

Increased Postoperative Morbidity Associated With Prolonged Laparoscopic Colorectal Resections Is Not Increased by Resident Involvement

Audrey S. Kulaylat, M.D.¹ • Christopher S. Hollenbeak, Ph.D.^{1,2}
David B. Stewart, Sr, M.D.¹

¹ Department of Surgery, Pennsylvania State University, College of Medicine, Hershey, Pennsylvania

² Department of Public Health Sciences, Pennsylvania State University, College of Medicine, Hershey, Pennsylvania

See editorial on page 527.

BACKGROUND: Although longer operative times are associated with increased postoperative morbidity, the influence of surgical residents on this association is unclear.

OBJECTIVE: The purpose of this study was to evaluate whether morbidity associated with operative times in laparoscopic colorectal surgery is increased by resident training.

DESIGN: This was a retrospective cohort study.

SETTINGS: The study was conducted using a national database.

PATIENTS: Laparoscopic ileocelectomies, partial colectomies, and low anterior resections were identified in the National Surgical Quality Improvement Project (2005–2012). This cohort was stratified by the presence of resident involvement (postgraduate clinical year ≤ 5) and then divided into tertiles of operative time (low, medium, and high), allowing comparisons of cases by duration with resident involvement with cases of similar length without resident involvement.

MAIN OUTCOME MEASURES: Postoperative morbidity (infectious and noninfectious), length of hospital stay, and unplanned reoperations were the primary study outcomes.

RESULTS: A total of 20,785 procedures were identified. In aggregate, prolonged operative time was associated

with both infectious (OR = 1.49, $p < 0.001$ with residents; OR = 1.38, $p < 0.001$ without residents) and noninfectious complications (OR = 1.51, $p < 0.001$ with residents; OR = 1.48, $p < 0.001$ without residents) when compared with short cases without residents. Longer hospital stay was observed both within the highest (additional 1.2 days ($p < 0.001$) with residents; 1.1 days ($p < 0.001$) without residents) and middle (additional 0.4 days ($p < 0.001$) with residents; 0.4 days ($p = 0.001$) without residents) tertiles of operative time. Within the highest tertile of operative length, there was no statistically significant difference in complication rates between cases with and without resident participation.

LIMITATIONS: The study was limited by its retrospective design and inability to define the complexity of case and extent of resident involvement.

CONCLUSIONS: Although longer operative times confer increased postoperative morbidity, there was no significant difference in complication rates within the highest tertile between cases with and without resident participation. Resident involvement does not appear to add to the risk of morbidity associated with longer and more complicated surgeries. See **Video Abstract** at <http://links.lww.com/DCR/A440>.



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Correspondence: David B. Stewart, M.D., Pennsylvania State University, College of Medicine, Department of Surgery, 500 University Dr, H137, PO Box 850, Hershey, PA 17033-0850. E-mail: dstewart@hmc.psu.edu

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KEY WORDS: Colorectal surgery; Laparoscopic; Morbidity; Operative time; Resident.

Laparoscopic colorectal surgery (LCRS) is an advanced surgical technique that requires proficiency operating in multiple quadrants within the peritoneal cavity. Despite being associated with a variable learning curve,^{1–3} the steepness of which depends on the skill set of the operator, LCRS offers patients a decreased incidence of certain postoperative complications, such as surgical

site infections and ileus, with shorter lengths of hospital stay.⁴ Therefore, teaching surgical residents to become skilled in LCRS is an essential educational goal, one especially important to residents who desire the assurance that their education will prepare them for excellence in their postgraduate careers.⁵

Across multiple surgical disciplines, including general surgery, neurosurgery, orthopedic surgery, and gynecology,^{6–9} longer operative times have been associated with a greater incidence of postoperative complications. Although there are multiple explanations for this association, its reproducibility across disciplines and its presence in both open and laparoscopic surgeries^{10,11} suggest that a relationship between operative time and patient outcomes is veridical. Recognition of this connection between operative time and outcomes may introduce an impediment to the training of surgical residents in laparoscopic colorectal techniques attributable to a perception that, because LCRS cases are often lengthy procedures, the additional time dedicated to teaching residents in the operating room may result in patient harm. Resident involvement in a variety of surgeries has been demonstrated to prolong the duration of numerous general surgical procedures, although these findings are not consistent across studies.^{12–14} In addition, the extent to which resident involvement increases complications because of increased operative times is also a matter of disagreement.^{12,13,15–18} Because there are already time and financial incentives that are at odds with an educational mission, concerns regarding patient safety in the context of resident training could introduce a persuasive deterrent to resident education in the operating room.

The current literature analyzing the relationship between operative time and resident education has several knowledge gaps. Few previous studies have focused their analysis on LCRS, which is a more complex form of minimally invasive surgery due, in part, to the frequent need to operate in >1 abdominal region. In addition, how the type of surgery being performed is controlled for is critical in an effort to isolate the influence, if any, of resident involvement on postoperative outcomes. The present study attempts to address gaps from previous publications by including both operative time and resident involvement, specifically in the area of LCRS, with statistical controls designed to independently account for the influence of both resident involvement and prolonged operative duration on outcomes. The hypothesis of this study was that, whereas resident involvement in LCRS would increase operative times, when controlling for the type of procedure performed and for patient characteristics, those cases involving residents would not have a statistically higher incidence of complications compared with surgeries without resident participation. To test this hypothesis, we analyzed data from the American College of Surgeons National Surgical Quality Improvement Project (NSQIP).

PATIENTS AND METHODS

Data

Data were obtained from the NSQIP Participant Use File from 2005 to 2012. All of the patients undergoing laparoscopic colorectal resections were identified and were stratified by the following Current Procedural Terminology codes: 44205 (laparoscopic ileocectomy), 44204 (laparoscopic partial colectomy), and 44207 or 44208 (laparoscopic partial colectomy with coloproctostomy, with and without colostomy). In accordance with our institutional guidelines, this retrospective study was exempt from institutional review board review.

Covariates

Primary covariates of interest included the involvement of general surgery residents (including postgraduate years 1–5) and the duration of surgery, the latter of which was subdivided into tertiles for each procedure category. Hospital teaching status could not be included because it is not a variable available within the NSQIP Participant Use Data File. For multivariable regression analyses, the following covariates were included in the models: elective versus emergent procedure designation, age >75 years, sex, disseminated cancer, BMI >30 kg/m², dependent functional status classification, advanced ASA classification defined as a score of 3 to 5, cigarette smoking within 1 year before surgery, chronic alcohol use exceeding 2 drinks per day, preoperative unintentional weight loss, pre-existing pulmonary (dyspnea, chronic obstructive pulmonary disease, or ventilator dependence), hepatic (ascites or esophageal varices), cardiac (congestive heart failure, myocardial infarction, previous coronary intervention or surgery, angina, hypertension, or peripheral vascular disease), renal (renal failure or dialysis) or neurologic (impaired sensorium, coma, hemiplegia, history of transient ischemic attack or cerebrovascular accident, or central nervous system tumor) comorbidities, diabetes mellitus, recent chemotherapy or radiotherapy, chronic steroid use, bleeding disorders, preoperative sepsis or septic shock, hypoalbuminemia, anemia, wound classification of contaminated or dirty, and units of red blood cell transfusion required.

Outcome Measures

The primary outcomes of interest were the occurrence of infectious (superficial, deep, or organ-space surgical site infections; pneumonia; urinary tract infection; sepsis; or septic shock) and noninfectious (dehiscence, reintubation, pulmonary embolism, deep vein thrombosis, failure to wean, renal insufficiency or failure, cerebrovascular accident, coma, cardiac arrest, myocardial infarction, or bleeding requiring transfusion) complications within 30 days after surgery. Secondary outcomes of interest included postoperative length of stay between the index procedure

and discharge, as well as unplanned reoperation within 30 days of the index procedure.

Statistical Analysis

Comparisons between cases with and without resident involvement were performed using standard univariate statistics. To account for the difference in operative times between cases with and without resident involvement, procedures were stratified into resident-specific and nonresident-specific tertiles of operative duration. This allowed for direct comparison between the longest cases with resident involvement and the longest cases without resident involvement, and so on, without negating the observation within the data that cases with residents tend to be prolonged compared with cases without residents. The cohort with the shortest operative time and with no resident involvement was used as the reference group. In all of the regression analyses, the models accounted for the 3 surgical procedures as fixed effects, as well as the other patient-specific demographics and comorbidities.

RESULTS

Description of Study Population

A total of 10,766 procedures with residents and 10,019 procedures without residents were identified. Within the study population, laparoscopic surgeries performed included 10,637 partial colectomies, 5357 low anterior resections, and 4791 ileocectomies. Differences in patient demographics and underlying comorbidities are shown in Table 1. Considering cases with and without resident involvement separately, procedure-specific tertiles were calculated, resulting in a total of 6 strata for analysis (Table 2).

Postoperative Complications

Multivariable logistic regression modeling was used to determine associations among operative times, resident involvement, and the occurrence of infectious and noninfectious complications (Tables 3 and 4). Compared with the lowest tertile, surgeries in the highest tertile of duration were associated with a 49% greater odds of experiencing an infectious complication if residents were involved (95% CI, 1.29–1.71) and a 38% greater odds if residents were not involved (95% CI, 1.20–1.60). Also compared with the lowest tertile, surgeries in the highest tertile of duration were associated with a 51% greater odds of experiencing a noninfectious complication if residents were involved (95% CI, 1.24–1.85) and a 48% greater odds if residents were not involved (95% CI, 1.21–1.82). Cases in the middle tertile of operative time were not associated with any increase in either infectious or noninfectious complications, regardless of whether residents were involved (Tables 3 and 4). Within the

Table 1. Patient Demographics and Comorbidities in Cases With and Without Surgical Resident (Postgraduate Clinical Year \leq 5) Involvement

Variable	With residents (N = 10,766), %	Without residents (N = 10,019), %	p
Procedure			<0.001
Partial colectomy	48.6	53.9	
Ileocectomy	25.3	20.6	
Low anterior resection	26.1	25.5	
Demographics			
Age >75 y	22.3	23.7	0.01
Men	47.0	48.0	0.13
BMI >30 kg/m ²	30.9	32.1	0.07
Procedure details			
Type			0.01
Elective	97.4	96.8	
Emergent	2.6	3.2	
ASA class			0.02
1–2	59.1	57.4	
3–5	40.9	42.6	
RBC transfusions per case (median)	0	0	0.29
Wound class			0.011
Clean/contaminated	88.0	86.7	
Contaminated	8.5	9.6	
Dirty/infected	3.5	3.8	
Comorbidities			
Pulmonary	4.1	4.9	0.005
Hepatic	0.5	0.6	0.07
Cardiac	51.3	54.2	<0.001
Renal	0.6	0.7	0.44
Neurologic	5.8	6.4	0.07
Diabetes mellitus	13.6	14.4	0.12
Disseminated cancer	2.5	2.4	0.68
Additional preoperative risk factors			
Cigarette smoking	16.1	15.6	0.37
Alcohol use	3.4	3.7	0.25
Preoperative weight loss	3.6	3.1	0.05
Dependent functional status	3.3	4.0	0.004
Recent chemotherapy/radiation	1.9	2.0	0.43
Chronic steroid use	5.0	3.9	<0.001
Bleeding disorder	3.2	3.3	0.72
Preoperative sepsis	0.5	0.9	0.003
Hypoalbuminemia	16.0	18.0	<0.001
Anemia	28.0	27.5	0.42

highest tertile of operative time, there were no statistically significant differences in the occurrences of infectious and noninfectious complications when comparing cases with and without resident involvement (Tables 3 and 4).

Reoperation

Regarding the need for unplanned major reoperation within 30 days of surgery (Table 5), procedures with long operative duration had a higher likelihood of return to

TABLE 2. Operative Times Associated With Tertiles of Operative Duration

	Low, h		Medium, h		High, h	
	Residents	No residents	Residents	No residents	Residents	No residents
Partial colectomy	<2.22	<1.88	<3.04 and ≥2.22	<2.68 and ≥1.88	≥3.04	≥2.68
Ileocelectomy	<1.9	<1.75	<2.63 and ≥1.9	<2.5 and ≥1.75	≥2.63	≥2.5
Low anterior resection	<2.6	<2.43	<3.63 and ≥2.6	<3.46 and ≥2.43	≥3.63	≥3.46

the operating room, but only in cases without resident involvement (OR = 1.27; 95% CI, 1.02–1.59). In cases with short operative duration, those with resident involvement actually had 24% lower odds of reoperation compared with those of the same time tertile without resident involvement (OR = 0.76; 95% CI, 0.60–0.97).

Postoperative Length of Stay

Postoperative length of stay was significantly impacted by increasing the duration of operative procedures. Notably, patients undergoing long-duration procedures remained hospitalized for ≈1 day longer, whether residents were involved in their surgery or not (Fig. 1). Medium-duration cases were associated with ≈12-hour longer length of stay, both with and without resident involvement.

DISCUSSION

The results of the present study confirm a previously reported association between longer operative times and higher incidences of postoperative complications.^{9,10,19} Unlike previous evaluations regarding duration of surgery or the influence of surgical residents, our study focused its analysis on laparoscopic colorectal surgeries with the data stratified by tertiles of operative time and the presence or absence of residents. Our results suggest that the involvement of residents in these complex surgeries and the additional time required allowing a surgeon in training to participate in these surgeries do not result in a measurable increase in postoperative complication rates. In fact, for operative procedures of a short duration, the odds of reoperation were reduced by 24% with resident involvement when compared with cases without their participation. This suggests that, in some circumstances, residents actually improve patient outcomes.

In the current study population, there was a significant association between both infectious and noninfectious postoperative complications and patients who underwent procedures at the highest tertile of operative time. Undergoing procedures with the middle tertile, however, was not associated with increased morbidity relative to the lowest tertile, whether or not residents were involved. Among previous studies that had a higher proportion of patients undergoing laparoscopic colectomy, conflicting results have been reported. Scheer et al¹¹ did not identify an increase in complications because of prolonged operative times after laparoscopic right

colectomies and sigmoid colectomies, although there was an increase with laparoscopic total abdominal colectomies. Two other studies also reported increased operative time being associated with worsened postoperative morbidity in laparoscopic colectomies.^{10,19} One of these studies focused only on postoperative pulmonary complications, however, and neither study addressed the potential influence of resident involvement in these procedures.

Many studies have evaluated the learning curve associated with resident training since its emergence in general surgery in the 1990s. Several studies have linked increased experience with decreased operative duration in laparoscopic colorectal resections, suggesting the presence of a learning curve at 30 to 50 cases.^{1–3,20} Increasing levels of experience were also associated with decreasing postoperative complications, shorter lengths of stay, and fewer conversions to laparotomy, although all of these benefits were not uniformly observed in each of these studies. Many of these previous works involved data from a single institution, however, and were also hindered by smaller study populations at risk for inadequate power to detect differences in infrequent complications between cohorts.

Although there are several reports documenting the effect of resident involvement on postoperative outcomes, many of these examine a very heterogeneous mix of procedures, with correspondingly heterogeneous results.^{12,15,16,18,21,22} Within a cohort of various general surgery procedures, Kiran et al¹⁶ associated resident involvement with longer operative times and increased SSI rates but with no increase in complications such as myocardial infarctions or venous thromboembolism. Among patients undergoing colorectal resections, Raval et al²² noted a higher occurrence of postoperative morbidity in cases with resident involvement after controlling for operative time, although these results were not consistent after accounting for hospital-level variation. Conversely, Iannuzzi et al²³ identified an increase in postoperative morbidity among open and laparoscopic colorectal resections where residents were involved, but this association largely disappeared after controlling for operative time in their regression model.

In the present study, we stratified laparoscopic colorectal resections into tertiles of operative time according to whether residents were involved, allowing for comparison of the longest tertile of duration without residents with the longest tertile of duration with residents. After this stratification, an operative duration longer than the highest ter-

TABLE 3. Logistic Regression of Infectious Complications

Variable	OR	95% CI	p
Strata			
Long duration, residents	1.49	1.29–1.71	<0.001
Long duration, no residents	1.38	1.20–1.60	<0.001
Medium duration, residents	1.13	0.98–1.31	0.10
Medium duration, no residents	0.96	0.83–1.12	0.63
Short duration, residents	1.01	0.87–1.17	0.94
Short duration, no residents	Reference		
Procedure			
Partial colectomy	Reference		
Ileocolectomy	0.96	0.87–1.07	0.46
Low anterior resection	1.11	1.00–1.23	0.04
Demographics			
Age >75 y	1.12	1.01–1.25	0.03
Men	1.00	0.92–1.09	0.93
BMI >30 kg/m ²	1.33	1.22–1.46	<0.001
Procedure details			
Emergent	1.65	1.33–2.05	<0.001
ASA class 3, 4, or 5	1.27	1.15–1.40	<0.001
RBC transfusions per case (median)	1.08	0.99–1.19	0.10
Wound class			
Clean/contaminated	Reference		
Contaminated	1.28	1.12–1.46	<0.001
Dirty/infected	1.05	0.85–1.30	0.67
Comorbidities			
Pulmonary	1.37	1.15–1.63	<0.001
Hepatic	1.66	1.07–2.55	0.02
Cardiac	1.10	1.01–1.21	0.04
Renal	0.81	0.51–1.27	0.36
Neurologic	1.11	0.95–1.31	0.20
Diabetes mellitus	0.99	0.88–1.11	0.85
Disseminated cancer	1.33	1.05–1.68	0.02
Additional preoperative risk factors			
Cigarette smoking	1.25	1.12–1.39	<0.001
Alcohol use	1.35	1.10–1.66	0.004
Preoperative weight loss	1.07	0.86–1.32	0.56
Dependent functional status	1.52	1.25–1.84	<0.001
Recent chemotherapy/radiation	1.07	0.81–1.42	0.64
Chronic steroid use	1.49	1.25–1.78	<0.001
Bleeding disorder	1.13	0.92–1.39	0.26
Preoperative sepsis	1.10	0.72–1.68	0.67
Hypoalbuminemia	1.23	1.10–1.38	<0.001
Anemia	1.05	0.95–1.16	0.34

RBC = red blood cell.

tile of time was consistently associated with postoperative morbidity, both with and without resident involvement. Resident involvement did not, in any instance, appear to be associated with an increase in infectious or noninfectious complications when compared with nonresident cases of similar operative duration and similar type of resection. As would be expected, surgeries within the highest tertile of operative time were associated with higher complication rates, likely because of their greater complexity, which is a scenario where resident involvement would not be expected to mitigate this association.

TABLE 4. Logistic Regression of Noninfectious Complications

Variable	OR	95% CI	p
Strata			
Long operative duration, residents	1.51	1.24–1.85	<0.001
Long operative duration, no residents	1.48	1.21–1.82	<0.001
Medium operative duration, residents	1.19	0.97–1.47	0.10
Medium operative duration, no residents	1.17	0.95–1.44	0.14
Short operative duration, residents	1.03	0.84–1.27	0.78
Short operative duration, no residents	Reference		
Procedure			
Partial colectomy	Reference		
Ileocolectomy	0.96	0.84–1.11	0.58
Low anterior resection	0.94	0.81–1.09	0.38
Demographics			
Age >75 y	1.63	1.42–1.86	<0.001
Men	1.30	1.16–1.46	<0.001
BMI >30 kg/m ²	1.19	1.04–1.35	0.009
Procedure details			
Emergent	1.85	1.44–2.37	<0.001
ASA class 3, 4, or 5	1.78	1.55–2.05	<0.001
RBC transfusions	1.02	0.91–1.15	0.69
Wound class			
Clean/contaminated	Reference		
Contaminated	1.26	1.03–1.53	0.02
Dirty/infected	1.50	1.15–1.95	0.002
Comorbidities			
Pulmonary	1.25	1.01–1.54	0.04
Hepatic	1.75	1.08–2.81	0.02
Cardiac	1.45	1.26–1.66	<0.001
Renal	1.24	0.80–1.94	0.33
Neurologic	1.29	1.07–1.55	0.006
Diabetes mellitus	1.03	0.89–1.20	0.69
Disseminated cancer	1.34	1.01–1.79	0.045
Additional preoperative risk factors			
Cigarette smoking	1.26	1.07–1.48	0.006
Alcohol use	1.55	1.18–2.04	0.002
Preoperative weight loss	0.97	0.74–1.27	0.81
Dependent functional status	1.49	1.21–1.84	<0.001
Recent chemotherapy/radiation	0.91	0.61–1.38	0.69
Chronic steroid use	1.26	0.99–1.61	0.06
Bleeding disorder	1.47	1.18–1.84	0.001
Preoperative sepsis	2.69	1.77–4.08	<0.001
Hypoalbuminemia	1.42	1.24–1.63	<0.001
Anemia	2.09	1.83–2.38	<0.001

RBC = red blood cell.

Within our study population, both medium- and long-duration cases were associated with a prolonged length of stay compared with short-length cases; this association was consistent regardless of resident involvement. Schlachta et al² correlated decreased operative times with decreases in postoperative lengths of stay after laparoscopic colon resections, although this study was focused on determining the learning curve for laparoscopy at a single institution.

TABLE 5. Logistic Regression of Unplanned Major Reoperation

Variable	Coefficient	95% CI	p
Strata			
Long operative duration, residents	1.18	0.94–1.47	0.15
Long operative duration, no residents	1.27	1.02–1.59	0.03
Medium operative duration, residents	0.81	0.63–1.03	0.09
Medium operative duration, no residents	0.88	0.69–1.12	0.30
Short operative duration, residents	0.76	0.60–0.97	0.03
Short operative duration, no residents	Reference		
Procedure			
Partial colectomy	Reference		
Ileocectomy	1.02	0.86–1.21	0.82
Low anterior resection	1.09	0.92–1.28	0.31
Demographics			
Age >75 y	1.10	0.92–1.31	0.29
Men	1.47	1.28–1.69	<0.001
BMI >30 kg/m ²	0.97	0.84–1.13	0.74
Procedure details			
Emergent	1.46	1.05–2.04	0.02
ASA class 3, 4, or 5	1.17	1.00–1.37	0.05
RBC transfusions per case (median)	1.28	1.14–1.44	<0.001
Wound class			
Clean/contaminated	Reference		
Contaminated	1.30	1.05–1.60	0.02
Dirty/infected	0.98	0.69–1.39	0.92
Comorbidities			
Pulmonary	1.13	0.85–1.49	0.40
Hepatic	1.93	1.09–3.43	0.03
Cardiac	1.29	1.10–1.50	0.001
Renal	2.15	1.28–3.59	0.004
Neurologic	1.09	0.84–1.40	0.52
Diabetes mellitus	0.82	0.67–1.00	0.05
Disseminated cancer	1.92	1.39–2.65	<0.001
Additional preoperative risk factors			
Cigarette smoking	1.38	1.16–1.65	<0.001
Alcohol use	1.46	1.09–1.96	0.01
Preoperative weight loss	0.97	0.69–1.37	0.87
Dependent functional status	1.55	1.16–2.07	0.003
Recent chemotherapy/radiation	0.93	0.59–1.46	0.74
Chronic steroid use	1.82	1.40–2.35	<0.001
Bleeding disorder	1.10	0.80–1.52	0.542
Preoperative sepsis	1.64	0.93–2.86	0.09
Hypoalbuminemia	0.97	0.81–1.17	0.75
Anemia	1.19	1.01–1.40	0.04

RBC = red blood cell.

With the exception of a single study,¹³ all previous reports addressing the effect of residents on postoperative length of stay noted that, regardless of whether morbidity was increased, the involvement of surgical residents was not associated with an increase in length of stay.^{12,15,16}

One study¹⁵ that assessed the incidence of unplanned returns to the operating room did not observe an associa-

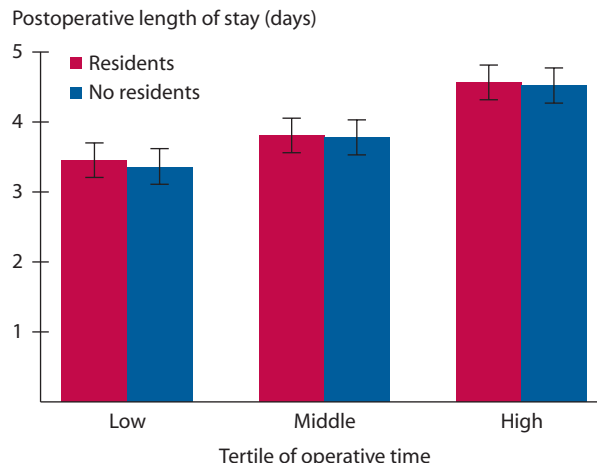


Figure 1. Bar graph illustrating differences in postoperative length of stay associated with tertile of operative duration and resident involvement.

tion between resident involvement and the need for major reoperation following general surgery procedures, consistent with the findings of the current study. Rather, the highest tertile of operative time in the current study was associated with increased odds of returning to the operating room, but only among cases without resident involvement.

The present study has several important limitations. It involves data from a large national database and is therefore subject to errors related to procedural coding, as well as errors related to accurate documentation of resident involvement. In addition, the presence of residents does not indicate their level of participation in the case, and this factor could lead to skewing of the associations drawn in this study between the presence of a resident and patient outcomes. Without a prospective study specifically designed to measure what portion of the surgery the resident performed under supervision, even a review of operative reports would be unable to provide an objective measure of how much of the surgery the resident performed, because this is not information typically volunteered within the medical chart. It is also not possible to determine the previous laparoscopic experience of the residents using data from NSQIP. The NSQIP database also does not contain information on attending surgeon specialization (eg, colorectal-trained versus general surgeons), nor does it detail the experience level of the attending surgeon. With regard to operative time, although we controlled for the available covariates that may have indicated increased complexity of a surgical procedure, we could not control for those factors not captured by NSQIP, such as the presence of severe adhesive disease or estimated blood loss. The database only captures complications that occurred within 30 days of the index procedure; complications that occur later in the postoperative course and that might still be attributed to a surgeon's skill, decision making, or technique (eg, anastomotic strictures or hernias) would not be accounted for in the current study.²⁴

Lastly, although it is possible that more complex cases were referred to teaching institutions, creating a potential difference in complexity of cases where residents would be involved, this observation would likely bias the results toward a higher incidence of complications among cases with resident involvement, a finding that was not identified in the current study. Considering that resident involvement was not associated with a higher incidence of complications in the highest tertile of operative time when compared with surgeries of similar duration without resident involvement, any tendency in the study population toward referring more complex cases to hospitals where residents are being trained would actually strengthen the conclusions of this report.

CONCLUSION

Data from this study suggest that resident involvement in laparoscopic colorectal resections does not worsen patient outcomes. There is both an a priori and an evidence-based case for shortening the length of surgery when feasible. Yet, although it is important to avoid unnecessary delays in the operating room, the added time spent teaching residents is not associated with compromised patient outcomes and is a necessary, vital part of the educational mission of teaching hospitals. Surgeons can invest that additional time in the training of residents in the operating room without concerns that the care of their patients is compromised as a result of their educational commitments.

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