Hand-Assisted Laparoscopic Colectomy: Rational Evolution for Diverticulitis

H. David Vargas, M.D.^{1,2,3}

ABSTRACT

Laparoscopic technique has proved to be a revolutionary advance in the surgical treatment of disease. However, limits exist regarding its application to colorectal resection as evidenced by the higher conversion rate and longer learning curve seen with colectomy. Conversion remains a complex issue related to multiple factors. One of the factors, inflammatory disease such as diverticulitis, exposes limitations of laparoscopic technique, specifically the absence of tactile sensation and use of one's hand as a surgical instrument. Nonetheless, the clinical benefits of smaller incisions, decreased pain, decreased ileus, and reduced hospitalization and disability make laparoscopic colectomy a compelling surgical option for the treatment of diverticulitis. Hand-assisted technique offers surgeons a practical and rational innovation for conventional laparoscopic colectomy and offers promise for improved feasibility and efficacy for the treatment of diverticulitis.

KEYWORDS: Laparoscopic colectomy, hand-assisted technique, diverticulitis

Objectives: On completion of this article, the reader should understand benefits of laparoscopic colectomy for diverticulitis, appreciate risk factors for conversion for laparoscopic colectomy for diverticulitis, and be familiar with the advantages of hand-assisted laparoscopic colectomy for diverticulitis.

DIVERTICULITIS AND THE ROLE OF SURGERY

Diverticulitis is a common disease of Western, industrialized nations. In the United States, approximately 200,000 admissions per year are attributed to this disease.¹ The specter of free perforation and peritonitis and the risk of emergent surgery necessitating Hartmann's procedure hover over this clinical entity and influence the judgment of physicians and surgeons in the management of their patients. Fortunately, in spite of the prevalence of diverticulosis, the actual risk of diverticulitis with free perforation remains low.² Therefore, the recommendations of the Standards Task Force of the American Society of Colon and Rectal Surgeons remain relevant.

Elective resection should be offered to patients after two bouts of uncomplicated diverticulitis or after a complication of diverticulitis occurs. The young patient and the immunocompromised patient represent unique situations in which early intervention may be warranted.³

ROLE OF SURGERY AND THE ADVENT OF LAPAROSCOPIC RESECTION

The role of surgery in the treatment of diverticulitis dates back to Mayo and his report on the management of five patients.⁴ Elective resection for recurrent diverticulitis and for complications can generally be performed safely in one stage, thereby avoiding colostomy

¹Tidewater Surgical Specialists, Colorectal Division, Chesapeake, Virginia; ²Colon and Rectal Surgery Program, Sentara Careplex Hospital, Hampton, Virginia; ³Department of Surgery, Eastern Virginia Medical School, Norfolk, Virginia.

Address for correspondence and reprint requests: H. David Vargas, M.D., Colorectal Division—Tidewater Surgical Specialists, 3205 Churchland Blvd., Chesapeake, VA 23321. E-mail: dv700@aol.com.

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Table 1 Conversion Rates: Cancer versus Diverticulitis

Author	N	Patients with Diverticulitis	Conversion Overall (%)	Conversion Cancer (%)	Conversion Diverticulitis (%)
Phillips et al ⁸	51	13 (25%)	7.8	5	15.3
Zucker et al ⁹	65	10 (15%)	3	0	10
Hoffman et al ⁷	80	26 (32.5%)	22.5	10	38
Sher et al ⁶	140	18 (9.7%)	23	4	38.9

creation.^{3,5} The role of surgical treatment of diverticulitis continues to evolve with the development of laparoscopic colectomy. The clinical benefits of minimal access surgery were evident in the early reports in the literature.⁶⁻⁹ However, this early experience indicated that diverticulitis necessitated conversion more frequently than operations performed for neoplasia (Table 1). Diverticulitis complicated by fistula or large abscess or phlegmon was especially challenging. One report found that fistula and abscess resulted in a conversion rate of 50%.⁶

LAPAROSCOPIC VERSUS OPEN SIGMOID COLECTOMY

Several small comparative studies evaluated laparoscopic and open colectomy for diverticulitis.¹⁰⁻¹⁵ Definitions for conversion varied and, consequently, reported conversion rates ranged from 0 to 19.7%. Also, inclusion criteria differed as only one of the studies included patients with fistulous complications. Generally, these single-institution nonrandomized reports provided evidence confirming the advantages of the laparoscopic approach to diverticulitis. Operations generally were longer but operative and postoperative morbidity was similar. Postoperatively, patients' outcomes revealed that laparoscopic resection resulted in decreased ileus and shorter length of stay (Table 2). In addition, with the exception of one report,¹⁰ overall cost was reduced in spite of increased operating room charges.¹¹⁻¹⁵ The one outlier indicated that operating room costs were the cause for increased total costs related to prolonged operating room time, mean 397 minutes.

Senagore et al reported a consecutive series of 61 laparoscopic sigmoid colectomies compared with 71 open cases performed during the same 20-month period at the Cleveland Clinic Foundation.¹⁵ Laparoscopic operations were performed by one surgeon. Operating room time was similar (109 minutes laparoscopic versus 101 minutes). Conversion was 6.6%, although indications for surgery and the presence of fistula or abscess are not mentioned. Length of stay was significantly shorter in the laparoscopic group, 3.1 days versus 6.8 days. Pulmonary complications and wound infections were significantly decreased in the laparoscopic group. Interestingly, total direct cost was significantly less in the laparoscopic group. The authors attributed this to reduced operating room cost by limited use of disposable instruments and by decreased length of stay.

Although study design limitations exist, the comparisons between laparoscopic and open colectomy for sigmoid diverticulitis generally prove favorable for laparoscopic colectomy. Conversion rates vary among the series. However, complications were not increased and in some cases were less than those with open colectomy. Length of stay was consistently less in the laparoscopic groups, and total cost generally was decreased. These comparisons indicate that laparoscopic colectomy offers distinct advantages over open colectomy for the treatment of diverticulitis.

ADEQUACY OF RESECTION AND RECURRENCE OF DIVERTICULITIS

The legitimacy of laparoscopic colectomy for diverticulitis ultimately hinges upon its effectiveness in

Table 2 Open Colectomy (OC) versus Laparoscopic Colectomy (LC) for Diverticulitis

Author Year	N OC:LC	Operating Room Time (min) OC:LC	Conversion LC (%)	LOS (Days) OC:LC	Cost (Dollars) OC:LC	Charges (Dollars) OC:LC
Liberman et al, 1996 ¹¹	14:14	182.5:192	0	9.21:6.29	13,400:11,500	36,745:29,981
Bruce et al, 1996 ¹⁰	17:25	115:397	12	6.8:4.2	10,230:7068	NA
Faynsod et al, 2000 ¹³	20:20	243:251	30	7.8:4.8	NA	NA
Dwivedi et al, 2002 ¹⁴	88:66	143:212	19.7	8.8:4.8	NA	14,863:11,528
Lawrence et al, 2003 ¹²	144:56	140:170	7	8.4:4.12	NA	20,270:17,414
Senagore et al, 2002 ¹⁵	71:61	109:101	6.6	6.8:3.1	4321:3458	

LOS, length of stay; NA, not available.

eradication of disease, that is, preventing recurrent attacks and complications. Benn et al identified complete sigmoidectomy and colorectal anastomosis as the key to adequate resection and prevention of recurrent diverticulitis.¹⁶ In this report, recurrence was 6.7% with a colorectal anastomosis as opposed to 12% when colocolostomy was performed.

Technique for laparoscopic sigmoid resection has been previously described in detail.¹⁷ Laparoscopy provides excellent visualization of the anatomic landmarks of the rectosigmoid junction: the coalescence of taenia coli and absence of appendices epiploica.¹⁸ Precise distal resection in the upper rectum should thus be reliably accomplished. Proximal resection generally is performed extracorporeally, ensuring resection of all thickened, hypertrophied colon. Splenic flexure mobilization, although not mandatory, can be accomplished, thereby ensuring tension-free anastomosis. Therefore, the critical elements signifying an adequate operation for diverticulitis—complete sigmoid resection with tension-free anastomosis of descending colon to upper rectum—should be consistently reproduced by laparoscopic technique identical to those with open operation.

Bergamaschi and Arnaud performed a study examining pathologic findings as well as proctologic and computed tomography scan findings to assess the location of the anastomosis in patients undergoing laparoscopic and open sigmoid resection for diverticulitis.¹⁹ In this review, laparoscopic operations actually resulted in colorectal anastomosis more often than open colectomy. Recurrence rates were lower in the laparoscopic group, although definitive conclusions could not be made because of differences in length of follow-up. Several series indicate that recurrence following laparoscopic resection is indeed rare.^{20–22} An additional study by Thaler et al examined recurrence following open and laparoscopic sigmoid colectomy.²³ Recurrence occurred in 5% of patients. As with the findings of Benn, this study identified colocolostomy as the only significant determinant for recurrence of diverticulitis.

INCREASED EXPERIENCE AND THE CHALLENGE OF CONVERSION

As surgeon experience increased and as technology developed for colorectal resections, larger series were published that focused on surgical treatment of diverticulitis. Kockerling et al reviewed the results of the Laparoscopic Colorectal Surgery Study Group, a multicenter study that involved 24 surgical departments in Germany, Austria, and Switzerland.²⁴ The study cohort involved 1118 patients with 304 patients undergoing colectomy for diverticulitis. Overall conversion was 7.2%. Complicated disease was present in 18.1% of cases, and conversion occurred in 18.2% of these patients. In comparison, uncomplicated recurrent diverticulitis was

associated with a much lower rate of conversion, 4.8%. Schwandner et al reported on a 10-year experience involving 396 patients operated on for diverticulitis.²² Overall conversion rate was 6.8%. According to the authors, conversion appeared to be directly related to the degree of inflammation and the presence of abscess or fistula. Complicated disease was associated with a conversion rate of 16.6% versus 4.9% in patients with recurrent diverticulitis. Conversion did decrease over time and with increased experience. Although total complications were not increased in patients undergoing conversion, patients requiring conversion experienced a longer duration of surgery, increased transfusion requirements, increased intensive care unit stay, and longer length of hospitalization. Contrary to the preceding reports, Stevenson et al found in their study of 100 consecutive patients that complicated diverticulitis was not necessarily associated with increased conversion to open.²¹ The overall conversion rate was low at 8%. However, postoperative morbidity was increased in patients requiring conversion to open.

Several issues were raised by this increasing experience with laparoscopic colectomy for diverticulitis. Although exceptions existed, increasing degrees of inflammation and complications of diverticulitis appeared to be a risk factor for conversion. In addition, patients requiring conversion experienced poorer postoperative outcomes.

Conversion ultimately remains a complex end point for study. Predictors of conversion include patient-related factors such as body mass index (BMI) and American Society of Anesthesiologists (ASA) grade; disease-related factors such as cancer and diverticulitis; type of resection; and surgeon experience.^{25,26} Tekkis et al attempted to define predictors for conversion.²⁵ This study evaluated 1253 patients undergoing colorectal resection laparoscopically and noted an overall conversion rate of 10%. Factors identified as predictors of conversion include BMI, ASA grade 3 or 4, left colectomy, presence of adhesions or fistula, and surgeon experience. These findings are especially pertinent to this discussion of diverticulitis, which involves left-sided resection and operations on inflammatory-type disease not infrequently complicated by abscess and fistula.

Conversion remains a necessary option for a variety of reasons, and early conversion signifies good surgical judgment as evidenced by reduced morbidity.²⁴ Unfortunately, conversion is often associated with increased morbidity.^{21,22,26,28} Marusch et al described the consequences of conversion among patients participating in a study within the Laparoscopic Colorectal Surgery Study Group.²⁸ Overall conversion for the cohort of 1658 patients was 5.2%. Among patients with diverticulitis, conversion for recurrent diverticulitis was 4.8% whereas the rate for complicated diverticulitis was 18.2%. This again supports the

direct relationship between increased inflammation and conversion. Of concern, however, were the observed increased operative complications of patients converted compared with those nonconverted, 27.9% versus 3.8%. Similarly, postoperative morbidity increased for patients undergoing conversion to open operation compared with those successfully completed laparoscopically, 47.7% versus 26.1%. Lastly, mortality was increased when conversion occurred, 3.5% versus 1.5% for nonconverted cases.

Although the conversion rate of 5.2% remains impressively low, the increased morbidity—both intraoperative and postoperative—and increased mortality raise important questions about the benefit of completing procedures laparoscopically. Multiple parameters indicate proficiency for laparoscopic colectomy: operative times, operative complications, completion rates, postoperative morbidity, and length of stay.²⁶ Increased experience with laparoscopic colectomy ideally should result in reduced operative times, conversion rates, and complication rates. Learning curves for colorectal resections, however, appear to vary according to type of resection and are also subject to the pathology encountered at the time of resection.²⁹ With regard to diverticulitis, the learning curve would be expected to be even longer given the left-sided nature of the resection and the inflammatory nature of a disease often complicated by abscess and fistulization. The early experience of surgeons performing laparoscopic operations on diverticulitis suggested a possible limitation of the technique, and subsequent larger series appeared to confirm that the more severe the inflammatory process of diverticulitis, the more likely that conversion would be necessary. The issue of the learning curve is compounded by the fact that general surgeons on average perform fewer than 20 colorectal resections per year.³⁰ Learning curves are reported to range between 30 and 70 cases,^{26,27,31} the implication being that average general surgeons would require several years before achieving proficiency with laparoscopic colectomy. Assuming that the learning curve for diverticulitis and its complications is longer than that for resections for other indications, one can infer that performing laparoscopic colectomy for diverticulitis may not be practical or advisable for surgeons with average case volumes.

HAND-ASSISTED LAPAROSCOPIC COLECTOMY: SURGICAL INNOVATION WITH A CAUSE

The challenge confronting surgery, therefore, is to improve laparoscopic proficiency for diverticulitis while maintaining clinical benefits and low morbidity. Answers to this challenge most likely lie in the continued technologic advances in laparoscopic instrumentation

and also the progressive innovation of surgical technique. With regard to the latter, a variation of laparoscopic colectomy called hand-assisted laparoscopic colectomy developed. This technique allowed surgeons to insert their hand into the small wound that ordinarily would be made for specimen retraction. This simple maneuver reintroduced manual dexterity, tactile sensation, and proprioception. This hybrid technique combined the distinct advantages of videoscopic perspective (access to all quadrants, magnification, improved clarity and resolution) with the incomparable versatility of the surgeon's hand as an instrument for retraction, dissection, and three-dimensional assessment. Schlachta et al stated that "Advanced laparoscopic procedures are technically challenging because they require the ability to identify and dissect tissue planes without the usual tactile clues."²⁶ Hand-assisted laparoscopic colectomy would therefore address this major shortcoming of conventional laparoscopic technique and perhaps would offer surgeons the technical advantage to master resection for diverticulitis and other complex operations.

Ou offered a comparative study involving patients undergoing hand-assisted laparoscopic colectomy and a group undergoing open colectomy.³² He described early enlargement of the specimen extraction wound for hand insertion and continued dissection and mobilization under laparoscopic guidance. None of the 12 cases required conversion. There were no differences in morbidity. Length of stay, however, was reduced, 4 versus 8 days. Subsequent studies indicated similar reduction in conversion without increase in morbidity.³³ The authors described improved dissection because of return of tactile sensation, proprioception, and manual dissection, especially in cases of inflammation. The wounds ranged from 6 to 8 cm, and patients behaved clinically similarly to those whose operations were performed with conventional laparoscopic technique.

Using a novel method for analysis, Sjoerdsma et al studied the mechanical efficiencies of open, laparoscopic, and hand-assisted laparoscopic surgery.³⁴ Colectomy was broken down into a series of discrete tasks or steps and analyzed graphically according to time-motion efficiency. This study reaffirmed that open surgery remains the "gold standard" in terms of surgical efficiency; conventional laparoscopic surgical technique was least efficient. The introduction of the hand into the abdomen improved time-motion efficiencies and was considered superior to conventional laparoscopic technique.

Targarona et al compared conventional with hand-assisted laparoscopic technique for cancer.³⁵ This prospective trial involved 27 patients in each arm. No difference in specimen length or lymph node harvest was noted between the two. Although serologic markers for inflammation were increased in the laparoscopic group and operative time was essentially the same, conversion was reduced from 22% to 7%. Postoperative variables

such as pain, use of narcotics, length of stay, and complications were found to be equivalent. In this study, cost was also assessed and there was no difference between the two groups. The HALS Study Group reported the results of a multicenter prospective randomized trial evaluating hand-assisted and conventional laparoscopic colectomy for a variety of resection types and indications.³⁶ Wound size was similar and there were no observed differences with regard to return of bowel function and length of stay. Conversion, however, was reduced in the hand-assisted group, 14% versus 22% in the laparoscopic group.

Two studies documented the effectiveness of hand-assisted laparoscopic compared with conventional laparoscopic technique for complex operations such as total abdominal colectomy and restorative proctocolectomy. Operative times improved with hand-assisted technique, and this was accomplished without a concomitant increase in complications.^{37,38}

The application of hand-assisted technique for resection of sigmoid diverticulitis perhaps best validates the legitimacy. The repeated bouts of inflammation lead to dense adhesions and fibrosis, distorting normal anatomic planes, and create a phlegmonous mass that is difficult to manipulate and retract, limiting visualization. The insertion of one's hand facilitates retraction and three-dimensional assessment of anatomic planes and inflammatory adhesions, and, lastly, hand assist enables surgeons to employ digital dissection of adhesions, a tried and true method of surgical dissection for diverticulitis.³⁹ Laparoscopic colorectal resection requires a wound for specimen extraction; therefore, it appears that full use of the wound allowing hand insertion would be a rational step for surgeons treating diverticulitis.

Vargas and Obias presented evidence for the effectiveness of hand-assisted sigmoid resection for diverticulitis in a comparative study evaluating hand-assisted laparoscopic resection (HALR) and conventional laparoscopic resection (CLR).⁴⁰ This study involved 21 patients in the hand-assist group and 28 patients in the conventional laparoscopic group; the type of resection performed resulted from the surgeon's preference among six surgeons in a private practice group, with two preferentially performing HALR. There were no differences between the two groups of patients in terms of ASA, BMI, and severity of diverticulitis (complicated diverticulitis). There were no major septic complications such as postoperative abscesses or anastomotic leaks in either group, and there were no deaths. Only one (5%) conversion occurred in the HALR group and nine (32%) occurred in the conventional group ($p=0.034$). The one conversion resulted from an anastomotic leak found at the time of proctoscopic testing that could not be visualized for repair. All four patients with complicated diverticulitis (three colo-

vesical fistulas, one pelvic abscess drained percutaneously) were successfully completed in the HALR group. Conversions for the CLR group were related to complicated diverticulitis. There were fewer complications in the HALR group, but this was not statistically significant. Tolerance of diet and length of stay were similar in the two groups. A follow-up study from the same group reviewed 102 cases performed using a hand-assisted technique.⁴¹ All types of resections were reviewed, and inflammatory disease represented 50% of the cohort. Sixteen patients had complicated inflammatory disease. Overall conversion was 5%. Reasons for conversion were remarkable for the fact that none of the conversions were related to inflammatory adhesions.

Milsom's group recently presented data comparing laparoscopic (CLR) and hand-assisted colectomy for diverticulitis.⁴² There were 21 patients in each arm. Operating room times were shorter in the HALR group and significantly shorter (88 minutes) in complicated cases. The conversion rate for complicated diverticulitis was 10% in the HALR group and 75% in the CLR group. Clinical outcomes were similar in the two groups.

Chang et al from the Lahey Clinic reported on patients undergoing HA sigmoid colectomy (66 patients) compared with CLR sigmoid colectomy (85 patients).⁴³ Diverticulitis represented the indication for surgery in 77% and 71% of cases, respectively. The HA group had shorter operating room times (189 versus 205 minutes) and slightly increased wound size (8.1 versus 6.2 cm). No difference in return of bowel function or length of hospital stay was observed. There were no conversions in the HA group, but the other group had a 13% incidence of conversion. Inflammation was the cause for conversion in one third of these cases. Most important, reduced conversion was not associated with increased morbidity as complication rates were similar in the two groups. This study perhaps best illustrates the potential of the hand-assisted technique for diverticulitis, as 66 consecutive procedures were completed without conversion and patients' outcomes maintained without increase in morbidity.

In summary, hand-assisted laparoscopic technique enables surgeons to perform a complex operation with greater facility and confidence. This has generally translated into shorter operative times and fewer conversions compared with standard laparoscopic technique. The return of tactile sensation improves retraction of the diverticular phlegmon, and the return of proprioception provides three-dimensional information, which enhances rapid assessment of inflammatory adhesions and the relevant anatomic structures. In addition, hand insertion allows pinch dissection of dense adhesions associated with fistulization and large abscesses or phlegmons, thereby broadening the application of a minimally invasive approach to complicated diverticulitis. Hand-assisted technique potentially shortens the learning

curve; broadens applicability to more severe disease, enabling surgeons to perform more complex operations without increased morbidity; and preserves the clinical benefits of a minimal access approach. This does not therefore represent a step backward or a lowering of the standard. Rather, hand-assisted laparoscopic technique would seem to be a rational evolution and advance of laparoscopic colorectal surgery.

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