

Laparoscopic or Open Surgery for Inflammatory Bowel Disease

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Although most patients with inflammatory bowel diseases may ideally be treated with laparoscopic surgery, challenges include inflammation and fragility of the bowel wall and the mesentery, difficulty identifying normal anatomic landmarks, and coexisting abscesses and fistulas. In addition, these diseases commonly require extensive resections while operating within limited spaces. In this article, we present current data regarding the techniques, advantages, and outcomes of laparoscopy for patients with inflammatory bowel diseases. Common indications for minimally invasive surgery are Crohn's disease of the terminal ileum, colectomy, total proctocolectomy, and stoma formation in patients with severe perianal disease. The literature supports laparoscopic bowel resection because of shorter time to first bowel movement, shorter hospitalization, and less morbidity compared with laparotomy. Laparoscopy can even be used with low morbidity in patients who have undergone surgery and/or who have abscesses and fistulas. The most common standard elective operations for ulcerative colitis are total abdominal colectomy with ileostomy and restorative proctocolectomy. Laparoscopy is preferentially used in these situations by experienced surgeons in major centers. Although the minimally invasive approaches to Crohn's disease and ulcerative colitis are associated with some complications and contraindications, numerous studies have proven the efficacy, feasibility, and safety of these procedures for appropriately selected patients when undertaken by properly qualified surgeons.

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During the past decade, laparoscopic techniques have rapidly gained acceptance since their first introduction into surgery in the late 1980s. Wexner et al at Cleveland Clinic Florida performed laparoscopic colorectal procedures, including proctocolectomies in 1991.^{1,2} At that time, they reported longer operative time and more blood loss than they encountered with matched open procedures. They also reported significant advantages of laparoscopic ileocolic resection for terminal ileal Crohn's disease (CD) and of fecal diversion for perineal CD.³ Since that time, with developments in technology and increased experience, the role of laparoscopy in ulcerative colitis (UC) and inflammatory bowel disease (IBD) in general has proven to be not only feasible but also beneficial. Potential benefits include smaller incision size, improved cosmesis, less postoperative pain, earlier return of bowel function, and more rapid tolerance of diet. In total, these advantages can be translated into faster recovery, reduced total cost, and earlier return to normal activity.

We will separately discuss the various aspects of laparoscopy in CD and UC because the time of introduction of techniques, challenges, and outcomes vary. A wide range of procedures apply in CD, whereas proctocolectomy is the primary elective operation in UC. In CD, laparoscopy gained early favor in segmental bowel resection and diversion because of its feasibility. Soon thereafter, laparoscopic ileocolic resections and subtotal colectomies were successfully attempted and performed. In contrast, as mentioned, early results of laparoscopic restorative proctocolectomy (LAP-RP) and ileal pouch-anal anastomosis (IPAA) for patients with UC were not promising. In the early 2000s, new instruments, including energy sources, became available, techniques improved, and surgeons gained experience with minimally invasive procedures. These changes allowed for greater acceptance and feasibility of laparoscopic proctocolectomies as perioperative conditions and outcomes improved. Consequently, laparoscopic procedures for more complicated cases of CD have been attempted. Nevertheless, rates of open operations and conversions from laparoscopic to open surgeries remain high.

In this article, we review the current status of the various

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minimally invasive surgical approaches to CD and UC, and we discuss perioperative and long-term outcomes.

Crohn's Disease

In CD, surgery is indicated in patients whose disease is intractable to medical therapy, in patients who have complications from aggressive medical therapy, and in those who develop complications, such as fistulas or strictures. Given the benign nature of the disease, the laparoscopic approach is an ideal one. Furthermore, laparoscopy provides superior cosmetic results, which are important for the large number of young patients afflicted with this disease.⁴ Several factors in CD have deterred surgeons from considering laparoscopy. These include thickened and friable mesentery, thickened bowel loops, inflammatory masses and phlegmons, abscesses, fistulas, and multiple adhesions from previous surgeries. Most patients with CD are aware that there is a high likelihood of having a future operation and therefore are more motivated to choose a minimally invasive operation that offers less scarring and faster recovery.^{5,6} Depending on the situation and the experience of the surgeon, even complicated cases can be laparoscopically attempted.

Early Postoperative Results

The experience of the surgeon influences not only the initial decision to perform the surgery laparoscopically and the rate of conversion but also the outcome during the early postoperative period. Early postoperative results are based on several parameters, including return of bowel function, length of hospital stay, and early postoperative complications. Patients undergoing laparoscopic colectomies have been found to experience an earlier return of bowel function, a decreased hospital length of stay, and a decreased rate of complications compared with patients undergoing open colectomies. A study from the University of Chicago compared short-term outcomes of laparoscopic colectomy (LC) versus open colectomy (OC) in patients with Crohn's colitis.⁷ During a 6-year period, data were recorded, including patient and disease-specific characteristics and perioperative and short-term postoperative outcomes. Forty-four percent of 125 patients underwent colectomy. In the LC group, median operative time was shorter, return of bowel function was earlier, and hospital length of stay was shorter. Postoperative complications occurred in 8 (14.5%) LC patients versus 16 (22.9%) OC patients. Disease recurrence was 10.9% in the LC group and 20% in the OC group. Laparoscopic procedures were associated with less blood loss and quicker return of bowel function. Similar results were found in studies by Soop et al,⁸ Tanaka et al,⁹ and Kroesen et al.¹⁰

The rate of anastomotic leak has also been studied in laparoscopic versus open operations in patients with CD. El-Gazzaz et al¹¹ recently published a review of 1526 consecutive patients undergoing laparoscopic bowel resection and anastomosis compared with 3258 patients undergoing similar open operations; 29.6% of the 4774 patients had CD. There was no difference in clinical leak rate between the

laparoscopic (2.6%) and open groups (2.1%). The researchers also found no differences in leak rates between laparoscopic right versus open right and laparoscopic left versus open left and between patients who underwent surgery during different periods.

The largest single-center study to date comes from The Mount Sinai Hospital in New York City.¹² The authors reported their results from 335 laparoscopic resections for CD during 15 years in a retrospective analysis of a prospective database. The most common operation was primary ileocolic resection (49%); 117 patients had fistulas. Eight conversions occurred (2%), primarily because of large inflammatory masses involving the intestinal mesentery. The overall postoperative complication rate was 13% and included bowel obstruction, anastomotic leak, and postoperative bleeding.

Long-term Results

Eshuis et al¹³ evaluated the long-term results of laparoscopically assisted versus open ileocolic resection for CD in a prospective randomized study of 60 patients who underwent ileocolic resection. Primary outcomes studied were reoperation and readmission rates for recurrent CD, and secondary outcomes were quality of life (QOL), body image, and cosmesis. At a median follow-up of 6.7 years, 16 of 29 patients in the laparoscopic group and 16 of 26 patients in the open group remained relapse free. Patients in the open group had higher rates of incisional hernia and bowel obstruction, whereas patients in the laparoscopic group had better body image and cosmesis.

Stocchi et al¹⁴ reported their long-term results of a prospectively randomized study comparing laparoscopic (LC) and open (OC) ileocelectomies. These researchers specifically analyzed long-term recurrence rates and complications. The mean follow-up for 56 patients was 10.5 years. Adhesiolysis was performed in 2 and 0 patients in the LC and OC groups, respectively. Incidences of anorectal disease, anorectal surgery, endoscopic or radiologic recurrence, and medication use were similar between the LC and OC groups. Patients in the OC group were significantly more likely to require multiple operations. In conclusion, regarding long-term results, LC is at least comparable with OC.

Complex CD/Recurrent Disease

Contrary to what was once thought, previous surgeries, abscesses, phlegmon, friable mesentery, and recurrent disease are not contraindications for laparoscopic surgery (LAP). However, complicated cases can still be difficult to complete laparoscopically, even for surgeons who are well experienced in laparoscopic procedures for IBD. Goyer et al¹⁵ prospectively analyzed the feasibility of laparoscopic ileocolonic resection for complex CD. Fifty-four patients with complex CD underwent laparoscopic ileocolic resection. Indications for surgery included fistula (43%), abscess (30%), and recurrent disease after ileocolic resection (27%). As a whole, complex CD was significantly associated with increased mean operative time, increased conversion rate to open procedure, and increased use of temporary stomas; no deaths were recorded.

Overall postoperative morbidity and mean length of hospital stay were similar between the complex and noncomplex groups. This large study suggested that laparoscopic ileocolic resection for complex CD is safe and feasible, without increase in postoperative complications.

A prospective study from the Mayo Clinic¹⁶ assessed the safety, feasibility, and short-term outcomes of a laparoscopic approach in patients with recurrent ileocolic disease. Seventy-five percent of the 40 patients studied had their operation laparoscopically completed and 25% experienced conversion to open surgery. The patients with conversions were significantly more likely to require adhesiolysis. The laparoscopic and the conversion groups had similar postoperative complications and 30-day readmission rates. Conversion did increase the hospital length of stay. Other authors have reported similar results.¹⁷⁻¹⁹

Hand-Assisted Surgery

Hand-assisted laparoscopic surgery (HALS) has become more popular as an alternative to LAP for treatment of complex intestinal diseases. A study by Nakajima et al²⁰ aimed to evaluate the feasibility, safety, and potential benefit of HALS subtotal and total colectomy for Crohn's colitis. Thirty-eight consecutive patients undergoing subtotal or total colectomy for Crohn's colitis were evaluated. These patients were divided into 3 groups: open (n = 14), LAP (n = 6), and HALS (n = 18). The groups were comparable in age, gender, body mass index (BMI), extent of disease, indications, and procedures. The median operative time was significantly longer for LAP (330 minutes) than for HALS (251 minutes) or open surgery (200 minutes), and the mean blood loss was significantly less in LAP (170 mL) and HALS (225 mL) than in open surgery (438 mL). There was no difference among the 3 groups in the incidences or types of postoperative complications. The authors concluded that HALS subtotal and total colectomies are feasible, safe, and potentially beneficial for patients with extensive Crohn's colitis by reducing the operative time for LAP while retaining its less invasive nature. However, postoperative adhesion formation and incisional hernia rates remain unknown.

Laparoscopic Resection—New Techniques

Natural orifice transluminal endoscopic surgery and single-incision LAP have recently been described. It has been clearly demonstrated that ileocolic resection for CD is feasible and safe, but an incision is always necessary for specimen extraction. Eshuis et al²¹ reported an observational study of 10 patients undergoing ileocolic resection, assessing the feasibility of endoscopic transcolonic specimen removal avoiding any type of incision. Outcomes were compared with previous data on laparoscopic ileocolic resections. Transcolonic removal was successful in 8 of 10 patients whose specimen was smaller than 7 cm. Median operative time was 208 minutes, and median postoperative hospital stay was 5 days. Postoperatively, 2 patients developed an intra-abdominal abscess and 1 patient had another site-specific infection. The operation was longer than that for conventional laparoscopy, and

no benefits were perceived by patients in terms of cosmesis or body image. Based on available data, we cannot yet conclude that this technique offers any benefits compared with conventional LAP.

Influence of Obesity

Obese patients present new challenges to LAP, including difficulties in creating sufficient pneumoperitoneum and impaired visualization of normal anatomy because of adipose tissue. A retrospective study of prospectively collected data from Cleveland Clinic Florida compared results of laparoscopic colorectal resections in normal-weight versus overweight and obese patients with IBD during an 8-year period.²² Analyses were based on patient demographics and clinical characteristics such as BMI, age, gender, comorbidities, American Society of Anesthesiologists classification, and surgical- and disease-related variables, including 60-day postoperative complications. The 213 patients in this study formed 2 groups: (1) normal weight (n = 127, BMI = 18.5-24.9) and (2) overweight (n = 67, BMI = 25.0-29.9) and obese (n = 19, BMI \geq 30). Operations performed included ileocolic resection (56% in both groups) and total colectomy with or without proctectomy (39.4% and 40.7% in the 2 groups, respectively). The conversion rates were 18.0% and 22.09% in the 2 groups, respectively ($P > 0.05$). The rates of major postoperative complications (wound infection, abscess, anastomotic leak, and small-bowel obstruction), and mean hospital stay were similar between groups, and there was no mortality in either group. These results demonstrated that an overweight or obese patient is a candidate for laparoscopic resection when performed by a skilled surgeon.

Meta-analysis

Several meta-analyses describing LAP in CD have been published.²³⁻²⁷ One of the most recent was published by Tan and Tjandra, who sought to determine the safety and feasibility of LAP in CD. These authors searched for English language publications between January 1990 and February 2006, using the MEDLINE and PubMed databases and the Cochrane Central Register of Controlled Trials. In the review, the rate of conversion from LAP to open surgery was 11.2%. Laparoscopic procedures took on average 25.5 minutes longer to complete. LAP was associated with a more rapid recovery of bowel function, earlier tolerance of oral intake, shorter duration of hospitalization, and lower morbidity. This and other meta-analyses of LAP in CD have demonstrated that the approach is safe and feasible.

Ulcerative Colitis

Restorative proctocolectomy with ileal J-pouch anal anastomosis is the standard elective operation in UC. In the early 1990s, Wexner et al^{1,2} reported their initial laparoscopic experience. Unfortunately, their early results were not very promising, as the laparoscopic technique seemed to be difficult to apply, took an extensive amount of time, and resulted in higher morbidity. Numerous publications during the sub-

sequent decade confirmed these challenges and cautionary notes. However, ultimately after technical advances and increased surgical experience, complex laparoscopic operations were successfully undertaken. More recent studies demonstrate more favorable results with laparoscopy, including earlier return of bowel function and shorter hospital length of stay.²⁸⁻³¹ Other studies have shown even more benefits, such as reduced postoperative pain, decreased morbidity, improved nutrition, preservation of immune response, and decreased short- and long-term complications. Functional outcomes and QOL have been shown to be similar in patients who underwent LAP versus open surgery.³²⁻³⁴ Nevertheless, long operative times and learning curves have deterred many surgeons from adopting laparoscopy in the management of UC.³⁵ Accordingly, Boller et al³⁶ suggested simplifying operations such as the IPAA procedure by subdividing them into single steps in a systematic manner.

Early Postoperative Results

Holubar et al³⁷ investigated the short-term outcomes of LAP in UC. They reported their prospective data on a cohort of patients who underwent laparoscopic total proctocolectomy with Brooke ileostomy during an 8-year period at the Mayo Clinic. The indications for surgery in the cohort of 44 patients were refractory colitis (82%) and neoplasia (18%). Twenty-three (52%) operations were HALSs, 13 (30%) were laparoscopic-assisted, and 8 (18%) were “laparoscopic incisionless” with transanal specimen extraction. The authors reported major postoperative complications in 4 (9%) patients and no mortalities.

The Mayo Clinic group also reported their data on short-term outcomes after laparoscopic IPAA versus open IPAA.³⁸ Thirty-day complication rates were not significantly different between the groups, but length of stay was significantly shorter in the laparoscopic group. Average return of bowel function was 2.5 days in the laparoscopic group and 4.8 days in the open group ($P = 0.001$). Time to soft diet was 3 days in the laparoscopic group and 6 days in the open group ($P < 0.001$). No mortalities or failed pouches were identified at the last follow-up.

The laparoscopic approach is clearly associated with an earlier return of bowel function and a more rapid discharge from the hospital.

Long-term Results

Long-term outcomes after laparoscopic IPAA have not been thoroughly evaluated. Fichera et al³⁹ conducted a prospective study comparing short- and long-term results. They evaluated 73 laparoscopic and 106 open IPAA patients at a mean follow-up of 24.8 months. Patients who underwent laparoscopic IPAA had faster return of flatus ($P = 0.008$), earlier intake of liquid diet ($P < 0.001$), and less blood loss ($P = 0.026$). Although complications were similar between the groups, the incidence of incisional hernias was lower in the laparoscopic group ($P = 0.011$). The average number of bowel movements was 6.8 per day for the laparoscopic group and 6.3 for the open group ($P = 0.058$). At 1 year, 68.4% of

all patients were fully continent, and during longer periods, up to 83.7% were continent; there were no differences in continence rates between groups. Other indicators of defecatory function and QOL were similar between the groups.

Larson et al⁴⁰ published on self-reported sexual function, body image, and QOL in patients after laparoscopic and open IPAA at the Mayo Clinic between 1978 and 2004. The data were based on 100 laparoscopic and 189 open operations. A survey was completed by the patients 1 year after operation to evaluate sexual function, body image, and QOL. A total of 125 of 289 patients (43%) returned completed surveys. There were no significant differences in terms of demographics, complications, or long-term functional outcomes between those who completed the surveys and those who did not. Men who underwent laparoscopic IPAA had lower orgasmic function scores; however, overall sexual function scores were equal to or better than normal values for men but were lower in women. Furthermore, overall body image and QOL scores were above the means published for the United States.

Indar et al⁴¹ also conducted a study in which adhesions to the anterior abdominal wall and adnexal organs after laparoscopic IPAA were evaluated. Adhesions were laparoscopically assessed at the time of ileostomy closure and quantified using the American Fertility Society adhesion score. In this prospectively maintained data, 34 patients (21 women) underwent laparoscopic IPAA. Twenty-three patients (68%) had no adhesions to the anterior abdominal wall, and the remaining 11 patients (32%) had few adhesions. Among the 21 women, 15 (71%) had no adnexal adhesions, 5 (24%) had filmy adhesions enclosing less than one-third of 1 adnexa, and 1 (5%) had filmy adhesions enclosing one-third to two-thirds of 1 adnexa. The authors concluded that laparoscopic IPAA results in few adhesions to the anterior abdominal wall or to gynecologic organs. In addition, the number of these adhesions was significantly fewer than previously reported for open operations.

Hand-Assisted Surgery

In a few randomized studies, hand-assisted laparoscopic restorative proctocolectomy (HALS-RP) has been shown to maintain several of the laparoscopic benefits. Tsuruta et al⁴² from Keio University in Tokyo studied the effectiveness of HALS-RP compared with LAP-RP in patients with UC. This retrospective review of prospectively maintained data included 30 HALS-RP patients and 40 LAP-RP patients during a 10-year period. In these patients, the median operative time was significantly shorter for HALS-RP (356 minutes) than for LAP-RP (505 minutes, $P < 0.001$). The median length of incision was significantly longer for HALS-RP (8 cm) than for LAP-RP (5.5 cm, $P < 0.05$). The 2 groups did not differ significantly for outcomes of estimated blood loss, length of hospital stay, and incidence of postoperative complications including anastomotic leaks.

Watanabe et al⁴³ reported on hand assistance in emergency subtotal colectomies for cases of severe UC. They compared 30 patients in a HALS group and 30 patients in an open

group. Although the median operative time was significantly longer in the laparoscopic group (242 vs 191 minutes, $P < 0.001$), their rate of early postoperative complications was significantly lower than that observed in the open group (37% vs 63%, $P = 0.041$). Four patients in the open group and no patients in HALS group required relaparotomy because of peritoneal abscess or strangulation ileus. HALS-RP seemed to maintain some of the advantages of laparoscopy.

Fulminant Colitis and Emergency Surgery

Multiple institutions have published data on LAP in emergency cases. Researchers at the Mayo Clinic evaluated safety, feasibility, and short-term outcomes of 3-stage minimally invasive surgery for fulminant UC.⁴⁴ They included 50 patients who underwent laparoscopic subtotal colectomies from 2000 to 2007. All patients had refractory colitis; 96% were on steroids, 76% were recently hospitalized, 59% had ≥ 5 -kg weight loss, 57% had anemia requiring transfusions, and 30% were receiving biologic-based therapy. Seventy-two percent of the 50 procedures were performed strictly with LAP, while 28% were performed with hand-assisted techniques. The conversion rate was 6%. Subsequently, 42 patients underwent laparoscopic completion proctectomy with IPAA. Median length of stay after each procedure was 4 days; there was 1 anastomotic leak and no mortality.

The group at Washington University in St Louis studied short-term outcomes of laparoscopic versus open total abdominal colectomy and end ileostomy for severe UC.⁴⁵ Thirty-seven patients underwent laparoscopic abdominal colectomy, and 41 patients underwent an open operation at the initial stage of a 3-stage restorative proctocolectomy. The laparoscopic patients underwent subsequent restorative proctectomy 49 days sooner and ileostomy closure 17 days sooner. The researchers concluded that laparoscopic abdominal colectomy for severe UC in selected patients was safe and leads to shorter recovery and completion of restorative proctocolectomy. A study of 90 patients from The Mount Sinai Hospital in New York showed laparoscopic subtotal colectomy to be safe and feasible and to result in improved cosmesis, reduced intraoperative blood loss, and shorter hospital stay.⁴⁶

It has been suggested that infliximab (Remicade, Janssen Biotech, Inc, Horsham, PA) may increase postoperative complication rates for patients who later require a restorative proctocolectomy with IPAA. Coquet-Reinier et al⁴⁷ aimed to address this question by assessing the postoperative course of patients after laparoscopic IPAA, comparing those who were and were not taking infliximab before surgery. The results indicated no significant differences between the groups in mean operative time, complication rate, and mean hospital length of stay.

Meta-analysis

Wu et al^{48,49} recently published a meta-analysis comprising 16 controlled trials, one of which was a prospective randomized study. The analysis revealed that postoperative fasting time and hospital length of stay were shorter for patients who

underwent LAP for UC. The overall complication rate was higher in the open surgery versus LAP group (54.8% vs 39.3%, $P = 0.004$). Although LAP lasted longer than open surgery, the 2 groups had comparable rates of peritoneal abscesses, anastomotic leaks, postoperative bowel obstructions, wound infections, reoperation, and mortality.

Outcomes of the laparoscopic approach were also systematically analyzed in a Cochrane review by Ahmed Ali et al,⁵⁰ which was based on 607 patients in 11 trials. The studies included 253 patients (41%) who underwent laparoscopic IPAA. No significant differences in complications, mortality, and reoperation and readmission rates were found between the 2 groups. Compared with open procedures, laparoscopic IPAA was associated with significantly longer operative times but shorter incision lengths and higher cosmesis scores.

These findings were based upon data accrued before the widespread availability of energy sources. The addition of energy sources to facilitate and expedite the operation has dramatically improved results.⁵¹

Conclusions

At this time, most major IBD centers have adopted LAP for CD. Laparoscopic segmental bowel resections, stoma formation, and colonic resections are widely performed. This approach is more frequently taken in complex cases in patients who have had previous operations, fistula, and abscess. Relative contraindications to LAP include small-bowel obstructions and acute and fulminant colitis. The extent of the minimally invasive approach is also obviously dictated by the size of the specimen and the skill and preference of the surgeon. Some surgeons may be more comfortable with a hand-assisted rather than a laparoscopic approach. Surgeons in most major IBD centers also perform laparoscopic restorative proctocolectomies and IPAA in UC, laparoscopic total abdominal colectomy, and laparoscopic total proctocolectomy. As described, short- and long-term results are at least comparable with those associated with open surgery. Some deterrents to the laparoscopic approach are the relatively long operative times and the steep learning curve. Future studies will elucidate optimal indications for LAP and will shed light on newer techniques, such as single-port operations and natural orifice transluminal endoscopic surgery.

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