

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

Bryce A. Basques,* MD, Bryan M. Saltzman,[†] MD, Shane S. Korber,[‡] MD, Ioanna K. Bolia,[‡] MD, MS, PhD, Erik N. Mayer,[§] MD, Bernard R. Bach,* MD, Nikhil N. Verma,* MD, Brian J. Cole,* MD, and Alexander E. Weber,^{‡||} MD

Investigation performed at the USC Epstein Family Center for Sports Medicine at Keck Medicine of USC, Los Angeles, California, USA

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.^{6,16} In addition to the frequency with which it is performed, arthroscopic knee surgery is well-tolerated with an overall low complication rate.^{12,18} 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.¹

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.^{3,15} Previous studies have investigated the impact of resident involvement on adverse outcomes and readmissions after spine surgery, total joint arthroplasty, and shoulder arthroscopy.^{2,5,7,9,13,14}

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

The Orthopaedic Journal of Sports Medicine, 8(12), 2325967120967460
DOI: 10.1177/2325967120967460
© The Author(s) 2020

This open-access article is published and distributed under the Creative Commons Attribution - NonCommercial - No Derivatives License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits the noncommercial use, distribution, and reproduction of the article in any medium, provided the original author and source are credited. You may not alter, transform, or build upon this article without the permission of the Author(s). For article reuse guidelines, please visit SAGE's website at <http://www.sagepub.com/journals-permissions>.

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.¹⁴ It contains information from >300 hospitals, and demographics, comorbidities, hospital data, and postoperative data are gathered.¹⁴ The full methodology of the data-collection process used by the ACS-NSQIP is described elsewhere.¹⁵ 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.⁴ 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.¹¹

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/space 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

^{||}Address correspondence to Alexander E. Weber, MD, USC Epstein Family Center for Sports Medicine at Keck Medicine of USC, 1520 San Pablo Street #2000, Los Angeles, CA 90033, USA (email: weber.ae@gmail.com).

*Midwest Orthopaedics at Rush, Chicago, Illinois, USA.

†OrthoCarolina Sports Medicine Center, Charlotte, North Carolina, USA.

‡USC Epstein Family Center for Sports Medicine at Keck Medicine of USC, Los Angeles, California, USA.

§Department of Orthopaedic Surgery, University of California, Los Angeles, Los Angeles, California, USA.

Final revision submitted June 11, 2020; accepted June 24, 2020.

One or more of the authors has declared the following potential conflict of interest or source of funding: B.A.B. has received hospitality payments from Stryker and Aesculap. B.M.S. has received educational support from Medwest, Peerless Surgical, and Smith & Nephew as well as grant support from Arthrex. N.N.V. has received consulting fees from Smith & Nephew, Medacta, and Arthrex; speaking fees from Pacira and Arthrex; and royalties from Smith & Nephew. B.J.C. has received educational support from Medwest; consulting fees from Arthrex, Genzyme, Pacira Pharmaceuticals, Anika Therapeutics, Vericel, Zimmer Biomet, Bioventus, Geistlich Pharma, Smith & Nephew, Acumed, and Flexion Therapeutics; speaking fees from Arthrex, Carticept Medical, Pacira Pharmaceuticals, and Lifenet Health; hospitality payments from GE Healthcare; honoraria from Vericel; and royalties from Arthrex and DJO. A.E.W. has received educational support from Arthrex and Smith & Nephew, speaking fees from Arthrex, and hospitality payments from Stryker. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval was not sought for the present study.

TABLE 1

Comparison of Patient Characteristics for Arthroscopic Knee Surgery Cases With and Without a Resident Present^a

	All Patients	No Resident Present	Resident Present	P Value
Overall	29,539	26,914	2625	
Age, y				<.001
18-49	29.7 (8773)	29.0 (7805)	37.1 (974)	
50-59	21.4 (6321)	21.0 (5652)	22.1 (580)	
60-69	25.2 (7444)	25.4 (6836)	23.4 (614)	
≥70	24.0 (7089)	24.6 (6621)	17.4 (457)	
Male sex	53.9 (15,922)	53.9 (14,507)	54.3 (1425)	.687
Body mass index				<.001
<25	21.0 (6203)	20.7 (5571)	24.4 (641)	
25-29	34.6 (10,220)	34.5 (9285)	36.1 (948)	
30-34	23.4 (6912)	23.6 (6352)	21.0 (551)	
≥35	21.0 (6203)	21.3 (5733)	18.5 (486)	
Diabetes	8.4 (2481)	8.5 (2288)	6.6 (173)	.001
Smoking	16.9 (4992)	16.9 (4548)	16.3 (428)	.404
COPD	1.4 (414)	1.4 (377)	1.0 (26)	.044
Congestive heart failure	0.1 (30)	0.1 (27)	0.1 (3)	.880
Hypertension	30.3 (8950)	25.1 (6755)	29.8 (782)	<.001
ASA ≥3	17.8 (5258)	18.1 (4871)	13.8 (362)	<.001

^aData are reported as % (No.). Bold P values indicate statistically significant differences between the no-resident and resident groups (P < .05). ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease.

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 and are reported in terms of relative risk.^{16,17} As there were multiple statistical comparisons, a Bonferroni correction was used for the results of bivariate and multivariate analyses, yielding a cutoff for statistical significance at P < .004.

RESULTS

A total of 29,539 patients who underwent arthroscopic knee surgery were included in the study, and 11.3% had a resident involved with the case (Table 1). There were several statistically significant differences noted between cases with and without resident involvement. Patients whose surgeries

TABLE 2
Procedure Type^a

Arthroscopic Procedure	CPT	%
Osteochondral Autograft ^b	29866	0.09
Allograft ^b	29867	0.10
Meniscal transplant ^b	29868	0.37
Lateral release	29873	1.53
Loose body removal	29874	1.09
Synovectomy		
Limited	29875	2.90
Major	29876	2.05
Chondroplasty	29877	6.97
Abrasion arthroplasty	29879	3.10
Meniscectomy		
Medial and lateral	29880	16.80
Medial or lateral	29881	45.66
Meniscal repair		
Medial or lateral	29882	2.39
Medial and lateral	29883	0.32
Lysis of adhesions	29884	0.51
Osteochondral drilling		
With bone graft	29885	0.03
Without bone graft	29886	0.07
With fixation	29887	0.15
Reconstruction		
ACL ^b	29888	15.50
PCL ^b	29889	0.36

^aACL, anterior cruciate ligament; CPT, Current Procedural Terminology; PCL, posterior cruciate ligament.

^bConsidered a “major” arthroscopic procedure.

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 most common procedure (Table 2) was medial or lateral meniscectomy (45.7%), followed by medial and lateral meniscectomy (16.8%) and ACL reconstruction (15.5%).

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,

TABLE 3

Association of Resident Involvement With 30-Day Adverse Events and Readmission After Arthroscopic Knee Surgery^a

	No Resident Present	Resident Present
Any adverse event	1.62	1.64
Any severe adverse event	1.43	1.37
Death	0.02	0.08
Ventilator >48 h	0.01	0.00
Unplanned intubation	0.01	0.00
Stroke/cerebrovascular accident	0.01	0.00
Thromboembolic event (DVT/PE)	0.46	0.50
Surgical site infection	0.48	0.34
Sepsis	0.06	0.11
Cardiac arrest requiring CPR	0.01	0.00
Myocardial infarction	0.02	0.11
Acute renal failure	0.00	0.00
Return to the operating room	0.64	0.53
Wound dehiscence	0.01	0.11
Any minor adverse event	0.22	0.46
Urinary tract infection	0.25	0.11
Pneumonia	0.10	0.15
Progressive renal insufficiency	0.01	0.00
Blood transfusion	0.06	0.23
Readmission	1.00	1.29

^aValues are presented as percentages. CPR, cardiopulmonary resuscitation; DVT, deep vein thrombosis; PE, pulmonary embolism.

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 al¹³ 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

TABLE 4

Multivariate Analysis-Associate of Resident Involvement With 30-Day Adverse Events and Readmission After Arthroscopic Knee Surgery^a

	Bivariate Analysis		Multivariate Analysis	
	RR	P Value	RR	P Value
Any adverse event	1.0	.933	1.0	.793
Any severe adverse event	1.0	.808	0.9	.525
Death	3.4	.132	4.5	.098
Thromboembolic event (DVT/PE)	1.1	.825	0.9	.854
Surgical site infection	0.7	.319	0.6	.178
Sepsis	2.1	.256	2.2	.228
Myocardial infarction	5.1	.021	7.6	.015
Return to the operating room	0.8	.501	0.8	.517
Wound dehiscence	7.7	.008	6.9	.007
Any minor adverse event	2.1	.017	2.4	.009
Urinary tract infection	1.6	.396	2.08	.211
Pneumonia	1.9	.418	1.8	.472
Blood transfusion	4.1	.003	4.5	.004
Readmission	1.3	.277	1.5	.134

^aOwing to multiple comparisons, a Bonferroni correction was used. Bolding indicates statistical significance ($P < .004$). DVT, deep vein thrombosis; PE, pulmonary embolism; RR, relative risk.

TABLE 5

Association of Resident Involvement With Operative Time^a

	Mean \pm SD		Bivariate Linear Regression		Multivariate Linear Regression	
	No Resident	Resident	Beta	P Value	Beta	P Value
	Operative time, min	43 \pm 41	57 \pm 48	+13	<.001	+6

^aBolding indicates statistical significance ($P < .004$).

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 al^{13,14} 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. Edelman 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.^{4,5,18,20} 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,⁸ 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.¹⁸ 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.²⁰ 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.

ACKNOWLEDGMENT

The authors acknowledge The Cappo Family Research Fund.

REFERENCES

1. Accreditation Council for Graduate Medical Education, American Board of Orthopaedic Surgery. The Orthopaedic Sports Medicine Milestone Project. Published July 2015. <https://www.acgme.org/Portals/0/PDFs/Milestones/OrthopaedicSportsMedicineMilestones.pdf>
2. Auerbach JD, Lonner BS, Antonacci MD, Kean KE. Perioperative outcomes and complications related to teaching residents and fellows in scoliosis surgery. *Spine*. 2008;33(10):1113-1118.
3. Babineau TJ, Becker J, Gibbons G, et al. The cost of operative training for surgical residents. *Arch Surg*. 2004;139(4):366-370.
4. Basques BA, Gardner EC, Varthi AG, et al. Risk factors for short-term adverse events and readmission after arthroscopic meniscectomy: does age matter? *Am J Sports Med*. 2015;43(1):169-175.
5. Basques BA, Saltzman BM, Mayer EN, et al. Resident involvement in shoulder arthroscopy is not associated with short-term risk to patients. *Orthop J Sports Med*. 2018;6(12):2325967118816293.
6. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. *Natl Health Stat Report*. 2009;(11):1-25.
7. Cvetanovich GL, Schairer WW, Haughom BD, Nicholson GP, Romeo AA. Does resident involvement have an impact on postoperative complications after total shoulder arthroplasty? An analysis of 1382 cases. *J Shoulder Elbow Surg*. 2015;24(10):1567-1573.
8. Dalstrom DJ, Venkatarayappa I, Manternach AL, et al. Time-dependent contamination of opened sterile operating-room trays. *J Bone Joint Surg Am*. 2008;90(5):1022-1025.
9. Edelstein AI, Lovecchio FC, Saha S, Hsu WK, Kim JY. Impact of resident involvement on orthopaedic surgery outcomes: an analysis of 30,628 patients from the American College of Surgeons National Surgical Quality Improvement Program Database. *J Bone Joint Surg Am*. 2014;96(15):e131.
10. Ferraris VA, Harris JW, Martin JT, Saha SP, Endean ED. Impact of residents on surgical outcomes in high-complexity procedures. *J Am Coll Surg*. 2016;222(4):545-555.
11. Hall BL, Hamilton BH, Richards K, et al. Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program: an evaluation of all participating hospitals. *Ann Surg*. 2009;250(3):363-376.
12. Hame SL, Nguyen V, Ellerman J, et al. Complications of arthroscopic meniscectomy in the older population. *Am J Sports Med*. 2012;40(6):1402-1405.
13. Haughom BD, Schairer WW, Hellman MD, Paul HY, Levine BR. Does resident involvement impact post-operative complications following primary total knee arthroplasty? An analysis of 24,529 cases. *J Arthroplasty*. 2014;29(7):1468-1472, e1462.
14. Haughom BD, Schairer WW, Hellman MD, Paul HY, Levine BR. Resident involvement does not influence complication after total hip

- arthroplasty: an analysis of 13,109 cases. *J Arthroplasty*. 2014;29(10):1919-1924.
15. Holt G, Nunn T, Gregori A. Ethical dilemmas in orthopaedic surgical training. *J Bone Joint Surg Am*. 2008;90(12):2798-2803.
 16. Kim S, Bosque J, Meehan JP, Jamali A, Marder R. Increase in outpatient knee arthroscopy in the United States: a comparison of National Surveys of Ambulatory Surgery, 1996 and 2006. *J Bone Joint Surg Am*. 2011;93(11):994-1000.
 17. Kothari P, Lee NJ, Lakomkin N, et al. Impact of resident involvement on morbidity in adult patients undergoing fusion for spinal deformity. *Spine*. 2016;41(16):1296-1302.
 18. Martin CT, Pugely AJ, Gao Y, Wolf BR. Risk factors for thirty-day morbidity and mortality following knee arthroscopy: a review of 12,271 patients from the national surgical quality improvement program database. *J Bone Joint Surg Am*. 2013;95(14):e98.
 19. Schoenfeld AJ, Serrano JA, Waterman BR, Bader JO, Belmont PJ. The impact of resident involvement on post-operative morbidity and mortality following orthopaedic procedures: a study of 43,343 cases. *Arch Orthop Trauma Surg*. 2013;133(11):1483-1491.
 20. Westermann RW, Pugely AJ, Ries Z, et al. Causes and predictors of 30-day readmission after shoulder and knee arthroscopy: an analysis of 15,167 cases. *Arthroscopy*. 2015;31(6):1035-1040, e1031.