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The impact of delaying elective resection of diverticulitis on laparoscopic conversion rate

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KEYWORDS:
Diverticulitis;
Laparoscopy;
Elective;
Colectomy;
Conversion;
Complication

Abstract

BACKGROUND: Guideline-concordant delay in elective laparoscopic colectomy for diverticulitis may result in repeated bouts of inflammation. We aimed to determine whether conversion rates from elective laparoscopic colectomy are higher after multiple episodes of diverticulitis.

METHODS: Prospective cohort study evaluating laparoscopic colectomy conversion rates for diverticulitis from 42 hospitals was conducted.

RESULTS: Between 2010 and 2013, 1,790 laparoscopic colectomies for diverticulitis (mean age 57.8 ± 13; 47% male) resulted in 295 (16.5%) conversions. Conversion occurred more frequently in nonelective operations ($P < .001$) and with fistula indications ($P = .012$). Conversion rates decreased with surgeon case volume ($P = .028$). Elective colectomy exclusively for episode-based indications (n = 784) had a conversion rate of 12.9%. Increasing episodes of diverticulitis were not associated with higher conversion rates, even among surgeons with similar experience levels.

CONCLUSIONS: Conversion from laparoscopic colectomy for diverticulitis did not increase after multiple episodes of diverticulitis. Delaying elective resection appears to not prevent patients from the benefits of laparoscopy.

Acute diverticulitis is one of the most common indications for hospitalization related to the gastrointestinal tract in the United States, where it is estimated that it will result in an estimated 300,000 admissions, 1.5 million days/year of inpatient care, and upwards of $1.8 billion in healthcare costs in 2014.[1,2] Although diverticulitis is one of the leading indications for emergency colectomy and colostomy,[3,4] most colectomies for diverticulitis are performed electively to prevent recurrence or progression of disease.

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Laparoscopic colectomy for the management of diverticular disease was more widely adopted after publication of initial studies in colorectal cancer in the early 2000s,[5,6] and contemporary evidence supports lower morbidity, shorter hospitalization, and higher patient satisfaction with the laparoscopic approach to diverticulitis.[4] Accordingly, most modern professional guidelines, including the 2014 update from the American Society of Colon and Rectal Surgeons (ASCRS),[1] recommend a laparoscopic approach to colectomy for diverticulitis.

However, given an increasingly recognized disconnect between episodes of diverticulitis and disease progression and recurrence,[4] the timing of elective colectomy has become less clear. The classic surgical dogma of operating after 2 episodes, maintained as recently as the 2000 ASCRS guidelines,[7] or delay operating until 3 or more episodes of diverticulitis as per the 2006 guidelines[8] have given way to recommendations to avoid episode-based surgery altogether and consider each patient's need for elective colectomy on a case-by-case basis.[1]

Whether this delay in operating until after multiple episodes of diverticulitis, potentially increasing inflammation and scarring, has impacted the ability to complete operations laparoscopically remains to be determined. More so than laparoscopy for malignancy, laparoscopy for diverticulitis entails technical challenges of inflammation and adhesions, and failed laparoscopy rates are as high as 20%.[9,10] Conversion to an open operation negates the benefits of a laparoscopic approach, and there is growing interest in factors associated with failed laparoscopy for diverticulitis. In Washington State, where nearly half of all colon operations are performed laparoscopically,[11] we sought to describe the factors associated with conversion and the impact of delayed elective colectomy on conversion from laparoscopy.

Methods

This study was exempted from human subjects review by the University of Washington Human Subject Review Committee. The Comparative Effectiveness Research Translation Network provided research and analytic support to the Surgical Care and Outcomes Assessment Program (SCOAP).[12]

Data sources and definitions

The primary cohort was defined by consecutive patients who underwent laparoscopic colon resection for diverticulitis between January 1, 2010 and December 31, 2013 in 42 Washington State hospitals that participated in SCOAP. Sociodemographic, clinical, and operative details were extracted from inpatient medical records by trained chart abstractors at each clinical site. SCOAP metrics and data dictionary are available via a secure page at www.SCOAP.org. A modified Charlson comorbidity index for each patient was calculated.[13]

The SCOAP data collection platform for diverticulitis has been previously described,[11] and includes indications for the operation such as number of prior episodes of diverticulitis; chronic complications including gastrointestinal bleeding, stricture, and fistula; and an 'other' category to capture additional indications. Surgical approach was derived from the operative report and operating room logs looking for specific identification of open, laparoscopic, laparoscopic/hand-assisted, and laparoscopic/robotic-assisted surgical approaches. As in our prior definitions, the latter 3 categories were considered laparoscopic procedures on an intention to treat basis.[14] Conversion was defined through operative reports indicating that opening the abdomen was necessary to complete the procedure. Operations included were right/transverse hemicolectomy, left hemicolectomy, low anterior resection (including sigmoidectomy), and total abdominal colectomy. Because of a recognized association between laparoscopic procedural volume and conversion rates,[15] we describe the relationship between conversion rates and surgical volume. Overall rates of procedures and conversions at the surgeon level were acquired using a de-identified code unique to each surgeon in the database (n = 198 surgeons).

The main outcome of interest for this study was the rate of conversion from laparoscopy. In addition, we describe rates of in-hospital complications and composite adverse events (CAE). In-hospital complications include SCOAP's standard measures of cardiac, pulmonary, renal, infectious, or other complications requiring nonoperative intervention. CAE included any of these with the addition of reoperative interventions and in-hospital deaths.[14]

The quality of indications data improved dramatically at SCOAP hospitals contemporaneous to a statewide benchmarking and educational initiative.[11] To minimize bias from chronic complication indications and missing data, we defined a subgroup a priori to include only those patients who underwent elective laparoscopic colectomy for an episode-based indication and had nonmissing data.

Statistical analysis

Patient characteristics, operative indications, and outcomes were summarized using frequency distributions for categorical variables, and mean (standard deviation) for continuous variables. We stratified our description by conversion from laparoscopy. Categorical variables were compared using Pearson chi-square statistic. Continuous variables were compared using the Student t test. Linear and logistic regression models were used to evaluate the association of case volume (clustered at surgeon level) and prior episode number, respectively, on conversion from laparoscopy, adjusting for patient, clinical, and operative characteristics identified as statistically significant ($P < .05$) on univariate evaluation or identified as clinically important in previous studies. A P value of less than .05 was considered statistically significant. All analysis was performed using STATA version 13 (STATA Corp, College Station, TX).

Results

Between 2010 and 2013, 49.5% (n = 1,790) of all colectomies performed for diverticulitis at Washington State's SCOAP hospitals were initiated laparoscopically and 16.5% (n = 295) were converted. Patients undergoing colectomy had a mean age of 57.8 ± 13 years and 47% were male. The demographics, indications, and short-term outcomes for this cohort are summarized in Table 1. Notably, conversions occurred more frequently in patients who had nonelective procedures, chronic complication indications for their operation, or had right/transverse hemicolectomy performed. Patients who had conversions had a longer length of stay, operative time, increased discharges to skilled nursing facilities, and more in-hospital complications and CAEs (all statistically significant at $P < .05$).

The surgeon-specific proportion of cases converted declined sharply with increasing case volume of laparoscopic colectomy ($P = .03$) (Fig. 1). Operations performed for criteria concordant to the 2006 ASCRS guidelines (3+ episodes or chronic complication) did not correlate with surgical volume ($P = .31$).

After adjusting for surgical volume, chronic complication indication, elective procedure, prior operation, body

Table 1 Demographics, indications and outcomes, stratified by conversion

	Not converted		Converted		Total cohort		
	n 1,495	% 83.5	*n* 295	% 16.5	*n* 1,790	% 100	*P* value
Mean age (SD)	57.5 (12.6)		59.1 (12.9)		57.8 (12.7)		.054
Sex							.63
Male	707	47.3	135	45.8	842	47.0	
Female	788	52.7	160	54.2	948	53.0	
White	1,307	87.4	254	86.1	1,561	87.2	.52
Comorbidities							.29
0	1,108	74.1	214	72.5	1,322	73.9	
1	311	20.8	59	20.0	370	20.7	
2	59	4.0	15	5.1	74	4.1	
3	17	1.1	7	2.4	24	1.3	
BMI 30+	620	41.5	115	39.0	735	41.1	.43
Indications							
Nonelective	114	7.6	56	19.0	170	9.5	<.001
Number of prior episodes*							<.001
None	115	12.1	43	23.4	158	13.9	
1	142	14.9	31	16.9	173	15.2	
2	137	14.4	27	14.7	164	14.5	
3–10	520	54.7	73	39.7	593	52.5	
>10	37	4.0	10	5.4	47	4.0	
Chronic complication†	238	16.1	65	22.1	303	17.1	.012
Colovesicular fistula	120	8.1	34	11.6	154	8.7	.054
Current GI bleed	33	2.2	7	2.4	40	2.3	.87
Stricture	61	4.1	17	5.8	78	4.4	.20
Other fistula	36	3.1	15	7.1	51	3.8	.01
Missing indication	453	30.3	81	27.5	534	29.8	.33
Operation type							
Right hemicolectomy	72	4.8	26	8.8	98	5.5	.01
Left hemicolectomy	450	30.1	83	28.1	533	29.8	.50
Low anterior resection‡	973	65.1	203	68.8	1,176	65.7	.22
Total abdominal colectomy	15	1	1	.3	16	.9	.27
Prior surgery	509	34.1	117	40.0	626	35.0	.17
Outcomes							
Mean OR time, min (SD)	174 (74)		197 (92)		178 (78)		<.001
Mean length of stay (SD)	5.2 (7.0)		7.2 (5.4)		5.6 (6.8)		<.001
Discharge home	1,430	95.7	266	90.2	1,696	94.8	.002
In-hospital complication	90	6.0	49	16.6	139	7.8	<.001
CAE§	140	9.4	70	23.7	210	11.7	<.001

BMI = body mass index; CAE = composite adverse events; GI = gastrointestinal; OR = operating room; SD = standard deviation.

*Number of episode % calculated from population with known episode information (total n = 1,135, nonconverted n = 951, converted n = 184).

†Calculated as Pearson chi-square for any chronic complication indication between converted and nonconverted cases.

‡Low anterior resection category includes sigmoidectomy.

§CAE includes complications as well as reoperative interventions and in-hospital deaths.

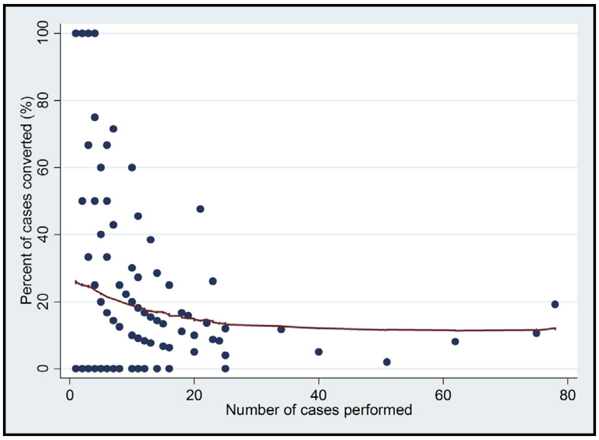

Figure 1 Surgeon-level relationship between number of operations and rate of conversion.

mass index (BMI) 30+, anatomic segment removed, and year of operation, increasing episode number was not associated with higher likelihood of conversion (P = .189) (Table 2).

A subgroup of 784 patients underwent elective resection solely for episode-based indications (Table 3). These patients were younger (mean age 55.3 ± 11 years) and had fewer comorbidities than the remainder of the cohort. The conversion rate in this group was 12.9%. After adjustment for surgical volume, prior operation, BMI 30+, anatomic segment removed, and year of operation, increasing episode number was not associated with higher likelihood of conversion in this subgroup (P = .75).

Comments

To our knowledge, this study represents the largest cohort of laparoscopic colectomy for diverticulitis in which conversion rates were evaluated. Between 2010 and 2013 at SCOAP hospitals in Washington State, nearly 1,800 colectomies for diverticulitis were started laparoscopically and 16.5% were converted. In the subgroup of patients undergoing elective colectomy for an episode-based indication, the rate of conversion was 12.9%. Conversion was higher in nonelective cases and those with complicated disease indications, and was inversely related to surgical volume. After adjustment for several factors known to be predictive of conversion including surgeon experience,[16,17] increasing episodes of diverticulitis preceding surgery were not associated with increased conversion rate.

Laparoscopic colectomy was widely and rapidly adopted following publication of the safety and benefits of the procedure in colorectal cancer,[5,6] and its application to diverticulitis has shown benefits in morbidity, hospitalization, cosmesis, and overall patient satisfaction, as substantiated by several randomized control trials and a systematic review.[4,18,19] However, laparoscopic colectomy for diverticulitis has unique technical difficulties that must be overcome to safely complete the operation, such as inflammation distorting landmark anatomy or fistulas to adjacent organs. Although conversion rates for all indications for colorectal surgery are approximately 13% according to a large meta-analysis,[20] conversion rates specific for diverticulitis (which range between 2% and 20%)[9,10] have been more difficult to define, in part because of challenges in the management of elective versus nonelective cases, as well as differences between uncomplicated and complicated diverticulitis. In addition, existing literature suggests that surgeon experience, BMI, prior surgery, and presence of complicated disease contribute to conversion from laparoscopy.[16,17]

Our findings support the higher frequency of conversion in patients requiring urgent operation and those having

Table 2 Association between number of prior episodes and likelihood of conversion

	Unadjusted association				Adjusted association*			
Conversion	OR	CI		P value	OR	CI		P value
Prior episodes†								
None	Reference	Reference			Reference	Reference		
1	.58	.35	.99	.04	.71	.41	1.22	.22
2	.53	.31	.91	.02	.59	.33	1.05	.07
3–10	.38	.24	.58	<.001	.53	.33	.85	.01
10+	.72	.33	1.58	.42	.99	.44	2.25	.99
Surgical volume	.99	.98	.99	<.001	.99	.98	.99	<.001
Chronic complication	1.48	1.09	2.02	.01	1.37	.96	1.95	.08
Elective	.35	.25	.50	<.001	.43	.29	.65	<.001
BMI 30+	.90	.70	1.16	.43	.92	.69	1.21	.54
Prior operation	.79	.61	1.02	.07	.75	.57	1.00	.052
Right hemicolectomy	1.91	1.20	3.05	.01	1.63	.93	2.83	.086
Year	.86	.77	.96	.01	.87	.77	.98	.03

BMI = body mass index; CI = confidence interval; OR = odds ratio.

*Adjusted for all other variables listed.

†Association listed for each category of prior episodes using no prior episodes as reference; overall associations for increasing category of episode are OR .91, 95% CI .83 to .99 (P = .026) and OR .94, 95% CI .87 to 1.03 (P = .189) for unadjusted and adjusted models, respectively.

Table 3 Elective surgery solely for episode-based indication: subgroup demographics and indications stratified by conversion

	Not converted		Converted		
	n 683	% 87.12	*n* 101	% 12.88	*P* value
Mean age (SD)	55.0 (11.6)		56.9 (12.7)		.13
Sex					.09
Male	311	45.53	55	54.46	
Female	372	54.47	46	45.54	
White	605	88.58	88	87.13	.44
Comorbidities					.53
0	513	75.11	70	69.31	
1	146	21.38	25	24.75	
2	20	2.93	5	4.95	
3	4	.59	1	.99	
BMI 30+	289	42.31	47	46.53	.42
Indications					
Number of prior episodes					.19
1	91	13.32	17	16.83	
2	102	14.93	14	13.86	
3–10	459	67.2	61	60.4	
>10	31	4.54	9	8.91	
Operation type					
Right hemicolectomy	21	3.07	5	4.95	.33
Left hemicolectomy	226	33.09	26	25.74	.14
Low anterior resection*	447	65.45	74	73.27	.12
Total abdominal colectomy	5	.73	0	0	.39
Prior abdominal surgery	231	33.82	42	41.58	.13

BMI = body mass index; SD = standard deviation.
*Low anterior resection category includes sigmoidectomy.

complicated disease, specifically fistula.[16,17] Additionally, our study demonstrates that higher case volume is associated with lower conversion rate, as conversion rates dropped as surgeons approached 30 cases. This number should be interpreted cautiously, as the case volume is limited to years in study and only to diverticulitis indications. Published literature estimates the learning curve for all laparoscopic colectomies to be between 30 and 50 cases[15] and may be as high as 60 for diverticulitis.[21] Much of what is known about learning curves for laparoscopy comes from single centers of excellence,[15,21] while our cohort, including 198 surgeons across 42 hospitals, may be describing practice that is more generalizable to the wider surgical community. Conversion forfeits the benefits of laparoscopy,[16,22] and our data confirm that converted cases had a longer operative time, hospitalization, and increased complications.

Overall, complicated diverticular disease is associated with a higher conversion rate than uncomplicated disease. This is not surprising as the most frequently described reasons for conversion are inflammation and adhesions, which occur more frequently when treating complicated diverticulitis. However, a higher rate of conversion with increasing prior episodes of diverticulitis, as would be suspected if multiple episodes were causing chronic inflammation, is not supported by our data. This finding is in line with other population-level studies suggesting that prior episodes are poor predictors of recurrence and progression of disease.[1,4]

Our study has certain limitations. First, the SCOAP registry is procedural rather than disease based, and subject to confounding bias. For example, it may be that surgeons with higher surgical volume (and lower conversion rates) may be more likely to delay surgery until multiple episodes of diverticulitis. We did not, however, find an association between the number of operations performed and proportion of cases concordant with 2006 ASCRS indications. In addition, the SCOAP data collection platform is based on operative reports, and there is heterogeneity in the technical aspects of how laparoscopic colectomy is performed and/or how individual surgeons describe these conversions (like hand-assistance, e.g.). Third, a substantial portion of patients was missing indication data. We have previously described the marked improvement in data quality in this cohort,[11] and note that we did not identify systematic differences in patients with and without indication data. Cognizant of this limitation in the data, we defined a subgroup with complete data for analysis, whose results parallel the patterns we saw in the larger cohort. Finally, we acknowledge that even this large cohort may be underpowered to make definitive claims about rates of conversion. As an estimate, to detect a difference between 20% and 10% conversion rates (alpha = .05, power = .90) with various numbers of preceding episodes would require over 550 patients in each episode group.

Despite these limitations, the results from this statewide cohort of laparoscopic colectomy for diverticulitis add contemporary evidence to inform the management of a disease whose surgical indications are in evolution. Our study also demonstrates that conversion rates from laparoscopy did not increase after multiple episodes of diverticulitis, while confirming previously published associations of conversion from laparoscopy to complicated disease and surgeon experience. These data suggest that delaying elective resection does not prevent patients from benefiting from the advantages of laparoscopic surgery.

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Discussion

Scott Browning, M.D.: Ten or 15 years ago elective resection for diverticulitis was routinely recommended after the second episode in order to avoid perforation, emergency surgery and a colostomy. We now understand that those most dramatic presentations are usually the 1st episode rather than the 3rd, 5th or 10th and thus elective resection for diverticulitis is delayed until the frequency, severity and impact of the episodes justify the risks of the resection. During this time there has also been a shift from open to laparoscopic surgery with its attendant benefits. However, laparoscopic colectomy for diverticulitis can be difficult and conversion to open surgery may be more likely than for other indications. The authors of this paper have sought to describe factors associated with such conversion and ask the specific question, does the current approach of delaying elective resection for diverticulitis reduce the likelihood that patients will receive the benefits of laparoscopy? That is, do an increasing number of prior episodes increase the likelihood of conversion? This question is relevant, as knowledge of such a relationship might lead patients to pursue elective surgery sooner in order to avoid open surgery, just as they did to avoid a colostomy in the past.

The authors extracted and studied details of 1790 consecutive patients whose resections for diverticulitis were initiated laparoscopically. The overall conversion rate was 16.5%, dropping to 14.8% for elective cases and 12.9% for elective cases performed for episode based indications alone. Those patients with chronic complications such as fistula were converted 21.4 % of the time and non-elective procedures 32.9% of the time. Patients were stratified by number of prior episodes with the groupings as zero, 1, 2, 3 to 10 or greater than 10 prior episodes. After adjusting for patient, surgeon and indication factors known to impact conversion rate, increasing episode number was not associated with a higher likelihood of conversion.

This paper succeeds in providing a useful description of factors associated with conversion from laparoscopic colectomy for diverticulitis. The authors conclude that delaying elective colectomy for diverticulitis does not increase conversion from laparoscopy. However, despite the large size of the initial cohort, the small size of most of the prior episode number groups leaves this study underpowered to detect a difference in conversion rates between them. That said, the raw numbers actually show a decreasing conversion rate moving from the zero to 1, to 2, to 3-10 prior episode groups, so I expect that the paper's primary conclusion is nonetheless correct. Of interest though, the greater than 10 prior episode group, even controlling for elective status and lack of chronic complications, had twice the conversion rate of the 3-10 prior episode group. It would be interesting to see if the results and conclusion would change if the episode number groups were chosen differently. It may yet be the case that beyond a certain number of episodes the risk of conversion does increase, but it will take a larger data set to detect it. I congratulate the authors on the useful descriptive data this study provides and for using a diverse statewide registry to study an important question.