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Epidural analgesia in the era of enhanced recovery: time to rethink its use?

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Abstract

Background Previous assessments of the impact of epidural analgesia (EA) on outcomes after colorectal surgery were related to the period before widespread implementation of the enhanced recovery after surgery (ERAS) protocols. This study evaluates the impact of EA on postoperative recovery after colectomy using recent multicenter data.

Methods Patients who underwent elective colectomy from the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) data (2014–2015) were identified. Demographics, comorbidities, diagnosis, procedure type and approach, and postoperative complications associated with EA were assessed. Impact of EA on postoperative ileus, length of stay (LOS), and prolonged LOS (defined as LOS > 75 percentile) was evaluated for all, open, and laparoscopic cases using univariable and multivariable analyses.

Results Of 9045 elective colectomy procedures, 3081 (34.1%) received EA. Epidural analgesia was associated with greater rates of postoperative ileus (15.9% vs. 10.8%, $p < 0.0001$), superficial (5.5% vs. 4%, $p = 0.001$) and deep (1.8% vs. 0.6%, $p < 0.0001$) wound infections, pulmonary embolism (0.8% vs. 0.4%, $p = 0.004$), deep vein thrombosis (1.3% vs. 0.7%, $p = 0.01$), sepsis/septic shock (4.6% vs. 3.1%, $p < 0.0001$), unplanned reintubation (1.5% vs. 0.8%, $p = 0.003$), cardiac complications (1.2% vs. 0.7%, $p = 0.03$), and transfusion (9.1% vs. 5.9%, $p < 0.0001$). Postoperative length of stay (LOS) [mean (SD), days: 6.7(6.2) vs. 5(4.5) days, $p < 0.0001$] was greater for EA. On multivariable analysis, EA had no impact on postoperative ileus for all and laparoscopic cases. However, EA increased the likelihood for ileus (OR 1.34, 95% CI 1.02–1.78) after open colectomy alone. Similarly, EA did not influence prolonged LOS for all and laparoscopic cases but was independently associated with prolonged LOS after open colectomy (OR 1.4, 95% CI 1.1–1.8).

Conclusion Epidural analgesia was not associated with improved recovery after elective colectomy in the era of ERAS.

Keywords Epidural analgesia · Postoperative ileus · Length of stay · Colorectal · ERAS

Enhanced recovery after surgery (ERAS) accelerates postoperative recovery without affecting morbidity [1, 2]. The inclusion of epidural analgesia (EA) into ERAS has been recommended [3, 4]. Previous studies that evaluated the effects of EA on outcomes after colorectal surgery have demonstrated opposing findings for hospital stay and return of bowel function [5–8]. Risk of anastomotic leak, urinary

tract infection, hypotension, and hospital charges with EA have been variably reported [8–10]. The use of EA while ERAS protocols were still inconsistently implemented [7, 8, 11, 12], results from single centers, [6] or small numbers of patients [9, 10, 12] and non-standardization of data [7, 8] may have contributed to the differences. It is not currently clear whether EA facilitates recovery after elective colectomy in the era of ERAS.

Using the recent American College of Surgeons—National Surgical Quality Improvement Program datasets (2014 and 2015) to overcome the drawbacks of the previous studies, we evaluate the influence of EA on recovery after elective colectomy.

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Materials and methods

Using the *Current Procedural Terminology (CPT)* codes: 44140, 44141, 44143, 44144, 44145, 44146, 44147, 44150, 44151, 44160, 44204, 44205, 44206, 44207, 44208, and 44210, adult patients who underwent elective colectomy were identified from the American College of Surgeons (ACS)—National Surgical Quality Improvement Program (NSQIP). Colectomy-targeted and general datasets of 2014 and 2015 were merged. ACS-NSQIP collects preoperative and intraoperative data from more than 600 hospitals using standardized definitions. Postoperative complications are tracked for 30 days after surgery. While primary operative anesthesia has been available from the database, a novel variable for the use of a secondary anesthetic technique, including EA, was introduced in 2014. Additional information about ACS-NSQIP can be found elsewhere [13].

Emergency and urgent procedures ($n = 17,047$) and primary operative anesthesia other than general ($n = 151$) were excluded. Records with unknown ($n = 30,134$) and multiple ($n = 192$) secondary anesthetic techniques, such as local, regional, and spinal anesthesia, were also removed from the analysis. Eventually, a total of 9045 elective colectomies under primary general anesthesia were included.

Patients who received EA as a secondary anesthetic technique were compared to others for demographics, functional status, comorbidities, bowel preparation, American Society of Anesthesiologists (ASA) and wound classifications, primary diagnosis, resection type, surgical approach, conversion to open and operating time. Postoperative surgical and medical complications, extended care, and readmission after discharge were also compared. The primary outcomes were 30-day postoperative ileus and prolonged hospital stay. Postoperative complications, discharge disposition, and readmission were the secondary outcomes. The effects of EA on recovery after open and laparoscopic procedures were separately assessed in a subgroup analysis. An IRB approval from the Columbia University Medical Center was obtained for this study.

Statistical analysis

Groups were compared using χ^2 and t test for categorical and continuous variables, respectively. Frequency (n) and percentage (%) were used to present categorical variables, while mean ± standard deviation (SD) were used for continuous variables. To simplify data illustration, few clinically relevant variables were combined such as postoperative renal insufficiency or failure, cardiac complications (myocardial infarction and cardiac arrest), and sepsis or septic shock. Functional status (dependent vs. independent), body mass index (overweight-obese vs. underweight-normal), ASA (III–IV vs. I–II) and wound (contaminated or dirty/infected vs. clean or clean/contaminated) classifications, surgical approach (open vs. other), and operating time (≤ 180 vs. ˃ 180 min) were newly formed binary variables. Prolonged colectomy was defined as operating time > 180 min, which is a risk factor for delayed recovery [14, 15]. Postoperative ileus was defined as the presence of nasogastric tube (NGT) and/or NPO until or beyond postoperative day 3. Postoperative length of stay above the 75th percentile was considered prolonged hospital stay. For open, laparoscopic and all colectomy procedures, length of stay > 75th percentile was > 8, 5 and 6 days after surgery, respectively. Given its impact on postoperative recovery [16], we chose to classify procedures according to the extent of colon resection (partial vs. total resection).

In order to evaluate the association between EA and recovery after colectomy, univariable analysis was performed. A multivariable logistic regression analysis was used to evaluate the association between EA and postoperative recovery (i.e., postoperative ileus and prolonged hospital stay). There were 11.5% and 15.1% overall missing data for mechanical bowel preparation and oral antibiotic use, respectively. Given the significant impact on recovery after colectomy [17, 18], we chose to consider both components of bowel preparation. Variables with $p < 0.05$ in the univariable analysis were considered statistically significant and included in the multivariable analysis.

The influence of EA on postoperative recovery, complications, extended care, and readmission was evaluated for all, open, and laparoscopic colon resections separately. All statistical analyses were conducted using IBM SPSS Statistics for Windows (version 24.0), Armonk, New York.

Results

Of 9045 included patients, 3081 (34.1%) underwent EA. Patient demographics were similar for the two groups barring a lower proportion of patients of white race in EA. There were more patients with malignancy in EA. Functional status and preoperative hospitalization were similar between groups, but ASA class was higher in EA. Fewer EA patients were overweight/obese, smokers and had hypertension and bleeding disorders, while dyspnea, congestive heart failure, disseminated cancer, neoadjuvant chemotherapy, and weight loss were associated with EA. EA patients had lower use of bowel preparation and had greater dirty or infected wound class, and more likely to undergo total, open, and prolonged colectomy (> 180 min) when compared to non-EA patients. Tables 1 and 2 give patient and operative characteristics of the two groups.

Table 1 Patients characteristics stratified by the use of epidural analgesia (EA) for all cases

Variable	No epidural (N=5964)	Epidural (N=3081)	p value
Age [n (%)]			
< 65 years	3444 (58.3%)	1754 (57.4%)	0.4
≥ 65 years	2463 (41.7%)	1302 (42.6%)	
Gender [n (%)]			
Male	2802 (47%)	1501 (48.7%)	0.1
Female	3162 (53%)	1580 (51.3%)	
Race (White) [n (%)]	4799 (89%)	2027 (86%)	<0.0001
Functional status [n (%)]			
Independent	5889 (98.8%)	3040 (98.8%)	0.4
Partially dependent	59 (1%)	35 (1.1%)	
Totally dependent	10 (0.2%)	2 (0.1%)	
Body mass index class [kg/m^2, n (%)]			
Underweight	120 (2%)	79 (2.6%)	0.01
Normal weight	1628 (27.4%)	929 (30.3%)	
Overweight	2083 (35%)	1037 (33.8%)	
Obese	2115 (35.6%)	1023 (33.3%)	
ASA classification [n (%)]			
I	149 (2.5%)	64 (2.1%)	<0.0001
II	3013 (50.5%)	1372 (44.5%)	
III	2622 (44%)	1530 (49.7%)	
IV	177 (3%)	114 (3.7%)	
Primary diagnosis [n (%)]			
Malignant disease	2604 (43.7%)	1734 (56.3%)	<0.0001
Benign disease	971 (16.3%)	304 (9.9%)	
Inflammatory bowel disease	386 (6.5%)	270 (8.8%)	
Diverticular disease	1437 (24.1%)	437 (14.2%)	
Obstruction/functional disorder	165 (2.8%)	103 (3.3%)	
Other diagnosis	401 (6.7%)	233 (7.6%)	
Preoperative hospitalization [n (%)]	180 (3%)	103 (3.3%)	0.4
Current smoker [n (%)]	978 (16.4%)	454 (14.7%)	0.04
Diabetes [n (%)]	839 (14.1%)	401 (13%)	0.2
Hypertension [n (%)]	2789 (46.8%)	1317 (42.7%)	<0.0001
Chronic obstructive pulmonary disease (COPD) [n (%)]	247 (4.1%)	149 (4.8%)	0.1
Dyspnea [n (%)]	358 (6%)	261 (8.5%)	<0.0001
Congestive heart failure [n (%)]	24 (0.4%)	25 (0.8%)	0.01
Disseminated cancer [n (%)]	273 (4.6%)	289 (9.4%)	<0.0001
Prior sepsis [n (%)]	66 (1.1%)	33 (1.1%)	0.9
Weight loss > 10% [n (%)]	179 (3%)	165 (5.4%)	<0.0001
Bleeding disorder [n (%)]	143 (2.4%)	51 (1.7%)	0.02
Preoperative transfusion [n (%)]	24 (0.4%)	15 (0.5%)	0.6
Preoperative steroid use [n (%)]	468 (7.8%)	277 (9%)	0.1
Preoperative open/infected wound [n (%)]	59 (1%)	43 (1.4%)	0.1
Preoperative chemotherapy within 90-day [n (%)]	345 (5.8%)	341 (11.2%)	<0.0001
Preoperative WBC × 10^9/L [mean (SD)]	7.5 (2.8)	7.5 (2.8)	0.7
Preoperative hematocrit % [mean (SD)]	39.2 (5.3)	38.6 (5.4)	<0.0001
Preoperative bowel preparation [n (%)][a]			
Oral antibiotic	2484 (46.6%)	1170 (43.7%)	0.02
Mechanical bowel preparation	3608 (71.8%)	1654 (62.2%)	<0.0001
Combined bowel preparation	2132 (43.9%)	1026 (39.8%)	0.001

[a]Missing data: 11.5% and 15.1% for oral antibiotic and mechanical bowel preparation, respectively

Table 2 Operative characteristics stratified by the use of epidural analgesia (EA) for all cases

Variable	No epidural (N = 5964)	Epidural (N = 3081)	p value
Wound class [n (%)]			
Clean	57 (1%)	19 (0.6%)	0.01
Clean/contaminated	4920 (82.5%)	2582 (83.8%)	
Contaminated	665 (11.2%)	290 (9.4%)	
Dirty/infected	322 (5.4%)	190 (6.2%)	
Resection type [n (%)]			
Partial colectomy	5721 (95.9%)	2898 (94.1%)	< 0.0001
Total colectomy	243 (4.1%)	183 (5.9%)	
Operative approach [n (%)]			
Open	1008 (16.9%)	1525 (49.5%)	< 0.0001
Laparoscopy	4909 (82.4%)	1552 (50.4%)	
Other	43 (0.7%)	4 (0.1%)	
Conversion to open surgery [n (%)]	439 (7.4%)	211 (6.8%)	< 0.0001
Operative duration (> 180 min) [n (%)]	2590 (43.6%)	1580 (51.3%)	< 0.0001

Postoperative ileus (15.9%, $p < 0.0001$ vs. 19.7%, $p = 0.01$ vs. 12.3%, $p = 0.01$), average hospital stay [mean (SD), days: 6.7 (6.2), $p < 0.0001$ vs. 8 (6.7), $p < 0.0001$ vs. 5.5 (5.5), $p < 0.0001$], and prolonged hospital stay (32.1%, $p < 0.0001$ vs. 44.6%, $p < 0.0001$ vs. 28.8%, $p < 0.0001$) were greater with the use of EA in all, open, and laparoscopic colectomy procedures, respectively. Similarly, deep surgical site infection (1.8%, $p < 0.0001$ vs. 2.6%, $p = 0.04$ vs. 1%, $p = 0.01$) was higher for EA (Table 3). EA patients had greater overall cardiac complications, perioperative transfusion, superficial surgical site infection, deep vein thrombosis, pulmonary embolism, sepsis or septic shock, unplanned reintubation, and extended care after discharge. Anastomotic leak, organ space wound infection, urinary tract infection, and readmission were comparable between EA and non-EA groups (Table 3).

Epidural analgesia and postoperative recovery: Tables 4, 5, 6, and 7

On multivariable analysis, the use of EA did not influence postoperative ileus for all and laparoscopic cases (OR 1.1, 95% CI 0.9–1.3) and (OR 1.0, 95% CI 0.8–1.3, respectively). However, EA was independently associated with ileus (OR 1.3, 95% CI 1.02–1.8) after open colectomy alone. Similarly, there was no impact on prolonged hospitalization (> 75th percentile) for all and laparoscopic procedures (OR 1.1, 95% CI 0.9–1.3) and (OR 1.0, 95% CI 0.9–1.2, respectively). The use of EA for open colectomy was independently associated with prolonged hospital stay (OR 1.4, 95% CI 1.1–1.8).

Discussion

The use of EA did not improve postoperative recovery after elective colectomy in the current analysis and was associated with increased postoperative ileus and prolonged hospital stay after open colectomy. EA has been used for effective perioperative pain control [19], which may facilitate recovery by minimizing the need for intravenous narcotics [10, 20]. Some studies that evaluated EA for colorectal procedures reported a reduction in pain scores and earlier return of bowel function [5, 12, 20], while others found EA did not impact pain management and negatively affected ileus and caused delayed discharge [7–10]. Whether EA influences recovery within ERAS in particular is unclear. In this study, we were able to characterize the influence of EA on postoperative recovery using recent multicenter data in the era of ERAS.

Previous studies that evaluated postoperative ileus identified the complication using clinical parameters such as emesis and NPO status, diagnostic and procedural billing codes for paralytic ileus and nasogastric tube placement. However, these definitions may consider nonspecific postoperative symptoms as postoperative ileus [21]. The use of diagnostic and procedural billing codes may not differentiate the occurrence of ileus before versus after surgery [22]. On the other hand, ACS-NSQIP uses standardized definition which combines the presence of nasogastric tube

Table 3 Complications, hospital stay, discharge disposition, and readmission stratified by the use of epidural analgesia (EA)

Variable	All cases			Open colectomy			Laparoscopic colectomy		
	No epidural ($N=5964$)	Epidural ($N=3081$)	p value	No epidural ($N=1008$)	Epidural ($N=1525$)	p value	No epidural ($N=4909$)	Epidural ($N=1552$)	p value
Postoperative ileus	646 (10.8%)	491 (15.9%)	<0.0001	155 (15.4%)	300 (19.7%)	0.01	485 (9.9%)	191 (12.3%)	0.01
Anastomotic leak	201 (3.4%)	121 (3.9%)	0.2	35 (3.5%)	71 (4.7%)	0.1	165 (3.4%)	50 (3.2%)	0.8
Superficial surgical site infection	239 (4%)	170 (5.5%)	0.001	54 (5.4%)	112 (7.3%)	0.048	185 (3.8%)	58 (3.7%)	1.0
Deep surgical site infection	36 (0.6%)	55 (1.8%)	<0.0001	14 (1.4%)	39 (2.6%)	0.04	22 (0.4%)	16 (1%)	0.01
Organ space surgical site infection	252 (4.2%)	138 (4.5%)	0.6	54 (5.4%)	86 (5.6%)	0.8	197 (4%)	52 (3.4%)	0.2
Pneumonia	79 (1.3%)	44 (1.4%)	0.7	23 (2.3%)	27 (1.8%)	0.4	56 (1.1%)	17 (1.1%)	0.9
Pulmonary embolism	21 (0.4%)	25 (0.8%)	0.004	8 (0.8%)	12 (0.8%)	1.0	13 (0.3%)	13 (0.8%)	0.002
Deep vein thrombosis	43 (0.7%)	40 (1.3%)	0.01	12 (1.2%)	24 (1.6%)	0.4	31 (0.6%)	16 (1%)	0.1
Sepsis or septic shock	183 (3.1%)	142 (4.6%)	<0.0001	44 (4.4%)	95 (6.2%)	0.04	41 (0.8%)	13 (0.8%)	1.0
Unplanned reoperation	260 (4.4%)	145 (4.7%)	0.5	45 (4.5%)	84 (5.5%)	0.2	213 (4.3%)	61 (3.9%)	0.5
Unplanned reintubation	48 (0.8%)	45 (1.5%)	0.003	10 (1%)	21 (1.4%)	0.4	38 (0.8%)	24 (1.5%)	0.01
Renal insufficiency or failure	63 (1.1%)	26 (0.8%)	0.3	19 (1.9%)	14 (0.9%)	0.04	43 (0.9%)	12 (0.8%)	0.7
Urinary tract infection	123 (2.1%)	73 (2.4%)	0.3	29 (2.9%)	46 (3%)	0.8	94 (1.9%)	27 (1.7%)	0.7
Cardiac complications	43 (0.7%)	36 (1.2%)	0.03	10 (1%)	21 (1.4%)	0.4	33 (0.7%)	15 (1%)	0.2
Transfusion	352 (5.9%)	280 (9.1%)	<0.0001	115 (11.4%)	191 (12.5%)	0.4	234 (4.8%)	89 (5.7%)	0.1
Mortality	39 (0.7)	25 (0.8%)	0.4	12 (1.2%)	17 (1.1%)	0.9	27 (0.6%)	8 (0.5%)	0.9
Postoperative LOS, mean (SD)	5 (4.5)	6.7 (6.2)	<0.0001	6.7 (5.4)	8 (6.7)	<0.0001	4.7 (4.2)	5.5 (5.5)	<0.0001
Postoperative LOS > 75 percentile	1084 (18.2%)	990 (32.1%)	<0.0001	340 (33.8%)	680 (44.6%)	<0.0001	1064 (21.7%)	447 (28.8%)	<0.0001
Discharge destination (alive)									
Home	5686 (95.8)	2871 (94%)	<0.0001	925 (92.6%)	1379 (91.7%)	0.4	4715 (96.4%)	1488 (96.2%)	0.7
Other facility	249 (4.2%)	183 (6%)		74 (7.4%)	125 (8.3%)		174 (3.6%)	58 (3.8%)	
Unplanned readmission	581 (9.8%)	309 (10.1%)	0.7	138 (13.7%)	179 (11.8%)	0.1	435 (8.9%)	130 (8.4%)	0.6

Data presented by frequency (*n*) and percentage (%), unless mentioned otherwise

LOS length of stay

Table 4 Multivariable analysis of factors associated with postoperative ileus (all cases)

Variable	Odds ratio	Confidence interval	*p* value
Anesthetic technique (epidural vs. no epidural)	1.1	0.9–1.3	0.5
ASA class (III–IV vs. I–II)	1.2	1.02–1.5	0.03
Functional status (dependent vs. independent)	2.1	1.2–3.7	0.01
Current smoker	1.6	1.3–1.9	<0.0001
Dyspnea	1.4	1.02–1.9	0.04
Preoperative chemotherapy	1.7	1.3–2.3	<0.0001
Resection type (total vs. partial) colectomy	2.5	1.8–3.4	<0.0001
Surgical approach (open vs. other)	1.9	1.6–2.3	<0.0001
Conversion to open surgery	2.0	1.5–2.7	<0.0001
Operative duration (> 180 min)	1.6	1.4–1.9	<0.0001

Table 5 Multivariable analysis of factors associated with postoperative ileus (open vs. laparoscopic colectomy)

Variable	Odds ratio	Confidence interval	*p* value
Open colectomy			
Anesthetic technique (epidural vs. no epidural)	1.3	1.02–1.8	0.04
Resection type (total vs. partial) colectomy	2.0	1.2–3.2	0.01
Operative duration (> 180 min)	1.4	1.1–1.9	0.01
Laparoscopic colectomy			
Anesthetic technique (epidural vs. no epidural)	1.0	0.8–1.3	0.9
Functional status (dependent vs. independent)	2.9	1.4–5.9	0.003
Current smoker	1.7	1.3–2.2	<0.0001
Preoperative chemotherapy	2.3	1.5–3.3	<0.0001
Resection type (total vs. partial) colectomy	3.0	2.1–4.4	<0.0001
Conversion to open surgery	2.1	1.6–2.8	<0.0001
Operative duration (> 180 min)	1.7	1.3–2.0	<0.0001

Table 6 Multivariable analysis of factors associated with prolonged hospital stay (all cases)

Variable	Odds ratio	Confidence interval	p value
Anesthetic technique (epidural vs. no epidural)	1.1	0.9–1.3	0.3
ASA class (III–IV vs. I–II)	1.5	1.3–1.8	<0.0001
Primary diagnosis (malignant vs. benign)	1.2	1.02–1.4	0.03
Functional status (dependent vs. independent)	2.7	1.6–4.5	<0.0001
Preoperative hospitalization	2.0	1.4–2.7	<0.0001
Dyspnea	1.4	1.1–1.9	0.01
Preoperative chemotherapy	1.9	1.5–2.4	<0.0001
Preoperative hematocrit level	0.97	0.95–0.98	<0.0001
Preoperative mechanical bowel preparation	0.8	0.6–0.9	0.004
Wound class (III–IV vs. I–II)	1.4	1.2–1.7	<0.0001
Resection type (total vs. partial) colectomy	2.1	1.6–2.7	<0.0001
Surgical approach (open vs. other)	3.3	2.8–3.9	<0.0001
Conversion to open surgery	2.4	1.9–3.1	<0.0001
Operative duration (> 180 min)	2.0	1.7–2.3	<0.0001

(NGT) and/or NPO status specifically until or beyond day 3 after colectomy.

Some recovery advantages to intrathecal analgesia have previously been shown for open colorectal surgery. This may have resulted in our findings of increased use of EA for elective open procedures in the current analysis (49.5% vs. 16.9%, $p \leq 0.0001$). In addition to effective pain control, small randomized trials from single centers demonstrated earlier recovery of bowel function and decreased ileus for open cases with EA [23–25]. However, larger studies using

Table 7 Multivariable analysis of factors associated with prolonged hospital stay (open vs. laparoscopic colectomy)

Variable	Odds ratio	Confidence interval	p value
Open colectomy			
Anesthetic technique (epidural vs. no epidural)	1.4	1.1–1.8	0.02
ASA class (III–IV vs. I–II)	1.8	1.4–2.4	< 0.0001
Preoperative hospitalization	9.0	5.3–15.0	< 0.0001
Prior sepsis	5.8	1.02–32.7	0.047
Preoperative oral antibiotic	0.4	0.2–0.8	0.01
Wound class (III–IV vs. I–II)	1.4	1.1–2.0	0.02
Operative duration (> 180 min)	2.1	1.6–2.7	< 0.0001
Laparoscopic colectomy			
Anesthetic technique (epidural vs. no epidural)	1.0	0.9–1.2	0.9
ASA class (III–IV vs. I–II)	1.6	1.3–1.8	< 0.0001
Primary diagnosis (malignant vs. benign)	1.3	1.1–1.5	0.002
Functional status (dependent vs. independent)	3.0	1.6–5.6	0.001
Preoperative hospitalization	2.1	1.4–3.2	< 0.0001
Hypertension	1.2	1.0–1.4	0.02
Dyspnea	1.5	1.1–2.0	0.01
Preoperative chemotherapy	2.1	1.6–2.9	< 0.0001
Preoperative mechanical bowel preparation	0.79	0.65–0.97	0.03
Resection type (total vs. partial) colectomy	1.7	1.2–2.4	0.002
Conversion to open surgery	3.1	2.5–3.9	< 0.0001
Operative duration (> 180 min)	1.9	1.6–2.2	< 0.0001

national or multi-institutional data showed EA to be associated with ileus [7] or without an impact on gastrointestinal recovery [8, 10, 11]. While laparoscopic cases were not negatively affected, similarly we found EA to worsen postoperative ileus after open colectomy in the current study.

One retrospective study reported shorter hospitalization with EA [6], while several demonstrated this factor to be insignificant [9, 10, 12, 22, 23]. In fact, larger analyses including open [7] and laparoscopic [8] colorectal procedures demonstrated a prolonged length of stay with EA. These studies may have had the drawbacks of single institution experience [6], limited sample size [9, 10, 12, 23, 25] and inclusion of data over a prolonged period with potential variations in the adoption of ERAS protocols [7, 8] that then led to the opposing findings. In this study, where EA was evaluated using large multicenter data within a time frame where ERAS is being widely adopted, hospital stay after all, open, and laparoscopic colectomy was longer with EA. On multivariable analysis, EA was independently associated with prolonged hospital stay (> 75th percentile) after open colectomy, while the effect was not significant for laparoscopic cases.

Previous studies have examined the influence of EA on perioperative morbidity. While some analyses demonstrated reduced cardiovascular and respiratory complications with EA [4, 26], others found no impact on complications [6, 7, 27]. Local complications, arterial hypotension, vasopressor use, urinary retention, and infection have been reported to be greater using EA [4, 8–10]. We similarly noted higher overall cardiac complications and perioperative transfusion requirement with EA. Surgical site infection, deep vein thrombosis, pulmonary embolism, and systemic infections were greater with EA. However, anastomotic leak, urinary, and respiratory infections were not influenced by the use of EA in our study. Although some perioperative risk factors were higher for EA in the current study, we controlled for this when evaluating outcomes for the two groups including any factor that was significant on univariate analysis in the adjusted logistic regression models.

Some discussion of the potential explanations of the causes of the findings is worthwhile. EA is usually an alternative approach in administering opioids perioperatively. With the higher chances of patient-controlled analgesia (PCA) problems with EA versus other traditional pain management options, the surgical team may not effectively control the use of opioids, hence potentially causing delayed gastrointestinal recovery. Delayed gastrointestinal recovery leads to prolonged hospitalization, which in turn predisposes patients to infections and venous thromboembolism. It is also possible that EA-specific complications may contribute to prolonged hospitalization observed in this study. The need to hold venous thromboembolism prophylaxis prior to inserting and removing the epidural catheter may have contributed to the higher rates of venous thromboembolism in EA group.

The retrospective nature of the data analysis and the presence of some missing information is a drawback of the study. The EA indication, type of agent, analgesic effect, and specific complications could also not be assessed due to the lack of information on the use of additional intravenous narcotics and the occurrence of hematoma and pruritus. However, the availability of data from a large number of patients from multiple institutions allowed an adequate assessment of the impact of EA on postoperative ileus, length of stay, and complications and thus clarifies the contemporary effect of EA after colorectal procedures. It was not possible to identify the ERAS protocol used for each colectomy procedure. Despite the potential variations in EA protocols for ACS-NSQIP participating hospitals, the data from this study suggest that the current practice of EA for such procedures in these hospitals is not associated with improved outcomes. It is feasible that there may be appropriate settings and protocols for EA that may be optimal for recovery after colectomy, but until these parameters are established the routine use of EA must be reassessed.

Conclusion

Epidural analgesia does not promote recovery after elective colectomy in the era of ERAS. In addition, EA may negatively affect recovery after open colectomy and therefore its ongoing use is to be questioned.

Compliance with ethical standards

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