

# The Complexity of Colorectal Resection for Endometriosis

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## Introduction

Endometriosis is the result of an inflammatory reaction from implants of endometrial-like tissue outside of the uterus and affects 10-12% of women of reproductive age [1]. Endometriosis can implant in various locations, including the sigmoid colon and rectum which is reported to be involved in up to 90% of intestinal lesions [2-4].

Bowel endometriosis can resemble typical endometriosis symptoms including dysmenorrhea and dyspareunia [2]. Alternatively, it can cause more bowel-specific issues such as diarrhea, rectal bleeding, constipation, dyschezia, and even bowel obstruction [2,5]. Surgical intervention has been shown to be effective at resolving these symptoms, however, there is scant literature on standardized surgical management of bowel endometriosis [6,7]. Conversely, resection of the diseased diverticular colon has robust data and standardized surgical guidelines.

The objective of this study is to examine the short-term outcomes of patients undergoing colorectal resection for endometriosis and compare those outcomes with patients undergoing elective resection for diverticular disease, a similarly benign and largely left-sided colorectal condition. We employed National Surgical Quality Improvement Project data to compare outcomes for left sided colectomy for diverticular disease versus endometrial disease. We hypothesize the endometrial cohort will be associated with increased morbidity given the complexity in management of this pathology.

## Methods

### Data Source and Patient Population

The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) 2016 to 2020 database was queried for all patients undergoing colorectal resection for a diagnosis of endometriosis. The ACS-NSQIP is a Health Insurance Portability and Accountability Act (HIPAA)-compliant data file that contains case information from participating hospitals across the United States and Canada. Patients were identified as having a colorectal resection for the

diagnosis of endometriosis (ICD9 codes 617.x and ICD10 codes N80.x) as the primary or secondary procedure based on primary procedure Current Procedural Terminology (CPT) codes. Colorectal resections were based on the following CPT codes: 44140-44160, 44202-44213, 45110-45123, and 45395-45397. Proctectomy was defined as the following CPT codes: 44145-44147, 44155-44158, 44207, 44208, 44211, 44212, 45110-45114, 45116, 45119, 45123, 45126, 45395 and 45397. Patients that did not undergo colorectal resection (i.e. colostomy or ileostomy reversal) were excluded from the analysis. This cohort contained a subset that was also captured using the colectomy-targeted participant-use file (PUF) which included additional variables such as bowel preparation, ileus, and anastomotic leak.

### Comparison Cohort

A comparison cohort was created by querying the same ACS-NSQIP 2016-2020 database for female patients undergoing elective colorectal resection for diverticular disease using ICD9 codes 562.x and ICD10 codes K57.x. The same CPT procedure codes were used as in the endometriosis cohort. This comparison cohort was chosen as diverticular disease is a benign condition that mostly requires left-sided resections similarly to bowel endometriosis. In order to exclude patients who had a semi-elective operation for acute diverticulitis (i.e. those who underwent surgical intervention for failure of medical management during the same admission), those who were admitted for 1 day prior, or more, to their operation were excluded. Patients who underwent closure of colostomy or ileostomy for diverticular disease were also excluded.

### Outcome Definitions

Standard NSQIP variable definitions were used [8]. Main clinical outcomes of interest were 30-day overall complications, reoperations, readmissions, and total length of stay (LOS). Postoperative complications included all events captured by the NSQIP: surgical site infections (superficial, deep, and organ space), wound disruption, pneumonia, unplanned intubation, acute renal failure requiring dialysis, urinary tract infection, cerebrovascular accident, cardiac arrest requiring

cardiopulmonary resuscitation, myocardial infarction, transfusion within 72h, Clostridium difficile infection, and sepsis/septic shock. The colectomy-targeted PUF also recorded anastomotic leak and ileus.

**Statistical Analysis**

All data are presented as n (%) or mean (SD), unless otherwise specified. Univariate analyses were performed using chi-squared test for categorical variables, and Student’s t-test or ANOVA for continuous variables. Regression analyses were performed (using multiple logistic for dichotomous variables such as complications, readmissions, and reoperations, or Poisson for count data such as length of stay) to determine the effect of disease indication on the main outcomes, adjusting for the ACS-NSQIP morbidity risk score, rectal resection, and minimally invasive approach. The ACS-NSQIP morbidity risk score already incorporates the most important risk factors for morbidity and is an estimate of the probability of overall morbidity [9,10]. A subgroup analysis was performed for patients ≤45 years old (this represented the 75th percentile of patient age in the endometriosis cohort). All analyses were performed using STATA 15.1 (StataCorp, College Station, TX).

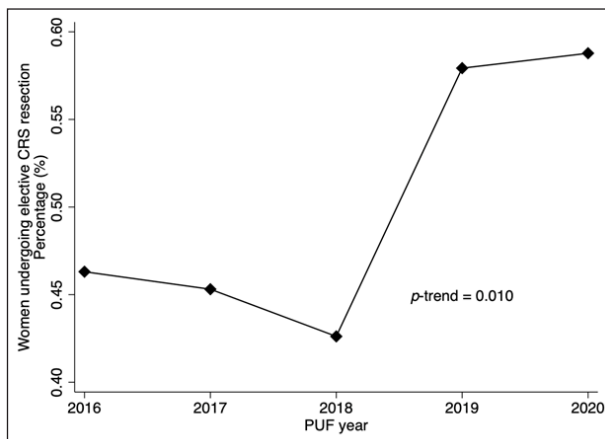
**Results**

A total of 117, 287 women underwent colorectal resections between 2016 and 2020, of which 590 (0.5%) had a diagnosis of endometriosis. {Table 1} reports the patient and operative characteristics of these cases. The proportion of colorectal resections performed for endometriosis significantly increased over time {Figure 1}. Most cases (80%) were performed by a general surgeon as primary surgeon, with the remaining 20% by gynecologists. A concomitant hysterectomy and/or oophorectomy was performed in 30.7% (181/590). A proctectomy was performed in 51% and a stoma created in 11%. The majority (66%) underwent a minimally invasive approach in the overall cohort, and in 79% in the colectomy-targeted PUF with a conversion rate of 7%. Table 2 reports the clinical outcomes of the endometriosis cohort. The overall 30-day complication rate was 21%, including reoperation in 3% and readmission in 9%. Mortality occurred in 1 patient only. The median length of stay (LOS) was 4 days (IQR 3-5). Colectomy-targeted data was available in 349 patients, of which 9% had an ileus and 3% had an anastomotic leak.

**Table 1: Comparison of patient and operative characteristics between patients undergoing elective colorectal resections for endometriosis versus diverticular disease**

	Endometriosis (n=590)	Diverticular (n=25, 878)	p-value
Mean age, years (SD)	40.2 (8.4)	61.4 (11.5)	<0.001
Mean body mass index, kg/m <sup>2</sup> (SD)	27.8 (6.5)	30.2 (7.0)	<0.001
Morbid obesity (BMI ≥35 kg/m <sup>2</sup> )	89 (15.1%)	5803 (22.4%)	<0.001
Race			<0.001
White	357 (60.5%)	21401 (82.7%)	

Black or African American	95 (16.1%)	1856 (7.2%)	
Asian	28 (4.8%)	186 (0.7%)	
American Indian or Alaska native	3 (0.5%)	121 (0.5%)	
Native Hawaiian or Pacific Islander	4 (0.7%)	28 (0.1%)	
Race combinations with low frequency	0 (0%)	1 (0.00%)	
Some other race	0 (0%)	3 (0.01%)	
Unknown/not reported	103 (17.5%)	2282 (8.8%)	
Hispanic ethnicity	57 (9.7%)	1842 (7.1%)	<0.001
ASA score 3+	109 (18.5%)	11537 (44.6%)	<0.001
Functional status			0.024
Independent	589 (99.8%)	25548 (98.7%)	
Partially dependent	0 (0%)	221 (0.9%)	
Totally dependent	1 (0.2%)	11 (0.04%)	
Unknown	0 (0%)	98 (0.4%)	
Mean estimated probability of morbidity	7.0% (3.7)	10.4% (5.7)	<0.001
Mean estimated probability of mortality	0.1% (0.7)	0.4% (1.3)	<0.001
Mean operative duration, min (SD)	256 (138)	196 (87)	<0.001
Minimally invasive approach	391 (66.3%)	19122 (76.7%)	<0.001
Stoma creation	64 (10.9%)	2755 (10.7%)	0.875
Proctectomy	303 (51.4%)	13949 (53.9%)	0.220
Colectomy-targeted PUF only	(n=337)	(n=16,686)	
Mechanical bowel preparation			<0.001
Yes	193 (57.3%)	11915 (71.4%)	
No	94 (27.9%)	2608 (15.6%)	
Missing/unknown	50 (14.8%)	2163 (13.0%)	
Oral antibiotics with bowel preparation			<0.001
Yes	174 (51.6%)	10594 (63.5%)	
No	113 (33.5%)	4179 (25.0%)	
Missing/unknown	50 (14.8%)	1913 (11.5%)	
Operative approach			<0.001
Open	72 (21.4%)	2232 (13.4%)	
Laparoscopic	178 (52.8%)	10801 (64.7%)	
Robotic	62 (18.4%)	2288 (13.7%)	
Unplanned conversion to open	25 (7.4%)	1365 (8.2%)	



**Figure 1:** Trend over time of elective colorectal resections for endometriosis

A comparison of the patient and operative characteristics of the endometriosis and diverticular cohorts is shown in {Table 1}. Endometriosis patients were significantly younger, had lower body mass index, less likely to be white, less comorbid, and therefore had a lower predicted risk of morbidity and mortality when compared to patients with diverticular disease. Endometriosis patients also were less likely to receive a minimally invasive procedure and had longer operative length. In the colectomy-targeted PUF, endometriosis patients were less likely to receive a mechanical or oral antibiotic bowel preparation. {Table 2} reports the differences in clinical outcomes between endometriosis and diverticular cohorts. There were no differences in overall 30-day complications, median length of stay, readmissions, or unplanned reoperations, however there was a higher proportion of venous thromboembolism and pulmonary embolism in the endometriosis cohort. On multiple regression analysis, endometriosis patients had higher overall 30-day complications (adjusted OR 1.70, 95% CI 1.38, 2.09) and longer length of stay (adjusted IRR 1.17, 95% CI 1.13, 1.22).

**Table 2: Comparison of 30-day clinical outcomes between patients undergoing elective colorectal resections for endometriosis versus diverticular disease**

	Endometriosis (n=590)	Diverticular (n=25,878)	p-value
Median total hospital stay, days [IQR]	4 [3-5]	4 [3-5]	0.350
30-day overall complications	122 (20.7%)	4772 (18.4%)	0.166
Clostridium difficile infection	4 (0.7%)	366 (1.4%)	
Myocardial infarction	0 (0%)	80 (0.3%)	0.428
Hemorrhage requiring transfusion	44 (7.5%)	4350 (6.3%)	0.255
Pneumonia	3 (0.5%)	190 (0.7%)	0.804
Pulmonary embolism	5 (0.9%)	80 (0.3%)	0.022
Renal insufficiency	2 (0.3%)	163 (0.6%)	0.593
Stroke	0 (0%)	34 (0.1%)	1.00
Sepsis or septic shock	16 (2.7%)	919 (3.6%)	0.275
Surgical site infection	44 (7.5%)	2000 (7.7%)	0.807
Superficial	12 (2.0%)	870 (3.4%)	0.076

Incisional/deep	3 (0.5%)	140 (0.5%)	0.915
Organ space	29 (4.9%)	1054 (4.1%)	0.307
Unplanned intubation	1 (0.2%)	114 (0.4%)	0.525
Urinary tract infection	18 (3.1%)	543 (2.1%)	0.112
Venous thromboembolism	9 (1.5%)	170 (0.7%)	0.011
Wound dehiscence	3 (0.5%)	138 (0.5%)	1.00
30-day return to OR	20 (3.4%)	868 (3.4%)	0.962
30-day readmission	52 (8.8%)	1992 (7.7%)	0.315
30-day mortality	0 (0%)	63 (0.2%)	0.230
Colectomy-targeted PUF only	(n=337)	(n=16,686)	
Ileus	28 (8.3%)	1068 (6.4%)	0.158
Anastomotic leak	11 (3.3%)	382 (2.3%)	0.238
Leak not requiring treatment	2 (0.6%)	25 (0.2%)	0.215†
Leak treated by antibiotics*	2 (0.6%)	75 (0.5%)	
Leak treated by interventional means	2 (0.6%)	85 (0.5%)	
Leak treated by re-operation	5 (1.5%)	197 (1.2%)	

\*defined in the colectomy-targeted PUF as “leak, treated with non-interventional/non-operative means”

†p-value comparing the distribution of the different types of anastomotic leak

On subgroup analysis in patients ≤45 years of age, the endometriosis cohort was associated with longer median length of stay and a higher incidence of overall 30-day complications (Table 3). There also were differences in certain complications that were not seen in the overall cohort such as hemorrhage requiring transfusion, urinary tract infection (UTI), and ileus. On multiple regression analysis, endometriosis remained independently associated with increased overall 30-day complications (adjusted OR 2.1, 95% CI 1.56, 2.74) and longer length of stay (adjusted IRR 1.21, 95% CI 1.16, 1.28), but with larger magnitudes of effect compared with the overall cohort.

**Table 3: Subgroup analysis of clinical outcomes patients ≤45 years old**

	Endometriosis (n=459)	Diverticular (n=2,390)	p-value
Median total hospital stay, days [IQR]	4 [3-5]	3 [2-5]	0.006
30-day overall complications	97 (21.1%)	359 (15.0%)	0.001
Clostridium difficile infection	3 (0.7%)	24 (1.0%)	0.478
Myocardial infarction	0 (0%)	0 (0%)	1.00
Hemorrhage requiring transfusion	35 (7.6%)	60 (2.5%)	<0.001
Pneumonia	3 (0.7%)	14 (0.5%)	0.773
Pulmonary embolism	4 (0.9%)	5 (0.2%)	0.021
Renal insufficiency	1 (0.2%)	5 (0.3%)	0.895

Stroke	0 (0%)	1 (0.04%)	1.00
Sepsis or septic shock	13 (2.8%)	83 (3.5%)	0.486
Surgical site infection	36 (7.8%)	174 (7.3%)	0.673
Superficial	9 (2.0%)	69 (2.9%)	0.265
Incisional/deep	3 (0.7%)	14 (0.6%)	0.863
Organ space	24 (5.2%)	98 (4.1%)	0.274
Unplanned intubation	0 (0%)	3 (0.1%)	1.00
Urinary tract infection	16 (3.5%)	32 (1.3%)	0.001
Venous thromboembolism	5 (1.1%)	10 (0.4%)	0.069
Wound dehiscence	3 (0.7%)	13 (0.5%)	0.733
30-day return to OR	15 (3.3%)	72 (3.0%)	0.771
30-day readmission	39 (8.5%)	160 (6.7%)	0.165
30-day mortality	0 (0%)	0 (0%)	1.00
Colectomy-targeted PUF only	(n=245)	(n=1,533)	
Ileus	18 (7.4%)	61 (4.0%)	0.018
Anastomotic leak	8 (3.3%)	36 (3.0%)	0.823
Leak not requiring treatment	2 (0.8%)	2 (0.1%)	0.298†
Leak treated by antibiotics*	1 (0.4%)	7 (0.5%)	
Leak treated by interventional means	1 (0.4%)	14 (0.9%)	
Leak treated by re-operation	4 (1.6%)	23 (1.8%)	

\*defined in the colectomy-targeted PUF as “leak, treated with non-interventional/non-operative means”

†p-value comparing the distribution of the different types of anastomotic leak

## Discussion

These data employ a comparison between endometrial and diverticular disease; both of which share a propensity for the left colon, are benign, and are inflammatory processes. Unlike endometriosis, the management of diverticular disease is highly standardized with rigorous associated clinical guidelines [11]. The aim of this study was to compare the surgical management of these analogous conditions and their associated complications.

We demonstrate that compared to diverticular disease, the surgical management of endometrial disease is less likely to employ mechanical or antibiotic bowel prep, and laparoscopy, but more likely to employ robotic or open resection. These differences may reflect the broader practice patterns of OBGYNs performing these procedures. Of interest, in the treatment of endometriosis associated pain, laparotomy and laparoscopy have been shown to be equally effective in non-randomized trials [12].

However, 80% of cases performed for endometriosis were performed by a general surgeon. Given inherent limitations present in NSQIP, we are unable to capture what proportion of these surgeons carry additional colorectal specialization or their case volume in colonic procedures. This is of obvious relevance, as surgeon experience plays a role in outcomes as the French group of Bendifallah et al. found an optimal value of

7-13 procedures a year per surgeon for significant reduction of severe complication rates [13].

Additionally, we are unable to determine if intra-operative colorectal or general surgical consults were called in any of these cases, or if any pre-operative planning involved colorectal surgeons. Multidisciplinary approaches to the management of endometrial disease are noted to not merely be important, but are considered standard of care [1,14,15].

In regards to overall complications and length of stay, we do not find differences between those who underwent resection for diverticular or endometrial disease. However, inherent differences exist in baseline characteristics between these groups; namely that those with endometrial disease are younger, less comorbid, and have a lower BMI – all factors which contribute to their lower predicted complication risk compared to the diverticular group.9 This is unsurprising, as diverticular disease has demonstrated association with older age and with elevation in BMI, while endometrial disease is inherently related to the menstrual cycle and therefore absent in older individuals [16,17].

To adjust for these differences, we performed subgroup analysis on patients under 45 years of age. In this subgroup we find endometriosis is associated with a longer median length of stay and had a higher incidence of 30-day complications. Further, specific complications including UTI and hemorrhage requiring transfusion were increased in endometriosis. While diverticular disease is notable for its propensity to involve pelvic structures, including the ovaries and bladder, elective resection makes use of antibiotics and time that enable the inflammatory reaction to abate.18 Conversely, endometriosis is persistently inflammatory and does not have a commensurate opportunity to create a less hostile operative field.

While both endometriosis and diverticulitis are inflammatory conditions, there are differences in the challenges these conditions present. As initially hypothesized, in this under 45 cohort, on multiple regression analysis endometriosis is independently associated with increased overall 30-day complications, and longer length of stay. This finding underscores the increased operative challenge present in colonic resection for endometrial disease.

Due to its retrospective nature, limitations of this study exist. Additionally, NSQIP data, while robust, does not enable us to capture variables that would aid in propensity matching these patient cohorts, such as the severity of diverticular or endometrial disease. For example, we are unable to determine the severity or chronicity of either condition, or if patients were subject to interventions prior to surgery such as drain placement for diverticular disease, or prior disk or shave excision for endometrial disease.

## Conclusion

These data demonstrate the complexity of endometriosis patients undergoing colorectal resection, especially in comparison to elective surgery for diverticular disease. This highlights the need for evidence-based colorectal practice guidelines.

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