care via these procedures at a teaching hospital.

While prior studies have suggested that longer operative duration increases the likelihood of contamination of sterile tray instruments by increasing the time that they are exposed to the air, prior data suggests that an important threshold of operative time in knee arthroscopy, over which the odds of any complication increases, is 1.5 hours—far greater than the mean value we report here of 46 minutes. Additionally, the mean increase of 6 minutes is well within the SD of 43 minutes of operative time found in the present study, likely indicating a clinically insignificant difference. Resident involvement in knee arthroscopy in this current analysis was based only on whether the resident was present or not during the case. The database used did not contain details on the specific procedures performed by the resident during knee arthroscopy (room setup, patient preparation, placement of dressings, specific surgical maneuvers, etc.). Therefore, based on our findings, it is difficult to explain the increase in operative time attributed to resident involvement in arthroscopic knee cases.

**Limitations**

While the ACS-NSQIP is one of the few large surgical registries to record resident involvement with surgical cases, the present study does have several limitations. First, while it can be determined whether a resident was involved with the case, there is no information about the extent of resident involvement. One way to improve this would be to modify the ACGME resident case log system to include the description of the procedures performed by the resident. For example, it must be clearly stated whether the resident helped with room or patient setup or if he or she actually performed surgical procedures. The last item would help to determine whether certain adverse events in knee arthroscopy could be related to resident involvement. In addition, data regarding the amount of resident involvement with postoperative care is not available. Second, there is a lack of information on orthopaedic-specific outcomes, such as pain, functional status, and clinical outcomes. Third, postoperative data and readmission are recorded for only 30 days, so any events that occurred after this period would not be captured.

**CONCLUSION**

Overall, resident involvement in arthroscopic knee surgery was not associated with an increased risk of adverse events or readmission. Resident involvement was associated with a mean increased operative time of only 6 minutes, a difference that is not likely to be clinically significant. These results support the safety of resident involvement with arthroscopic knee surgery.

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