Laparoscopy for Inflammatory Bowel Disease: Pushing the Envelope

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ABSTRACT

Despite the slower learning curve of laparoscopic colectomy and the lack of prospective randomized trials, laparoscopic procedures have repeatedly demonstrated a shortened length of stay, reduction in postoperative ileus, and earlier resumption of diet. However, laparoscopy in inflammatory bowel disease has unique challenges that must be overcome. For the patient with uncomplicated terminal ileal Crohn's disease, there are definite reproducible advantages to a minimally invasive approach. As surgeons gain experience, more complex cases may be attempted laparoscopically with a low threshold to alternate the approach if difficulties are encountered. We will continue to "push the envelope" in patients with complex Crohn's disease to allow more to be done in complex cases. For the patient with Crohn's colitis and ulcerative colitis, the role of a minimally invasive approach is less well defined. In experienced hands, a laparoscopic total colectomy can be performed safely and offers the patient all the advantages seen with laparoscopic segmental resection. Outcomes are likely to improve with better training, techniques, and equipment. As the field of minimally invasive surgery continues to expand, what is being "pushed" today will be routine in the future.

KEYWORDS: Laparoscopy, inflammatory bowel disease, restorative proctocolectomy

Objectives: On completion of this article, the reader should be familiar with expanding the management of inflammatory bowel disease using laparoscopic techniques.

Laparoscopic colorectal surgery has met with certain challenges that distinguish it from other minimally invasive procedures. Access to multiple quadrants of the abdomen and the need to create some type of incision to extract the disease specimen and to restore intestinal continuity separate laparoscopic colectomy from laparoscopic cholecystectomy and laparoscopic fundoplication. In 2006 we are "pushing the envelope" in performing minimally invasive procedures for patients with inflammatory bowel disease. However, laparoscopy in the setting of inflammatory bowel disease has its own set of unique challenges that must be overcome.

For patients with Crohn's disease, the dissection is hampered by inflammatory changes in the mesentery, difficulty in assessing bowel involvement and identifying normal anatomic landmarks, and the development of associated abscess and fistulous disease often seen in the Crohn's patient. For the ulcerative colitis patient and the patient with isolated Crohn's colitis, the challenges are more technical. This article reviews the outcomes of laparoscopic surgery for terminal ileal Crohn's disease and also restorative and urgent colectomy in patients with ulcerative colitis. Because the majority of studies are retrospective case-control series or noncomparative

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reports, the conclusions must come from the repetitiveness of the results rather than the superiority of study design. For any one study, the evidence is weak; however, collectively, because of the reproducibility of results by a large number of institutions, even with different operative techniques and postoperative management parameters, the preponderance of evidence favors a laparoscopic approach to surgery for inflammatory bowel disease.

CROHN'S DISEASE

Crohn's disease of the terminal ileum seems to be an appealing arena for the application of a minimally invasive approach. The disease is usually limited to one area of the abdomen, and only mobilization and vascular pedicle ligation are required laparoscopically. The resection and anastomosis are generally performed extracorporeally. Patients with Crohn's are typically young and are interested in undertaking a procedure that minimizes incisional scarring. In addition, because many of these patients require reoperation over their lifetime, a minimally invasive approach is appealing. Early reports of laparoscopic ileocolic resection showed it to be feasible and safe but were generally small nonrandomized uncontrolled studies. More recent studies¹⁻¹⁴ (Table 1) have a larger experience on which to draw more meaningful conclusions. The majority of studies, however, are retrospective case-control series.

Operative Time

In nearly all comparative series of laparoscopic ileocolic resection for Crohn's disease, with two exceptions,^{2,13} the

operative times for the laparoscopic procedure are longer than those for similar conventional procedures. The added operative time ranges from 30 to 60 minutes. As with most other reports of laparoscopic colectomy, the operative time is likely to diminish as the surgical team gains experience, but rarely does it return to the comparable time for a conventional approach.

Early Outcomes

As expected, the outcomes following laparoscopically assisted ileocolic resection for Crohn's disease mirror those seen in other studies of laparoscopic colectomy for benign and malignant disease. In comparative studies (Table 1), laparoscopic ileocolic resection is associated with a quicker return of bowel function and earlier tolerance of an oral diet. The quicker resolution of ileus, earlier resumption of diet, and reduced postoperative pain have resulted in a shortened length of stay for patients after laparoscopic resection compared with traditional procedures. Recovery after conventional surgery has also been shortened but not consistently throughout the literature. In the absence of minimally invasive techniques, it would seem unlikely that the length of stay could be reduced further. In nearly all comparative studies, the length of hospitalization is 1 to 5 days less for the laparoscopic group. The wide variation in time to discharge represents institutional and cultural bias but has consistently shown an advantage for the laparoscopic group.

Skeptics of minimally invasive colorectal surgery will note that the current studies are nonrandomized series that have the inherent errors associated with uncontrolled reports. To date, there is only one

Table 1 Recent Studies of Laparoscopic Resection for Crohn's Disease

Ileocolic Resection									
Author	Year	No. of Patients		OP Time (min)		LOS (days)		Morbidity (%)	
		LAP	CON	LAP	CON	LAP	CON	LAP	CON
Bauer et al ¹	1996	25	14	—	—	6.5	8.5	—	—
Wu et al ²	1997	46	70	144	202	4.5	7.9	10	21
Dunker et al ³	1998	11	11	—	—	5.5	9.9	9	9
Wong et al ⁴	1999	55	—	150	—	6.0	—	5	—
Canin-Endres et al ⁵	1999	70	—	183	—	4.2	—	14	—
Alabaz et al ⁶	2000	26	48	150	90	7.0	9.6	—	—
Bemelman et al ⁷	2000	30	48	138	104	5.7	10.2	15	10
Young-Fadok et al ⁸	2001	33	33	147	124	4.0	7.0	—	—
Schmidt et al ⁹	2001	46	—	207	—	5.7	—	—	—
Milsom et al ¹⁰	2001	31	29	140	85	5.0	6.0	16	28
Duepre et al ¹¹	2002	21	24	75	98	3.0	5.0	14	16
Shore et al ¹²	2003	20	20	145	133	4.3	8.2	—	—
Benoist et al ¹³	2003	24	32	179	198	7.7	8.0	20	10
Bergamaschi et al ¹⁴	2003	39	53	185	105	5.6	11.2	9	10

CON, conventional; LAP, laparoscopic; LOS, length of stay; OP, operative.

Table 2 Results of Prospective Randomized Trial for Ileocolic Crohn's Disease¹⁰

	Laparoscopic Group (<i>n</i> = 31)	Conventional Group (<i>n</i> = 29)	<i>p</i> value
Age (years)*	37 (16–60)	32 (16–59)	NS
Sex: M:F	13:18	12:17	NS
ASA class			NS
I	16	17	
II	12	12	
III	3	0	
Operative time (minutes)†	140 (± 45)	85 (± 21)	< 0.0001
Incision length (cm)†	5.3 (± 1.6)	12.7 (± 5.5)	< 0.0001
Passage flatus (days)*	3 (1–5.5)	3.3 (2–11)	= 0.07
Bowel movement (days)*	4 (1.7–7)	4 (2.5–13)	NS
Morphine sulfate usage† (mg/kg/day)	1.3 (± 0.6)	1.4 (± 0.6)	NS
Return of 80%FEV1/FVC (days)*	2.5	3.5	= 0.03
Length of stay (days)*	5 (4–30)	6 (4–18)	NS
Morbidity	16%	28%	NS

*Values expressed in median (range).

†Values expressed in mean (± standard deviation).

ASA, American Society of Anesthesiologists; FEV1, forced expiratory volume (one second); FVC, forced vital capacity.

published prospective randomized trial in laparoscopic colorectal surgery for Crohn's disease. Milsom et al¹⁰ published a prospective randomized trial comparing conventional and laparoscopic ileocolic resection for refractory Crohn's disease. Sixty patients were randomly assigned to either conventional or laparoscopic resection after an initial diagnostic laparoscopy to assess the feasibility of a laparoscopic resection. Two surgeons (Jeffrey Milsom and myself) completed all procedures. The results favor a laparoscopic approach with regard to pulmonary function, morbidity, and length of stay (Table 2). There were no apparent short-term disadvantages. All patients had oral intake withheld for 3 days to evaluate nutritional parameters. This affected the timing of dietary intake and was probably responsible for a delay in discharge for some patients. The total length of stay in this randomized study was 1 day shorter in the laparoscopic group (5 versus 6 days) but did not reach statistical significance. Had dietary intake not been withheld, I believe the shortened length of stay of the laparoscopic group would have achieved significance.

Hospital Costs

One of the proposed disadvantages of laparoscopy is the higher operative costs related to longer operative times and increased expenditure in disposable equipment. Whether the total cost of the hospitalization (operative and hospital costs) is higher following laparoscopic colectomy is debatable. A case-control study from the Mayo Clinic has looked at total costs following laparoscopic and open ileocolic resection for Crohn's disease.⁸ Sixty-six

patients underwent laparoscopic (*n* = 33) or conventional (*n* = 33) ileocolic resection during the same time period (October 1995 to July 1999) and were well matched. Patients in the laparoscopic group had less postoperative pain, tolerated a regular diet sooner by 1 to 2 days, and had a shorter length of stay (4.0 versus 7.0 days). In their cost analysis, despite higher operative cost, the overall mean costs were \$3273 less in the laparoscopic group. The procedures were performed by different groups of surgeons at the institution, and although the surgeons may have introduced biases, this study was undertaken during the current era of cost containment in which all physicians are encouraged to reduce hospital stay. Other studies by Duepre et al¹¹ and Shore et al¹² have confirmed these findings in elective ileocolic resection with mean reductions of \$438 in costs and \$7465 in hospital charges in patients undergoing laparoscopic compared with conventional ileocolic resection. Clearly, if operative times and equipment expenditure are minimized, the overall cost of a laparoscopic resection should not exceed that of a conventional approach.

Long-Term Outcomes

With the loss of tactile sensation, one of the remaining concerns about performing laparoscopic surgery in the patient with terminal ileal Crohn's is missing an isolated proximal lesion. In our experience of 55 laparoscopic ileocolic resections, no patient has required medical or surgical treatment of a known missed lesion with a median follow-up of 18 months.⁴ During the initial exploration of a laparoscopic resection, the small bowel is run systematically and any areas of concern are tagged

with a suture intracorporeally and can be brought out through the infraumbilical wound prior to the ileocolic resection. Additional small bowel resection or stricturoplasty has been performed in addition to an ileocolic resection. Many patients following ileocolic resection develop a symptomatic recurrence proximal to the ileocolic anastomosis. There are now, however, several studies that have reported recurrence rates following laparoscopic ileocolic resection. In one paper, the long-term follow-up (mean 39 months) of 32 patients over 7 years who underwent a laparoscopic ileocolic resection was compared with that of 29 patients undergoing open resection.¹⁵ The rate of Crohn's recurrence was high but similar in both groups (48% laparoscopic, 44% conventional), as was the disease-free interval (24 months, $p=1.00$). In another review of long-term outcome, Bergamaschi et al reported the results of 39 laparoscopic and 53 conventional ileocolic resections with a 5-year follow-up.¹⁴ Recurrent disease was determined by patients' symptoms and confirmed both radiographically and endoscopically in 27% of patients undergoing a laparoscopic procedure and in 29% of patients with a conventional resection. Interestingly, the incidence of small bowel obstruction was significantly less in the laparoscopic group (11% versus 35%, $p=0.02$). This is thought to be due to less adhesion formation following a laparoscopic procedure. Laparoscopic ileocolic resection does not appear to offer any advantage over conventional resection with regard to symptomatic recurrence, but it also did not lead to a higher rate of recurrence or discovery of a missed lesion.

Meta-Analysis

A meta-analysis of 16 studies, from 1990 to 2004, comparing the results of laparoscopic and open surgery for Crohn's disease has been published.¹⁶ The analysis evaluated pooled effects estimated using a random-

effects model. The analysis demonstrated a longer operative time in the laparoscopic cases (26 minutes) but a quicker return of bowel function and shorter length of stay by 2.6 days. Six studies had adequate long-term follow-up and, when analyzed, demonstrated fewer episodes of postoperative bowel obstruction compared with open resection. Most cases of bowel obstruction were managed conservatively. This is the first large meta-analysis and the results echo the results of the individual reports.

In reviewing the results of laparoscopic ileocolic resection for Crohn's disease, the procedure appears to be safe and feasible and offers the advantages seen in other reports of laparoscopic colorectal procedures. For the inexperienced laparoscopist, the initial uncomplicated terminal ileal resection is an ideal procedure in which to gain laparoscopic experience. An initial laparoscopic survey should be performed in the majority of patients with refractory ileal Crohn's disease with a low threshold to alternate the approach if a complex case beyond the skill of the surgeon is encountered. The goal should not be to avoid conversion but rather to reach an early assessment of feasibility, which should not prolong operative time or expenditure.

MUCOSAL ULCERATIVE COLITIS

There are no prospective randomized studies of laparoscopic total colectomy for ulcerative colitis.¹⁷⁻¹⁹ The only results available for analysis are prospective and retrospective case-control studies and noncomparative reports²⁰⁻³² (Table 3). Until recently, there were few reports of laparoscopic proctocolectomy for patients with ulcerative colitis. Several reasons probably account for the slow acceptance of laparoscopic total colectomy, including the steep learning curve to performing even segmental colectomy, the technical challenges of transverse colon resection, and the unfavorable early

Table 3 Recent Studies of Laparoscopic Colectomy for Ulcerative Colitis

Author	Year	No. of Patients	Comment
Meijerink et al ²⁰	1999	10	Feasible, 7 for acute colitis
Marcello et al ²¹	2000	13	Restorative proctocolectomy, favorable results
Seshadri et al ²²	2001	37	25% morbidity
Hamel et al ²³	2001	21	Compared with ileocolic resection, similar morbidity and LOS
Marcello et al ²⁴	2001	16	For acute colitis, comparative study, favorable results
Brown et al ²⁵	2001	25	Longer operative time in laparoscopic group
Dunker et al ²⁶	2001	35	Better cosmesis
Ky et al ²⁷	2002	32	Single-stage procedure, good results
Bell and Seymour ²⁸	2002	18	Total colectomy for acute colitis, appears safe
Rivadeneira et al ²⁹	2003	23	Hand-assisted procedure reduced operative time
Kienle et al ³⁰	2003	59	Large study, laparoscopic colon mobilization only
Nakajima et al ³¹	2004	16	Hand-assisted technique, favorable results
Larson et al ³²	2005	33	Cases matched study, favorable 1-year outcomes

LOS, length of stay.

reports of laparoscopic total colectomy. The group from Cleveland Clinic Florida attempted laparoscopic total colectomy for patients with ulcerative colitis in the early 1990s and published several comparative reports.^{17,18} The results showed a longer operative time and higher blood loss than for matched open procedures with no apparent benefit. The authors discouraged the use of minimally invasive techniques for patients requiring total colectomy. This was an appropriate recommendation during the early era of laparoscopic colectomy. However, with advances in technology and experience gained with segmental resection, we began several years ago to reevaluate the role of laparoscopic total colectomy for inflammatory bowel disease.

While at the Cleveland Clinic Foundation, two surgeons (Jeffrey Milsom and myself) performed more than 750 laparoscopic colorectal procedures, including more than 100 total abdominal colectomies for a variety of indications.¹⁹ Because of the complexity of the procedure, however, it was not until recently that we attempted laparoscopic total colectomy for patients with ulcerative colitis. We reported a comparative study of patients with ulcerative colitis and familial adenomatous polyposis who underwent an elective laparoscopically assisted restorative proctocolectomy.²¹ Two thirds of patients had ulcerative colitis and were well matched to a conventional group during the same recent operative period. Despite a longer operative time (roughly 100 minutes longer), patients undergoing a laparoscopically assisted procedure had a quicker return of bowel function (median 2 days versus 4 days, $p = 0.03$). For the diverted patients, the median length of stay was reduced by 2 days in the laparoscopic group (6 versus 8 days, $p = 0.01$), and laparoscopic patients later in the study were reliably discharged on the fourth postoperative day. Complications occurred equally in both groups (laparoscopic 20% versus open 25%). This is still a procedure in evolution and requires an experienced laparoscopy team. But the advantages are analogous to those reported in segmental colonic resection.

The favorable results seen in the elective setting for the colitis patient lead a second case-control study, which also demonstrated similar benefits in the acute setting. Patients with acute nonfulminant colitis unresponsive to medical therapy and requiring surgical intervention were studied in a well-matched case-control study.²⁴ None of the patients had colonic dilatation or fulminant disease, defined as two or more of the following: tachycardia (heart rate >120 beats per minute), temperature greater than 38.0°C , peritoneal signs, and white blood cell count greater than $11,000/\text{mL}$. The decision to perform a total colectomy and ileostomy versus a proctocolectomy and ileoanal pouch in the ulcerative colitis patients was left to the discretion of the operating surgeon. None of these patients were thought to be good candidates for a restorative procedure

during this hospitalization. Although the colon was undoubtedly more inflamed, there were no inadvertent colon injuries during mobilization and no procedure required conversion. Even with an experienced team, the median operative time for the laparoscopically assisted group was roughly 90 minutes longer than for the conventional group (210 minutes versus 120 minutes). Remarkably, even with the prolonged operative time, these acutely ill patients had a dramatic recovery. Bowel function returned more quickly in the laparoscopic group, which led to the shortened length of stay. The rate of complication was low for both groups (laparoscopic 16% versus open 24%). These two studies were not randomized and, therefore, some bias in favor of the laparoscopic group is possible. However, the patients undergoing a laparoscopically assisted procedure were generally unsolicited and were referred to the staff surgeon on call. The procedures were all performed during the same time period, with an emphasis placed on early discharge of both the laparoscopically and conventionally operated patients. One other study has confirmed the safety of laparoscopic total colectomy for acute colitis in experienced hands.²⁸

In an effort to reduce operative times, we have used hand-assisted techniques for restorative proctocolectomy.²⁹ This study represents the first study to evaluate the effectiveness of a hand-assisted laparoscopic approach in comparison with a conventional laparoscopic method in patients undergoing laparoscopic proctocolectomy (Table 4). Both groups (10 hand assisted [HAL] versus 13 standard laparoscopy [SL]) were well matched, with no differences in age, sex, American Society of Anesthesiologists (ASA) level, operative indication, steroid usage, or diagnosis. The results demonstrated no differences in incision size (mean 8 cm), operative blood loss, rate of conversion (HAL 10% versus SL 0%), or complications (HAL 40% versus SL 31%). The operative times progressively decreased in the HAL group (mean 247 minutes) while remaining constant in the SL group (mean 300 minutes, $p < 0.05$) over the period of study. This 1-hour reduction in operative time is significant to the busy practicing surgeon and may open the door to more surgeons in performing laparoscopic restorative proctocolectomy. Another study by Nakajima et al showed similar advantages of hand-assisted total colectomy for ulcerative colitis.³¹ Hand-assisted restorative proctocolectomy can be accomplished without detriment to bowel function, length of stay, or patients' outcomes.

The functional outcomes of laparoscopic and open proctocolectomy with ileoanal pouch construction have been published by the Mayo Clinic.³² Previous reports have looked at only perioperative outcomes. This is the first study to ensure that the functional results of ileoanal pouch surgery are the same for patients undergoing laparoscopic restorative proctocolectomy. Thirty-three

Table 4 Results of Comparative Study of Hand-Assisted Laparoscopic Restorative Proctocolectomy²⁹

	Laparoscopic Group (n = 13)	Hand-Assisted Group (n = 10)	p value
Age (years)	30 (16–57)	34 (16–54)	NS
Sex: M:F	7:6	9:1	NS
Body mass index (kg/m ²)	25 (20–34)	26 (20–30)	NS
Diagnosis			NS
MUC	12	9	
FAP	1	1	
Incision size (cm)	8 (5–10)	8 (8–20)	NS
Operative time (minutes)	300 (240–400)	247 (210–390)	< 0.01
Estimated blood loss (mL)	250 (100–400)	200 (100–1900)	NS
Conversion	None	1	NS
Return of bowel function (days)	3 (2–10)	2 (1–4)	= 0.02
Length of stay (days)	6 (4–17)	4 (3–13)	NS
Morbidity	31%	40%	NS

Values expressed in median (range).

FAP, familial adenomatous polyposis; MUC, mucosal ulcerative colitis.

patients undergoing a laparoscopically assisted procedure were matched to 33 patients undergoing conventional surgery. The functional results were similar in the two groups as anticipated. After 1-year follow-up, function and quality of life outcomes were equivalent.

The role of laparoscopic total colectomy for patients with inflammatory bowel disease is not well defined but is likely to expand as surgeons become more comfortable with segmental resection. Advantages seen in segmental resection have been reproduced in patients undergoing laparoscopic total colectomy. Again, although the evidence based upon study design and size for any one report is not optimal, the reproducibility of the results among many institutions provides adequate evidence to demonstrate clear advantages of laparoscopic total colectomy for ulcerative colitis over a conventional approach. The use of hand-assisted laparoscopy has not reached the population of ulcerative colitis patients requiring surgery, but it is probably another venue that may shorten operative time while maintaining the benefits of a minimally invasive approach.

CONCLUSION

Despite the slower learning curve of laparoscopic colectomy and the lack of prospective randomized trials, the reproducible outcomes demonstrated in the majority of comparative studies allow several conclusions to be drawn. Whether influenced by psychological conditioning or physician bias, laparoscopic procedures have repeatedly demonstrated a shortened length of stay, reduction in postoperative ileus, and earlier resumption of diet. For the patient with uncomplicated terminal ileal Crohn's disease, there are definite reproducible advantages to a minimally invasive approach.

As surgeons gain experience, more complex cases may be attempted laparoscopically with a low threshold to alternate the approach if difficulties are encountered. We will continue to "push the envelope" in patients with complex Crohn's disease to allow more to be done in complex cases. For the patient with Crohn's colitis and ulcerative colitis, the role of a minimally invasive approach is less well defined. In experienced hands, a laparoscopic total colectomy can be performed safely and offers the patient all the advantages seen in laparoscopic segmental resection. Outcomes are likely to improve with better training, techniques, and equipment. As the field of minimally invasive surgery continues to expand, what is being "pushed" today will be routine in the future.

REFERENCES

1. Bauer JJ, Harris MT, Grumbach NM, et al. Laparoscopic-assisted intestinal resection for Crohn's disease. Which patients are good candidates? *J Clin Gastroenterol* 1996;23:44–46
2. Wu JS, Birnbaum EH, Kodner IJ, et al. Laparoscopic-assisted ileocolic resections in patients with Crohn's disease: are abscesses, phlegmons, or recurrent disease contraindications? *Surgery* 1997;122:682–688
3. Dunker MS, Stiggelbout AM, van Hogezaand RA, et al. Cosmesis and body image after laparoscopic-assisted and open ileocolic resection for Crohn's disease. *Surg Endosc* 1998;12:1334–1340
4. Wong SK, Marcello PW, Hammerhoffer KA, et al. Laparoscopic surgery for Crohn's disease: an analysis of 92 cases. *Surg Endosc* 1999;13:S4 (Abstract)
5. Canin-Endres J, Salky B, Gattorno F, et al. Laparoscopic assisted intestinal resection in 88 patients with Crohn's disease. *Surg Endosc* 1999;13:595–599

6. Alabaz O, Irotulam AJ, Nessim A, et al. Comparison of laparoscopically assisted and conventional ileocolic resection for Crohn's disease. *Eur J Surg* 2000;166:213-217
7. Bemelman WA, Slors JFM, Dunker MS, et al. Laparoscopic-assisted vs open ileocolic resection for Crohn's disease: a comparative study. *Surg Endosc* 2000;14:721-725
8. Young-Fadok TM, Hall Long K, McConnell EJ, et al. Advantages of laparoscopic resection for ileocolic Crohn's disease. Improved outcomes and reduced costs. *Surg Endosc* 2001;15:450-454
9. Schmidt CM, Talamini MA, Kaufman HS, et al. Laparoscopic surgery for Crohn's disease: a single institution experience. *Ann Surg* 2001;233:733-739
10. Milsom JW, Hammerhofer KA, Bohm B, et al. A prospective, randomized trial comparing laparoscopic versus conventional surgery for refractory ileocolic Crohn's disease. *Dis Colon Rectum* 2001;44:1-9
11. Duepre HJ, Senagore AJ, Delaney CP, et al. Advantages of laparoscopic resection for ileocecal Crohn's disease. *Dis Colon Rectum* 2002;45:605-610
12. Shore G, Gonzalez QH, Bondora A, et al. Laparoscopic vs. conventional ileocolic resection for primary Crohn's disease. *Arch Surg* 2003;138:76-79
13. Benoist S, Panis Y, Beaufour A, et al. Laparoscopic ileocecal resection in Crohn's disease: a case-matched comparison with open resection. *Surg Endosc* 2003;17:814-818
14. Bergamaschi R, Pessaux P, Arneaud JP. Comparison of conventional and laparoscopic ileocolic resection for Crohn's disease. *Dis Colon Rectum* 2003;46:1129-1133
15. Tabet J, Hong D, Kim CW, et al. Recurrence after laparoscopic bowel resection for Crohn's disease: comparison to open technique. *Can J Gastroenterol* 2001;15:237-242
16. Rosman AS, Melis M, Fichera A. Metaanalysis of trials comparing laparoscopic and open surgery for Crohn's disease. *Surg Endosc* 2005;19:1549-1555
17. Schmitt SL, Cohen SM, Wexner SD, et al. Does laparoscopic-assisted ileal pouch anal anastomosis reduce the length of hospitalization? *Int J Colorectal Dis* 1994;9:134-137
18. Reissman P, Salky BA, Pfeifer J, et al. Laparoscopic surgery in the management of inflammatory bowel disease. *Am J Surg* 1996;171:47-50
19. Milsom JW, Ludwig KA, Church JM, et al. Laparoscopic total abdominal colectomy with ileorectal anastomosis for familial adenomatous polyposis. *Dis Colon Rectum* 1997;40:675-678
20. Meijerink WJH, Eijssbouts QAJ, Cuesta MA, et al. Laparoscopically assisted bowel surgery for inflammatory bowel disease. *Surg Endosc* 1999;13:882-886
21. Marcello PW, Milsom JW, Wong SK, et al. Laparoscopic restorative proctocolectomy: a case-matched comparative study with open restorative proctocolectomy. *Dis Colon Rectum* 2000;43:604-608
22. Seshadri PA, Poulin EC, Schlachta CM, et al. Laparoscopic total colectomy and proctocolectomy: short and long term results. *Surg Endosc* 2001;15:837-842
23. Hamel C, Hilderbrandt U, Weiss E, et al. Laparoscopic surgery for inflammatory bowel disease: ileocolic resection versus subtotal colectomy. *Surg Endosc* 2001;15:642-645
24. Marcello PW, Milsom JW, Wong SK, et al. Laparoscopic total colectomy for acute colitis: a case control study. *Dis Colon Rectum* 2001;44:1441-1445
25. Brown SR, Eu KW, Seow-Choen F. Consecutive series of laparoscopic-assisted vs. minilaparotomy restorative proctocolectomies. *Dis Colon Rectum* 2001;44:397-400
26. Dunker MS, Bemelman WA, Slors JF, et al. Functional outcome, quality of life, body image, and cosmesis in patients after laparoscopic-assisted and conventional restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2001;44:1800-1807
27. Ky AJ, Sonoda T, Milsom JW. One-stage laparoscopic restorative proctocolectomy: an alternative to the conventional approach? *Dis Colon Rectum* 2002;45:207-211
28. Bell RL, Seymour NE. Laparoscopic treatment of fulminant ulcerative colitis. *Surg Endosc* 2002;16:1778-1782
29. Rivadeneira DE, Marcello PW, Roberts PL, et al. Benefits of hand-assisted laparoscopic restorative proctocolectomy: a comparative study. *Dis Colon Rectum* 2004;47:1613-1619
30. Kienle P, Weitz J, Benner A, et al. Laparoscopically assisted colectomy and ileoanal pouch procedure with and without protective ileostomy. *Surg Endosc* 2003;17:716-720
31. Nakajima K, Lee SW, Cocilovo C, et al. Hand assisted laparoscopic colorectal surgery using Gelport: initial experience with a new hand access device. *Surg Endosc* 2004;18:102-105
32. Larson DW, Dozios EJ, Piotrowicz K, et al. Laparoscopic assisted vs. open pouch anal anastomosis: functional outcomes in a case matched series. *Dis Colon Rectum* 2005;48:1845-1850