Laparoscopic Management of Diverticular Disease

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ABSTRACT

Despite its potential advantages, laparoscopic management of diverticular disease is currently performed by a minority of surgeons on a small group of patients. However, the role for laparoscopy in diverticular disease continues to develop. At present, adequate evidence exists for the routine use of laparoscopy for uncomplicated diverticular disease. Complicated disease, including fistulizing disease and free perforation requires additional expertise and study. As the experience grows among individual surgeons and institutions, it can be expected that the complication and conversion rates will continue to decline allowing even further evolution of laparoscopy for the treatment of this challenging disease process.

KEYWORDS: Diverticular disease, diverticulitis, laparoscopy, minimally invasive

Objectives: On completion of this article, the reader should be able to summarize the advantages of laparoscopic sigmoid colectomy for diverticular disease and to summarize the differences in laparoscopic technique for the management of sigmoid diverticular disease.

BACKGROUND

By their 80th year, 60% of people living in Western society will have acquired diverticular disease. Up to 25% of these individuals will develop diverticulitis at some point in their lives.¹ In a classic article describing the natural history of diverticular disease, Parks found that 30% of patients necessitated operation around the time of their first admission.² Although the majority of initial episodes will resolve with medical therapy, approximately a third will have a recurrent attack and another third will have a subsequent attack.^{2,3} Whereas the mortality and morbidity during an acute attack may reach 5 and 25% respectively, during subsequent episodes these figures may reach 10 and 60%.⁴

The role of laparoscopy in managing diverticular disease has evolved rapidly since laparoscopic sigmoid colectomy was described in 1991.^{5,6} A variety of techniques and modifications have been developed to improve

the morbidity and mortality of this widely prevalent disease. However, an analysis of the nationwide inpatient samples databases from 1992 to 2001 found that only 3.6% of patients underwent laparoscopic management of their sigmoid diverticular disease.⁷ Despite evidence supporting improved outcomes and fewer complications in patients managed laparoscopically, the widespread use of this technique for diverticulitis has yet to become standard.

In this article, we will review the current literature regarding the risks, benefits, complications, and future of laparoscopically managed diverticular disease.

TECHNIQUE

Several techniques have emerged for the minimally invasive management of sigmoid diverticular disease. Each procedure has its own inherent risks and benefits.

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Several comparative reviews have been published which demonstrate the strengths and weaknesses of each style, though a randomized controlled trial comparing outcomes of these techniques for the management of diverticular disease is lacking.

Although the techniques vary, the anatomic result after operation for diverticular disease must be uniform to provide the best chance for optimum outcome. Ensuring a margin of resection beyond the distal sigmoid is critical to acceptable results. A recent study designed specifically to identify predictors for recurrence after elective laparoscopic colectomy for uncomplicated diverticulitis found, on multivariate analysis, only a colorectal rather than colosigmoid anastomosis predicted lower recurrence.⁸

Laparoscopic sigmoid colectomy was originally described as a totally intracorporal technique.^{5,6} With the surgeon on the patient's right, a 10-mm camera port is inserted infraumbilically. Additional cannulae are placed in the left upper quadrant, right lower quadrant, and suprapubically. The bowel is divided at the recto-sigmoid junction and a stapler or energy device is used to divide the mesentery. The lateral attachments are dissected using scissors or cautery and the splenic flexure is mobilized as necessary. The bowel is then divided at the proximal extent of inflammation on the sigmoid colon and the distal colon is transected beyond the recto-sigmoid junction, leaving the colon open. The specimen is then extracted through the anus. A purse-string is then sewn intracorporally around the proximal bowel, the distal bowel is stapled closed, and a circular stapled anastomosis is created after passing the EEA stapler transanally.⁹

The laparoscopic-assisted technique differs from the totally intracorporal approach in that the specimen is removed via an incision made at a port site. The patient is positioned in modified lithotomy on a bean bag. Our favored approach begins by placing a 10-mm Hassan port at the umbilicus. A 12-mm port is placed in the right lower quadrant to allow passage of the laparoscopic linear stapler. Five millimeter ports are placed in the right upper quadrant and the left lower quadrant. The surgeon and camera operator stand to the patient's right. The camera is placed in the umbilical port and dissection is accomplished with a medial to lateral approach. The inferior mesenteric artery (IMA) is identified initially and working posterior to the vessel the ureter is identified and preserved. The IMA is divided with the linear stapler or an energy device. The IMA pedicle is lifted anteriorly as the dissection continues in a medial to lateral approach toward the Line of Toldt. The inferior mesenteric vein (IMV) is transected if necessary for additional length. The colon is then reflected medially, and the remaining lateral dissection is completed. The splenic flexure is typically fully mobilized to ensure a tension-free anastomosis. After complete mobilization

of the left colon, the mesorectum is windowed at the convergence of the taenia and the recto-sigmoid is divided with the laparoscopic linear stapler. The specimen is extracted through a muscle-splitting incision made in the left lower quadrant by extending the 5-mm port site incision. The proximal colon is divided extracorporally at a site proximal to any muscular hypertrophy and free of any inflammatory change. A purse-string is placed followed by the anvil of the circular stapler. The proximal colonic end with the anvil in place is returned intraabdominally, the extraction site closed, and pneumoperitoneum is reestablished. The circular stapler is passed transanally and an intracorporal anastomosis is created.¹⁰

A variety of devices emerged in the mid 1990s to allow insertion of the surgeon's hand into the abdomen to facilitate dissection during laparoscopic surgery.¹¹ Our preferred hand-assisted laparoscopic surgery (HALS) technique involves placement of a Gelport® (Applied Medical, Rancho Santa Margarita, CA) in the midline through the umbilicus. The incision is tailored to the size of the operating surgeon's hand. A 12-mm port is placed in the right lower quadrant to accommodate the linear stapler. Five millimeter ports are placed in the suprapubic position, the right upper quadrant and the left lower quadrant. A 5-mm, 30-degree scope is preferred and is placed in the suprapubic port or right lower quadrant port initially. The surgeon and camera operator stand to the patient's right. The surgeon's left hand is placed in the handport to facilitate dissection. The sigmoid is reflected medially and the lateral attachments taken down. Attention is turned to identifying the ureter initially. The cautery shears (or other energy device) are used for dissection through the right lower quadrant or suprapubic port. The left colon is fully mobilized and the splenic flexure is taken down. Splenic flexure mobilization is facilitated by dissection via the left lower quadrant port. This dissection is accomplished most expeditiously by moving the operating surgeon from the right lower quadrant to a position between the stirrups. The 30-degree, 5-mm scope facilitates the dissection greatly as it can be moved as needed for visualization to any of the ports. After the flexure is mobilized, the laparoscope is moved to the right upper quadrant port and the IMA pedicle is lifted anteriorly with the hand. Isolation of the IMA pedicle is then completed with dissection via the right lower quadrant port. The pedicle is divided with the stapler or an energy device. The IMV may be isolated and divided as well if additional length is necessary for reconstruction. The mesorectum is windowed at the recto-sigmoid junction and divided with the linear stapler. Windowing of the mesorectum is greatly facilitated by use of the hand. The mesorectum is divided with an energy device and the specimen is extracted via the handport. The colon is divided at an appropriate proximal point

and a purse-string and anvil placed for the circular stapler. The proximal end is returned to the abdomen, the Gelport® replaced, and pneumoperitoneum is reestablished. The stapler is then passed transanally and an intracorporeal anastomosis is performed. The hand-assist technique greatly facilitates dissection in the case of a phlegmon or fistula allowing a safe finger fracture technique, which cannot be easily accomplished with a purely laparoscopic approach.

Several studies have compared the various laparoscopic techniques in an effort to determine the optimal, minimally invasive approach to diverticular disease. A meta-analysis published in 2008 evaluated the existing literature on HALS and laparoscopic-assisted (LAC) techniques for colectomy across all diagnoses. This study included 499 HALS and 518 LAC patients reviewed from the existing literature. Overall, for segmental colectomy, HALS had a lower conversion rate (OR 0.3) and shorter operating time (19 minutes), whereas LAC had a smaller incision. Both methods were equivalent with regard to length of hospital stay, postoperative morbidity, estimated intraoperative blood loss, total cost, and mortality.¹² A single study included in the meta-analysis, specifically compared HALS and LAC for sigmoidectomy due to diverticulitis. This study found a significantly longer operative time and shorter incision length for the LAC approach to sigmoid colectomy for diverticulitis. Conversion rate, length of stay, and estimated blood loss were equivalent. A subgroup analysis of complicated diverticulitis patients was performed, however, and demonstrated a higher conversion rate with LAC in those challenging patients, though no difference in morbidity was found.¹³

Data comparing total intracorporeal and laparoscopic-assisted techniques have been conflicting. As the incision size through which the extracorporeal resection and anastomosis are performed in LAC has become smaller, the potential advantages of intracorporeal colectomy have waned. Whereas a French study demonstrated shorter hospital stay, shorter time to full diet, and shorter operating room time with intracorporeal resection for uncomplicated diverticulitis, these differences were not found in a larger American trial.^{14,15} Morbidly obese patients may be the one subgroup who could benefit from totally intracorporeal colectomy for sigmoid diverticular disease where shorter incisions may reduce wound complications.^{16,17}

COMPARISON WITH OPEN OPERATION

The introduction of laparoscopic colectomy in the 1990s provided a new tool for the management of diverticular disease. After the initial learning curve was surpassed, many studies were undertaken to evaluate the safety, efficacy, and potential benefits of laparoscopy over the traditional open approach.

The foremost question in evaluating any new technique is its safety. Laparoscopic colectomy was first demonstrated to be safe in the management of patients with colon and rectal cancer.^{18–20} The application of this technique to the management of diverticular disease, however, meant operating with inflammation and adhesions beyond the level typically associated with cancer operations. Despite this, overall complication rates were found to be lower in those patients undergoing laparoscopic colectomy for diverticular disease.

The Sigma Trial, a randomized controlled trial of laparoscopic versus open operation for diverticular disease is ongoing. Preliminary data have been reported, however, demonstrating significant advantages of laparoscopy with regard to pain, length of hospital stay (LOS), and major complications.²¹

The level of postoperative pain has been shown to be reduced among patients undergoing laparoscopic colectomy. Measurements of pain have been analyzed by duration of narcotic requirement and subjective pain scores. Overall, patients have less pain with laparoscopic colectomy than open.^{22,23} This finding has also been shown in the Sigma Trial.²¹

Return of bowel function postoperatively is faster among patients undergoing laparoscopic colectomy for diverticular disease. Kasperek et al described the placement of a manometry probe into the splenic flexure via the anus of patients undergoing laparoscopic or open sigmoid colectomy for cancer ($n=8$) or diverticular disease ($n=12$). Although a small trial, the amplitude of contractions in the laparoscopic group was significantly higher than those in the open group. Further, these patients had a faster oral tolerance and shorter LOS than the open group.²⁴ This faster return of bowel function postoperatively has been observed by others, including a 2006 meta-analysis comparing laparoscopic and open operation for diverticular disease.^{25–27}

Postoperative complications are also reduced in patients undergoing laparoscopic colectomy for diverticular disease. These include short-term complications related to wound infection, pulmonary function, cardiovascular disorders, and ileus, as well as long-term complications, such as hernia and adhesive small bowel obstruction.^{21,25,28–30} Although the long-term reduction in complications is supported by several studies and a meta-analysis of the literature, the long-term results of the Sigma Trial will be helpful in defining this difference further.

The overall satisfaction of patients undergoing laparoscopic colectomy for diverticular disease is improved when compared with open surgery. The Sigma Trial has shown improvement in health-related quality of life in the laparoscopic group, as measured by the SF-36 questionnaire.²¹ This was also shown in an earlier report comparing laparoscopic and open colectomy for all benign disease. Although overall the SF-36 scores in

this earlier study were equivalent, there was a higher incidence of small bowel obstruction and incisional hernia in the open group, which contributed to overall lower SF-36 scores in this cohort.³¹

Operative time tends to be longer in patients undergoing laparoscopic resection for diverticular disease when compared with open surgery.^{30,32} The meta-analysis by Purkayastha et al found the weighted mean difference to be 67 minutes longer for laparoscopy.²⁵ Although HALS has been shown to take less time than LAC, it still requires more time than open surgery.³³ Despite the increased operative time, the overall cost for the hospitalization of a patient undergoing laparoscopic colectomy for diverticular disease is lower than that of a patient undergoing an open operation. This is likely due to the shorter LOS in laparoscopically treated patients.^{25,26,30,32} In an evaluation by Senagore et al of direct cost for laparoscopic and open colectomy specifically for diverticular disease, the total direct cost for the laparoscopic group was \$3,458 while the open group averaged \$4,321.²⁹ The reduced overall cost of laparoscopy in diverticular disease is supported by other publications.^{26,30,32,34}

As diverticular disease tends to present in the elderly, the safety of laparoscopic management of this process in older patients has been assessed. Overall, the advantages of laparoscopy appear to be accentuated in the elderly population. A significant reduction in morbidity and LOS is seen when compared with open operation. Among people aged over 75 years, a greater proportion were found to maintain their independence after laparoscopic surgery than with open.³⁵ Also, fewer patients required additional rehabilitation after hospitalization when their operation was performed laparoscopically.³⁶ Thus, among the elderly population, the advantages of laparoscopic management of diverticular disease are most pronounced.

COMPLICATED DIVERTICULITIS

Historically, management of perforated diverticulitis has been performed in three stages. At the first operation, washout of the peritoneum and diverting colostomy were performed. Once the acute inflammatory reaction had resolved, colon resection and anastomosis were completed. Ostomy reversal was performed at a third operation.^{37,38} This three-stage approach was associated with a high morbidity and mortality, resulting in the application of a two-staged approach consisting of resection and colostomy initially (Hartmann's procedure), followed by stoma takedown after recovery from the first operation.³⁹ Today, the operative management of complicated diverticulitis has progressed to include laparoscopic surgical techniques.

Defining the degree of complexity in complicated diverticulitis continues to rely on the Hinchey classifi-

Table 1 Modified Hinchey Classification

Stage	Definition
I	Pericolic abscess confined to colonic mesentery
IIa	Distant pelvic abscess amenable to percutaneous drainage
IIb	Complex abscess ± fistula
III	Generalized peritonitis
IV	Fecal peritonitis

cation. This system was first described in 1978 to determine which patients should undergo primary anastomosis after resection.⁴⁰ With improvements in percutaneous intervention, this system has been modified to the classification currently in widespread use (Table 1).⁴¹

The safety of laparoscopic management for complicated and fistulizing diverticular disease has been addressed in several publications. The incidence of both early and late complications have been shown equivalent among patients undergoing laparoscopic management of complicated and uncomplicated diverticular disease. Hassan et al compared the incidence of early and late complications in patients with complicated and uncomplicated diverticular disease. Early complications included wound infections, bleeding, and venous thromboembolism (VTE); late complications were abdominal wall hernia, stricture, small bowel obstruction, and recurrence. The complicated diverticular group did not have a higher incidence of early or late complications with 2-year follow-up.⁴²

The intraoperative course of complicated diverticular patients undergoing laparoscopic resection would be expected to be challenging. However, several reports have demonstrated no increase in the duration of operation or conversion rate among this group of patients. Specifically evaluating the operative time and postoperative return of bowel function, no difference was found between patients with Hinchey stage I, II, or III disease.⁴³

Fistulizing diverticular disease has also been shown amenable to laparoscopic management. Several groups have demonstrated no difference with regard to length of stay or postoperative complications in patients with laparoscopically treated colovesical or colovaginal fistulas when compared with those treated with an open approach.⁴⁴⁻⁴⁶ The conversion rate in these studies ranges from 7.7 to 25%. The highest conversion rate was in a study comparing HALS sigmoid colectomy for fistulizing diverticulitis with the same procedure for recurrent uncomplicated diverticulitis.⁴⁶

Although laparoscopy has been demonstrated to be a reasonable approach to complicated diverticular disease, the question remains whether to perform a primary anastomosis or Hartmann's procedure. A recently developed scoring system has been proposed to risk stratify patients for the two operative options. Based

on the patient's body mass index (BMI), Hinchey classification, Mannheim peritonitis index, and operative urgency, the likelihood of requiring a Hartmann's procedure can be ascertained.⁴⁷ In cases where a Hartmann's procedure is required, laparoscopic resection with subsequent laparoscopic colostomy reversal has been described. Conversion and complication rates are comparable to those described for laparoscopic primary anastomosis in complicated diverticular disease.⁴⁸

CONVERSION

The conversion rate from laparoscopic to open operation across all colorectal procedures has been estimated at 15.38% based on a large meta-analysis of available literature published in 2001.⁴⁹ This study also found converted patients were subject to longer hospital stays and operative time. Although this study evaluated all laparoscopic colectomies, patients undergoing left hemicolectomy or operation for diverticulitis had a higher conversion rate than other operations or diseases.

The conversion rate specifically for diverticular disease is less well defined. In part, this is due to the differences in technical difficulty between elective management of recurrent diverticular disease, elective management of complicated or fistulizing disease, and urgent management of perforated disease. Several studies have attempted to characterize these differences and quantify the conversion and complication rates for each of these processes.

The most common indication for operation in sigmoid diverticular disease is elective resection to prevent recurrence or progression of disease. Conversion rates among this population have been reported between 2 and 19.7%, excluding patients with perforation, abscess, or fistula.^{26,50,51} Among patients with complicated diverticular disease, the conversion rate has been reported between 8 and 61%.^{52,53} The high conversion rate originated from a report early in the experience with laparoscopic management of complicated diverticulitis. More recent studies have found an upper range conversion rate for complicated disease of 26%.⁴²

Conversion to open operation is not without consequences. Longer operative time, even when compared with planned open operation, longer LOS, and increased time to return of bowel function have been reported among converted patients when compared with laparoscopically completed operations.^{42,53-55} Increased wound and infectious complications have also been demonstrated among patients necessitating conversion.⁴² The time from case initiation to conversion has been shown a significant predictor of postoperative complication with increased morbidity in patients undergoing conversion more than 30 minutes into the case.⁵⁶ One question that remains to be answered is whether conversion from LAC to HALS as an inter-

mediary could reduce the number of conversions to open colectomy for diverticular disease. Early results from the Sigma Trial suggest that this may be true. Although the trial reports a conversion rate of 19.2%, half of these were conversion from LAC to HALS, and did not require further conversion to open colectomy.²¹ This remains an ongoing area of investigation.

Factors predictive of conversion have been evaluated by several authors. These include surgeon experience,^{57,58} BMI,⁵⁶⁻⁵⁹ previous abdominal surgery,⁴² presence of fistula,⁵⁷ inflammation extending beyond the sigmoid colon, and adhesions.^{56,59} One scoring system has been developed to predict the risk for conversion in laparoscopic colorectal surgery, but this is not specific to diverticular disease. In this system, points are awarded for a diagnosis of malignancy, surgeon experience of fewer than 50 cases, and weight. Conversion risk was found to increase from 1.1% with no points to 25.4% in patients who accrued all possible points.⁵⁷ A specific risk score for conversion in diverticular disease has not been published.

The largest report comparing conversion rates between complicated and uncomplicated diverticular disease managed laparoscopically showed an 18.1% conversion for Hinchey I through IV disease and only 4.8% for others.⁶⁰ A comparison of outcomes for patients undergoing elective laparoscopic sigmoid colectomy for diverticular disease showed that those with Hinchey stage I or II, or fistula, had an almost fivefold higher conversion rate than those without inflammation at the time of operation, but the higher conversion rate was only 9%.⁵¹ Overall, complicated diverticular disease is associated with a higher conversion rate than uncomplicated disease. This is not surprising as the most frequently described reasons for conversion are inflammation and adhesions, which would be expected in abundance when treating complicated diverticulitis.

LEARNING CURVE

Critics of laparoscopic management of diverticular disease often point to the additional technical obstacles that must be overcome to safely complete the operation. Several authors have attempted to define the learning curve for laparoscopic sigmoid colectomy. Evaluating all laparoscopic colectomies, the learning curve is estimated to lie between 30 and 50 cases before acceptable results are achieved.^{61,62} In a database study of laparoscopic left hemicolectomy specifically, the majority of which were performed for diverticular disease, the authors found that 62 cases were necessary to overcome the learning curve.¹⁷ Although operative time was found to decrease, readmission and complication rates remained unchanged as surgeon experience progressed.

The longer learning curve associated with laparoscopic sigmoid colectomy relates to the added technical

challenge with this procedure. The addition of inflammation, adhesions, and fistulas, as one would expect in managing diverticular disease, certainly prolong the learning curve even further. The report by Dincler et al supports this with the finding that laparoscopic sigmoid colectomy is subject to a higher learning curve than other laparoscopic colectomies, necessitating 70 or 80 cases to achieve a steady state of postoperative complications and conversion.⁶³ A study following 500 patients after laparoscopic colectomy for diverticular disease was recently published demonstrating significantly improved outcomes after the first 100 laparoscopic colectomies.⁵⁰ In the second group of 400 patients, the operative time had decreased a median of 60 minutes, the conversion rate had dropped from 8% to 1.5% and the incidence of major morbidity had fallen from 21% to 8.5%. These significant changes reinforce the technically complicated nature of these operations and the importance of experience in safely completing these procedures.

Operative volume of both surgeons and hospitals has been shown to correlate with the likelihood of laparoscopic colectomy being performed for the management of diverticular disease. Surgeons who perform more than 15 sigmoid colectomies per year are greater than 8 times more likely to perform their sigmoid resection for diverticular disease laparoscopically. Similarly, patients seen at high volume hospitals were 3 times more likely to have a laparoscopic rather than open sigmoid colectomy for diverticular disease.⁷ These findings were similar to those of a large German study. A decrease in conversion rate, morbidity, and mortality were all observed at hospitals performing more than 30 laparoscopic sigmoid colectomies during the study period, and an even further reduction was noted in hospitals with more than 100 procedures.⁶⁴ These findings suggest that the technical challenges of laparoscopic sigmoid colectomy are compounded in the face of diverticular disease and are currently mostly performed by high volume surgeons in high volume hospitals.

LAPAROSCOPIC COLORRHAPHY WITH PERITONEAL WASHOUT

As laparoscopy continues to evolve as a tool for the management of diverticular disease, it is likely to play a more prominent role even in the management of acute perforation. At present, there are a few reports of successful management of Hinchey III and IV disease with laparoscopic peritoneal washout,⁶⁵ plus laparoscopic colorrhaphy when an obvious perforation is identified.^{65,66} The results of these studies are promising. By delaying the definitive operation to an elective setting, the risks associated with Hartmann's procedure or primary anastomosis in a contaminated field are avoided. Caution has been advised, however, as this technique has been evaluated only in limited studies and is currently

not part of the guidelines from the American Society of Colon and Rectal Surgeons or the Society of Surgery of the Alimentary Tract for the management of diverticular disease.^{1,67} Although the European Association for Endoscopic Surgery has recommended that selected patients in selected centers be candidates for this procedure, they also have not advocated this technique as a general recommendation.⁶⁸

CONCLUSION

The management of diverticular disease has evolved rapidly since the introduction of laparoscopy in the early 1990s. The benefits of laparoscopy with regard to morbidity, pain, cosmesis, length of hospital stay, overall hospital costs, and independence among elderly patients have been well documented. Despite these many advantages, laparoscopic management of diverticular disease is performed by a minority of surgeons on a small group of patients. With the addition of the randomized, controlled, Sigma Trial, perhaps more surgeons will begin to offer minimally invasive treatment of this process.

The role for laparoscopy in managing diverticular disease continues to develop. At present, adequate evidence exists for the routine use of laparoscopy for uncomplicated diverticular disease. Based on the existing publications, however, it seems likely that more data will emerge in support of laparoscopic management of complicated disease, including fistulizing disease and free perforation. As the experience grows among individual surgeons and institutions, it can be expected that the complication and conversion rates will continue to decline allowing even further evolution of laparoscopy for the treatment of this challenging disease process.

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