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Ileocolic Resection for Crohn's Disease: A Minimally Invasive Approach Claims Its Place

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Ileocolic resection is the most common operation performed for Crohn's disease patients with terminal ileum involvement. We sought to evaluate the outcomes in Crohn's disease patients who underwent open ileocolic resection (OIC) and laparoscopic ileocolic resection (LIC) by using the ACS-NSQIP database from 2006 to 2015. Of 5670 patients, 48.3 per cent (2737) patients had OIC and 51.7 per cent (2933) had LIC. The number of LIC increased from 40 per cent in 2006 to 60.7 per cent in 2015. Moreover, the annual number of LIC surgeries has exceeded the number of OIC surgeries since 2013. Patients in the LIC group had shorter hospital length of stay compared with OIC group (6.65 days vs 8.66 days, $P < 0.01$). The LIC procedure also had shorter operation time compared with OIC (148.658 vs 153.676 minutes, $P < 0.01$). Overall morbidity (15.8% vs 25.3%, AOR: 0.54, confidence interval (CI): 0.46–0.62, $P < 0.01$), serious morbidity (10.9% vs 18%, AOR: 0.55, CI: 0.46–0.65, $P < 0.01$), and SSI (9.9% vs 15.5%, AOR: 0.59, CI: 0.49–0.70, $P < 0.01$) rates were lower in the LIC group than the OIC group. We demonstrated that in Crohn's disease patients, LIC has improved outcomes for ileocolic resection compared with OIC and has been chosen as the preferential treatment approach for most patients.

Crohn's Disease is a chronic inflammatory condition that can affect the entirety of the alimentary tract. The reported incidence rate of Crohn's disease in the United States, reported by the Centers for Disease Control, is 3.1 to 14.6 cases per 100,000 person-years.¹ Nonoperative management is considered the first-line approach for patients with inflammatory bowel disease, including Crohn's disease and ulcerative colitis.^{2,3} Despite the advances in the medical management for Crohn's disease, up to 80 per cent of such patients still require operative management during their course of the disease.⁴⁻⁸ The terminal ileum and proximal colon are the most commonly affected sites^{4,6}; therefore, ileocolic resection is the most common surgical procedure performed.⁹⁻¹²

The chronic nature of the disease requires surgery at a young age and frequent reoperations. This makes minimally invasive surgery (MIS) procedures especially attractive in this subset of patients, given that small case series have shown improved outcomes, such as improved cosmesis, less postoperative pain, shorter length of stay, earlier return to work, reduced adhesion formation, and decrease in the incidence of incisional hernia.^{6,13-17} Because of the inflammatory nature of the Crohn's disease pathology, MIS approaches were initially discouraged because of complexity. Although

previous studies reported the safety of laparoscopic approach in Crohn's disease patients,¹⁸ there are limited data in this topic and also contraindications to a minimally invasive approach for individual patients with Crohn's disease are less clear.^{15, 19} We aimed to investigate the outcomes of ileocolonic Crohn's disease patients, who underwent open ileocolic resection (OIC) and laparoscopic ileocolic resection (LIC) and also present the trends in MIS utilization in Crohn's disease patients.

Methods

We used the ACS-NSQIP files from 2006 to 2015. ACS-NSQIP is a nationwide outcome-based risk adjusted database, which provides preoperative to 30-day postoperative information of surgical patients based on the clinical data in the United States.²⁰ It includes more than 150 patient variables using standardized definitions created by the ACS-NSQIP database, is exempt from obtaining informed consent of individual patients, and is covered by the hospitals' patient consent forms. Approval of the use of the NSQIP patient-level data in this study was obtained from the Institutional Review Board of the University of California, Irvine Medical Center, and NSQIP.

Study Design and Population

We analyzed the available data of the patients having Crohn's disease, who underwent open and LIC. The NSQIP database from 2006 to 2015 was queried for patients with a primary postoperative diagnosis of Crohn's disease based on the ICD-9-CM codes. The primary diagnosis category codes (555.0, 555.1, 555.2, and 555.9) were then cross-referenced with the CPT codes (44,205 and 44,160) to identify only the patients with Crohn's disease who had undergone a laparoscopic or an OIC. Emergent cases and patients with disseminated cancers were excluded. Patient variables that were analyzed included demographic data (age, gender, race, and body mass index); comorbid conditions (hypertension, diabetes mellitus, chronic obstructive pulmonary disease, dyspnea, chronic steroid use, obesity, ascites, weight loss, and preoperative renal failure); and American Society of Anesthesiologists score, smoking, hypoalbuminemia, surgical approach (laparoscopic vs open). Baseline patient demographics, comorbidities, operative details, and postoperative complications were extracted from the database. The outcomes evaluated were 30-day inhospital mortality, overall morbidity, serious morbidity, renal failure, urinary tract infections, unplanned intubation, ventilator dependency more than 48 hours, pneumonia, venous thromboembolism, superficial SSI, deep SSI, organ space SSI, overall SSI, wound dehiscence, intraoperative blood transfusion, sepsis, septic shock, unplanned reoperation, unplanned readmission operation time, and length of hospital stay. Definitions of NSQIP collected data points according to the ACS definition are available online in the NSQIP user guide.²⁰ Serious morbidity was defined as at least one of the following: organ space SSI, wound dehiscence, ventilator dependence >48 hours, progressive renal insufficiency, acute renal insufficiency, CVA/stroke, cardiac arrest, myocardial infarction, bleeding requiring transfusion, pulmonary embolism, sepsis or septic shock. Overall morbidity was defined as having documentation of a serious morbidity or at least one of the following ACS NSQIP complications: superficial SSI,

deep SSI, pneumonia, unplanned intubation, urinary tract infection, and deep vein thrombosis. The primary end points investigated were the postoperative complications in patients undergoing laparoscopic compared with patients undergoing OIC.

Statistical Analysis

The SPSS software statistical package version 23 (SPSS, Inc., Chicago, IL) was used for the analysis of the data. Univariate analysis was performed to compare characteristics of the LIC and OIC cohorts. The major method of analysis was multivariate analysis using logistic regression model to eliminate the effects of confounding variables. Variables which significantly increased risk in univariate analysis were selected to be included in multivariate analysis. We calculated the adjusted odds ratio with a 95 per cent confidence interval and the P values less than 0.05 were used to indicate the statistical significance.

Results

In this study, a total of 5751 patients with Crohn's disease who underwent ileocolic resection were identified. Of these, 2800 (48.7%) underwent OIC and 2951 (51.3%) underwent LIC. The number of LIC surgeries increased from 40 per cent in 2006 to 60.7 per cent in 2015. As shown in Figure 1, the number of LIC procedures gradually increased during the last decade and has exceeded the number of OIC procedures since 2013.

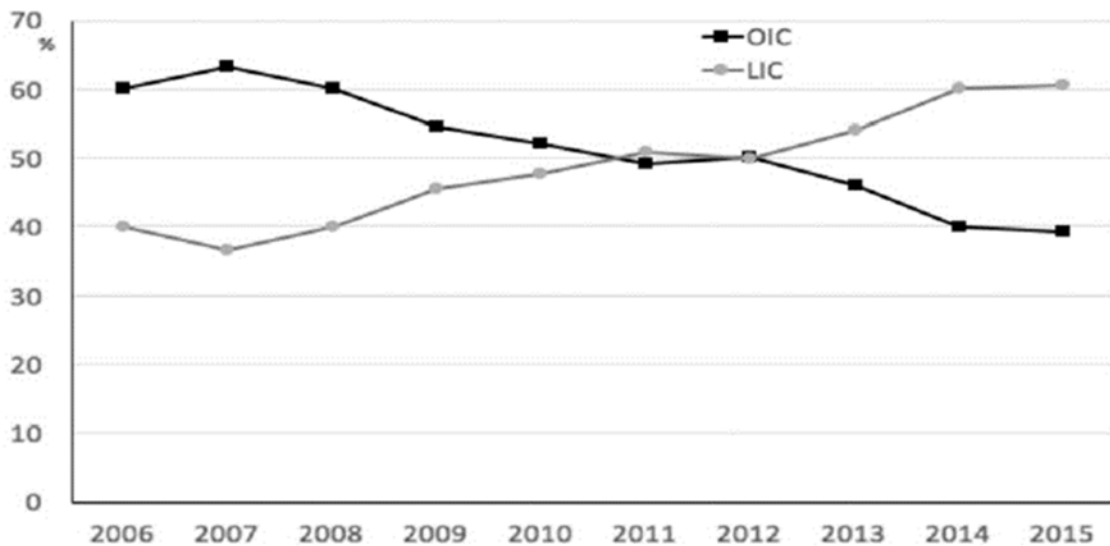


FIG. 1. Proportion of OIC (OC) versus LIC (LAP) from 2006 to 2015.

Demographics and clinical data were summarized in Table 1. The mean patient age was 40 ± 15 years, and the majority of the patients were white (90.3%) and female (54.1%). With respect to comorbidity profile, the LIC group had lower rates of hypertension (12.7% vs 18.2%, $P < 0.01$), chronic obstructive pulmonary disease (1.1% vs 1.8%, $P = 0.02$), hypoalbuminemia

(46.8% vs 52.4%, $P < 0.01$), diabetes mellitus (2% vs 3.1%, $P < 0.01$), and history of smoking (24.1% vs 30.2%, $P < 0.01$) compared with OIC. However, the rate of chronic steroid use was significantly higher in LIC cohort compared with OIC (51.4% vs 48.7%, $P = 0.04$). Patients undergoing LIC had shorter length of hospital stay compared with OIC (6 ± 5 days vs 8.6 ± 8 days, $P < 0.01$).

Table 2 summarizes the multivariate logistic regression analyses for patients who underwent LIC versus OIC. Compared with OIC, patients in LIC group had lower rates of overall morbidity (15.8% vs 25.3%, AOR: 0.54, confidence interval (CI): 0.46–0.62, $P < 0.01$) and serious morbidity (10.9% vs 18%, AOR: 0.55, CI: 0.56–0.65, $P < 0.01$). There was no significant difference in the inhospital mortality in the two groups (0.1% vs 0.2%, AOR: 0.39, CI: 0.07–2.07, $P = 0.27$).

Figure 2 shows the trend of overall morbidity rate for OIC, LIC, and entire cohort. The overall morbidity

TABLE 1. Patient Characteristics and Clinical Data in Patients for LIC versus OIC

Patients' Characteristics and Clinical Data	OIC (N = 2737)	LIC (N = 2933)	P-Value
Age: mean \pm SD (years)	43 \pm 15.2	38 \pm 15	<0.01
Male (vs female)	1350 (49.3%)	1253 (42.7%)	<0.01
BMI (Kg/m ²) (mean \pm SD)	25.5 \pm 6.5	25.15 \pm 6	0.45
Race			
White	2071 (90.6%)	2312 (90%)	0.63
Black	198 (8.7%)	241 (9.4%)	0.31
Asian	15 (0.5%)	14 (0.5%)	0.42
Other ethnicities	3 (0.1%)	1 (0.03%)	0.57
American Society of Anesthesiologists more than two	969 (35.4%)	679 (23.2%)	<0.01
Hypertension	497 (18.2%)	373 (12.7%)	<0.01
History of smoking	826 (30.2%)	707 (24.1%)	<0.01
Weight loss	240 (8.8%)	216 (7.4%)	0.05
Dyspnea	100 (3.7%)	58 (2%)	<0.01
COPD	48 (1.8%)	31 (1.1%)	0.02
Diabetes mellitus	84 (3.1%)	58 (2%)	<0.01
Chronic steroid use	1334 (48.7%)	1508 (51.4%)	0.04
Preoperative ascites	11 (0.4%)	5 (0.2%)	0.10
Preoperative renal failure	7 (0.3%)	2 (0.1%)	0.08
Hypoalbuminemia	1435 (52.4%)	1372 (46.8%)	<0.01
Mean operative duration (minutes \pm SD)	153 \pm 76	148 \pm 58	0.01
Mean length of stay (days \pm SD)	8.6 \pm 8	6 \pm 5	<0.01

Data are reported as n (%) or mean \pm SD.

TABLE 2. Risk Adjusted; LIC versus OIC

Complications	OIC (N = 2737)	LIC (N = 2933)	AOR	95% CI	P-Value
Inhospital mortality	6 (0.2%)	3 (0.1%)	0.39	0.07–2.07	0.27
Overall morbidity	692 (25.3%)	464 (15.8%)	0.54	0.46–0.62	<0.01
Serious morbidity	493 (18%)	319 (10.9%)	0.55	0.46–0.65	<0.01
Renal failure	20 (0.7%)	8 (0.3%)	0.54	0.23–1.28	0.16
Urinary tract infections	61 (2.2%)	37 (1.3%)	0.46	0.28–0.73	0.01
Unplanned intubation	28 (1%)	13 (0.4%)	0.44	0.21–0.94	0.03
Ventilator dependency	22 (0.8%)	12 (0.4%)	0.59	0.27–1.30	0.19
Pneumonia	49 (1.8%)	27 (0.9%)	0.64	0.38–1.08	0.10
Venous thromboembolism	37 (1.4%)	28 (1%)	0.67	0.39–1.14	0.14
Superficial SSI	210 (7.7%)	132 (4.5%)	0.53	0.41–0.68	<0.01
Deep SSI	48 (1.8%)	25 (0.9%)	0.59	0.35–1.03	0.05
Organ space SSI	195 (7.1%)	146 (5%)	0.67	0.37–0.86	<0.01
Wound dehiscence	25 (0.9%)	18 (0.6%)	0.63	0.31–1.25	0.18
Any SSI	424 (15.5%)	291 (9.9%)	0.59	0.49–0.70	<0.01
Intraoperative blood transfusion	174 (6.4%)	95 (3.2%)	0.49	0.37–0.64	<0.01
Sepsis	178 (6.5%)	103 (3.5%)	0.47	0.34–0.69	<0.01
Septic shock	29 (1.1%)	15 (0.5%)	0.68	0.33–1.43	0.31
Unplanned reoperation	52 (2.1%)	55 (1.9%)	0.93	0.61–1.40	0.73
Unplanned readmission	196 (7.2%)	199 (6.8%)	0.92	0.74–1.15	0.49

Data are reported as n (%).

changed from 2006 to 2015, from 23.1 to 19.8 per cent for the OIC cohort, from 12.3 to 15 per cent for LIC cohort, and from 18.8 to 16.9 per cent for entire cohort. LIC was

associated with the lower risk of SSIs compared with patients who underwent OIC (9.9% vs 15.5%, AOR: 0.59, CI: 0.49–0.70, $P < 0.01$). LIC was also associated with the lower risk of postoperative sepsis (3.5% vs 6.5%, AOR: 0.47, CI: 0.34–0.69, $P < 0.01$), intraoperative blood transfusion (3.2% vs 6.4%, AOR: 0.49, CI: 0.37–0.64, $P < 0.01$), and urinary tract infections (1.3% vs 2.2%, AOR: 0.46, CI: 0.28–0.73, $P < 0.01$) compared with OIC group.

Discussions

Our study revealed a steady increase in the number of LIC operations for patients with Crohn's disease during the last decade. Minimally invasive approaches also result in decreased operative time, length of stay in the hospital, intraoperative bleeding, postoperative sepsis, and SSIs.

This study showed the noticeable inflection in the trend observed during the last decade strongly suggests that the minimally invasive approach has been broadly accepted as the preferred procedure for ileocolic resection in Crohn's disease patients. This noticeable shift in approach is reported for the first time and indicates the change in the current practice for surgical management of patients with Crohn's disease. During the last decade, the laparoscopic approach has been steadily rising. In 2006, 40 per cent of ileocolic resections were performed through minimally invasive approach compared with the open procedure (60%) but the number of LIC surgeries increased to 60.7 per cent in 2015. This increase in surgical approach has also been reported by Lee et al., who demonstrated a similar trend in the number of open and laparoscopic colorectal operations in favor of a minimally invasive approach.²¹

Several published studies have shown that the laparoscopic use for ileocolic resection in Crohn's disease patients reduces major and minor complications when compared with the open procedure.^{12, 21, 22} Also, another previous ACS-NSQIP-based study indicated that patients selected for LIC for Crohn's disease have a significant lower rate of 30-day major and minor complications compared with open surgery which is consistent with the results of our study. The higher rate of overall morbidity in OIC subset likely reflects some case selection bias which cannot be overcome by multivariable analysis.

It is well known that a minimally invasive approach significantly decreases the risk of SSIs in colorectal surgical procedures compared with open approach.^{23, 24} Some studies have shown that the risk of intra-abdominal abscesses is equivalent between LIC and OIC in patients with Crohn's disease.^{7, 18, 25} In this study, we found that LIC utilization is significantly associated with reduced odds of SSI development which is consistent with other published literature.^{6, 26, 27}

With respect to length of hospitalization in our study, the significant reduction in the length of stay in MIS group, logically follows the reduction in the complications, which concurs with other studies reported in a published review article. Lim et al. concluded that the benefits of laparoscopic surgery over open surgery are quicker return to bowel function, decreased wound infection rates, and shorter hospital stays.⁶ Maartense et al. in a randomized clinical trial similarly showed significant decrease in 30-day morbidity rate, hospital length of stay, and cost in the group undergoing laparoscopic approach when compared with the open approach.²⁸

Some studies published before 2005 demonstrated that there was no difference in intraoperative blood loss and transfusion between laparoscopic and open surgeries in patients with Crohn's disease.²⁹ However, similar with other recent studies, our result showed that intraoperative bleeding was significantly higher in the group undergoing open procedure as compared with the laparoscopic group. This might be related to the advancement of minimally invasive technology

and devices, such as ultrasonic and bipolar dissection that has been broadly used over the last decade.³⁰

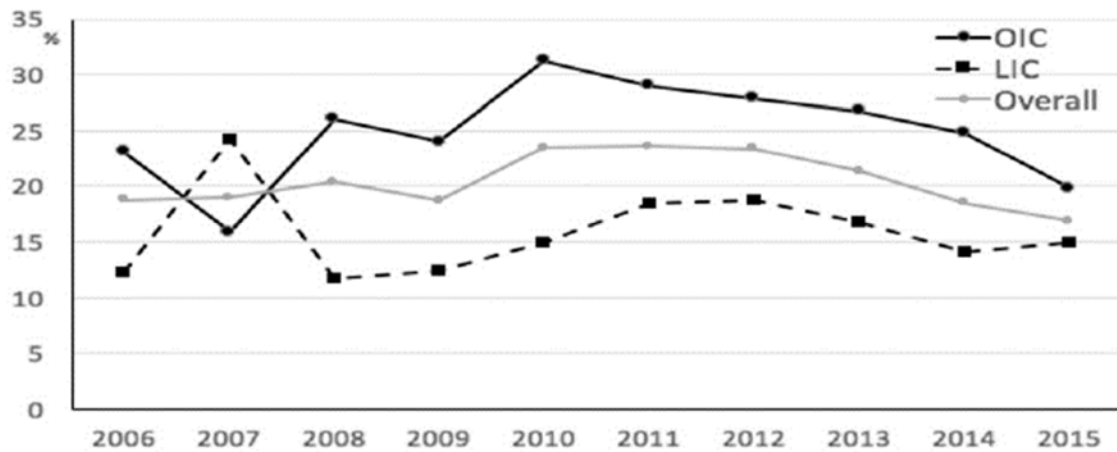


FIG. 2. Rate of overall morbidity from 2006 to 2015.

Previous studies have shown that the operative time is longer in the laparoscopic group than in the open group.^{12, 31} We found that open procedures have modestly but significantly longer operation times than laparoscopic procedures, which is consistent with the previous ACS-NSQIP study with less number of participants and shorter duration of study.¹⁸ Shorter operative times for laparoscopy may reflect improved minimally invasive technology and increased surgeons' experience and familiarity with its use in Crohn's disease during the last decade.

There are several inherent limitations to this study. First, this study is a large retrospective reviewed and is subject to the usual retrospective study biases such as selection bias. Also, ACS-NSQIP database only extends follow-up to 30 days postoperatively, and therefore, the true rate of complications may be underestimated. As with any national database, there are limitations regarding the accuracy in coding and input of data. Lack of information regarding hospital settings and surgeons' expertise also can affect the study outcomes. Although, we found multiple preoperative factors which were statistically significant, but some of them are not clinically significant. This might be because of the utilization of a large sample database that makes some variables statistically significant on the analysis. Furthermore, this is a nonrandomized mix of cases in the NSQIP program that does not necessarily reflect the general population. Despite these limitations, this study provides a large sample size to examine the short-term postoperative outcomes of laparoscopic versus OICs and also point out the change of trend in utilization of these approaches.

Conclusions

We have demonstrated that in Crohn's Disease patients, LIC has emerged as the preferential treatment approach for most patients. This shift in approach has been accomplished with no significant change in the overall morbidity of the entire patient population. OIC continues to be used for a significant proportion of patients, however, and has been accompanied by increasing morbidity over the decade studied, likely

because of case selection. Future randomized prospective studies are needed to confirm the true clinical advantages of MIS approach.

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