ORIGINAL ARTICLE

Laparoscopy Decreases Anastomotic Leak Rate in Sigmoid Colectomy for Diverticulitis

Melissa Levack, MD; David Berger, MD; Patricia Sylla, MD; David Rattner, MD; Liliana Bordeianou, MD

Background: Early studies comparing laparoscopic and open operations for diverticulitis failed to show any advantages of the laparoscopic approach. Our study compared the 30-day postoperative outcomes of laparoscopic and open sigmoid colectomy for diverticulitis by surgeons who had performed 20 or more laparoscopic colectomies before the study period.

Hypothesis: Patients who undergo an elective laparoscopic operation for diverticulitis have reduced postoperative complications compared with patients who have a traditional open operation.

Design: Retrospective analysis.

Setting: Academic medical center.

Patients: A total of 249 patients who underwent elective open (n=127) or laparoscopic (n=122) sigmoid colectomy with primary anastomosis for diverticulitis between July 1, 2001, and February 1, 2008.

Main Outcome Measures: Combined rates of free and contained anastomotic leaks. A logistic regression model was used to determine predictors of anastomotic leaks while controlling for significant differences between study groups.

Results: Patients who underwent laparoscopic or open operations were similar in age, sex, history of diagnosed intraabdominal abscess (9.4% vs 12.3%), and history of preoperative percutaneous abscess drainage (3.9% vs 4.9%). Patients who underwent the open procedure had a higher Charlson comorbidity index (1.6 vs 1.2; $P=.04$), and those who underwent laparoscopy more frequently underwent splenic flexure mobilization (82.8% vs 26.7%; $P<.001$). Patients who underwent a laparoscopy had lower rates of anastomotic leaks (2.4% vs 8.2%; $P=.04$). This finding held true on logistic regression analysis (odds ratio, 0.67; 95% confidence interval, 0.008-0.567; $P=.01$), even when controlling for age, Charlson comorbidity index, splenic flexure mobilization, and length of resected bowel.

Conclusion: Anastomotic leaks occurred less frequently after laparoscopic sigmoid colectomy performed by experienced laparoscopic colorectal surgeons.

Arch Surg. 2011;146(2):207-210

Author Affiliations: Colon and Rectal Surgery Program, Division of Gastrointestinal Surgery, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts.

DIVERTICULITIS REMAINS A common disease with a rising incidence in Western society.[1] Today, most attacks of diverticulitis can be managed without surgical intervention as antibiotic efficacy, percutaneous drainage, and diagnostic modalities improve.[2,3] As a result of the increase in nonoperative management, the indications for elective colectomy for diverticulitis have evolved as well. Infrequently, patients may still need traditional laparotomies and colostomies to treat perforated feculent peritonitis. Far more commonly, however, patients undergo elective procedures to prevent future trips to the emergency department, minimize pain associated with attacks, and reduce anxiety associated with developing further attacks of diverticulitis.[4,5] The timing for elective operations for these patients, however, is a matter of heated debate.[3,5]

Concomitant with the shift toward a more nonoperative approach to the treatment of diverticulitis, the surgical community is also witnessing rapid advancement in the development of laparoscopy. Since the first description of laparoscopic colectomy in 1991,[6] numerous authors have published reports on the advantages of laparoscopic colectomy for diverticular disease.[7-14] These and other studies documented multiple short-term benefits in patients who underwent laparoscopic colectomies, including shortened length of hospital stay, fewer wound infections, decreased pain, and better pulmonary function.[15,16] On the other hand, investigators have not been able to show significant differences in the rates of serious complications such as deaths, anastomotic leaks, and reoperations—nor were they able to show any long-term advantages of laparoscopy.[7,14,17,18]

Open sigmoid colectomy remains the criterion standard for the surgical approach for patients with prior attacks of diverticulitis; however, this assertion has recently been challenged.[19] Information concerning 8660 patients who underwent either open or laparoscopic colectomies were entered into the database maintained by the American College of Surgeon's National Surgical Quality Improvement Program (NSQIP). A review of these data found that laparoscopy for abdominal colectomy decreased overall complications as well as individual complications, independent of the NSQIP morbidity probability statistic, which is an NSQIP method for estimating a patient's risk for postoperative complications based on that patient's preoperative comorbidities.[20] In addition, the authors found a significant increase in wound and septic complications in the open colectomy group. However, because the NSQIP database only documents deep infections in general, this study was hindered by its inability to report one of the most important complications pertinent to colorectal operations, specifically, the rate of anastomotic leaks. The authors also were unable to report how many patients required diversion or how many patients never received an anastomosis. Furthermore, their data contradicted the results of several randomized controlled studies that claim that laparoscopic and open techniques have similar postoperative outcomes.[21,22]

The purpose of this study was to systematically compare the 30-day postoperative outcomes of laparoscopic vs open sigmoid colectomies performed by surgeons who had completed 20 or more laparoscopic colectomies before the study period. Our goal was to test the hypothesis that patients who underwent elective laparoscopic sigmoid colectomy for diverticulitis have reduced postoperative complications compared with patients who had traditional open sigmoid colectomy.

METHODS

PATIENTS

Our study population consisted of 249 patients who underwent elective laparoscopic or open sigmoid colectomy with primary anastomosis from July 1, 2001, through February 1, 2008, by 1 of 9 surgeons at the Massachusetts General Hospital. These patients were identified from the Massachusetts General Hospital medical records database using the Research Patient Database Query tool to identify patients who underwent partial colectomy for the diagnosis of diverticulitis using the *International Classification of Diseases*, Ninth Revision[23] procedure code 562.11. The initial search generated 421 results. These electronic records were then individually reviewed and 172 patients were excluded because their operation was miscoded and they underwent a subtotal colectomy, diverticulitis was not the indication for surgical intervention, intestinal continuity had not been restored, or the operation was not performed on an elective basis. The remaining 249 patients became our study population. Diverticulitis of the sigmoid colon was diagnosed in these patients based on the results of computed tomography imaging, and the disease was considered asymptomatic at the time they were admitted for their elective colectomy. Their medical records were then carefully reviewed to document sex, age, comorbidities, preoperative medications, preoperative disease history (eg, number of attacks of diverticulitis before resection, number of attacks with associated abscesses, and number of attacks requiring percutaneous drainage), details of the ultimate operative procedures, and postoperative recovery and complications. The age-adjusted Charlson comorbidity index, initially developed in 1987 and extensively used in the literature to demonstrate predictive validity for risk of mortality,[24,25] was calculated for each patient based on data collected for preexisting comorbidities.

Our primary end point was the cumulative rate of postoperative complications within 30 days after the surgical procedure, including anastomotic leaks; postoperative wound infections; early small-bowel obstructions; cardiac (myocardial infarction or cardiac arrest), renal (rise in serum creatinine or new dialysis requirement), pulmonary (acute respiratory distress syndrome or respiratory distress requiring intubation), or neurologic (stroke or paralysis) complications; postoperative sepsis; reexploration in the operating room; intraabdominal abscess diagnosed by computed tomography scan; or readmission. We defined anastomotic leaks based on the criteria established by Damrauer et al.[26] *Free leaks* were defined as diffuse gross contamination of the peritoneal cavity (peritonitis) as demonstrated on computed tomography scan or in the operating room during a reexploration. *Contained leaks* were defined as localized perianastomotic collections that demonstrated communication with the gastrointestinal lumen during their percutaneous drainage or during reexploration.

STATISTICAL ANALYSIS

All statistical analysis was completed using SAS software (SAS Institute, Inc, Cary, North Carolina). Categorical variables are reported as percentages and frequencies; continuous variables are reported as mean (SD). We used intention-to-treat analysis to compare other differences between the groups, such as demographic factors, medical comorbidities, and ultimate surgical outcomes, using Fisher exact test, χ^2 test, or t test, as appropriate. Finally, a multivariate logistic regression model was fitted to determine predictors of anastomotic leaks while controlling for differences identified on univariate analysis. $P < .05$ was considered statistically significant.

RESULTS

One hundred twenty-seven patients underwent elective laparoscopic sigmoid colectomy and 122 patients underwent elective open sigmoid colectomy. Twenty-two patients (17.3%) who underwent a laparoscopic procedure eventually needed an open operation. The decision to convert was made at the discretion of the surgeon at the time of operation. Reasons for conversion included extensive adhesions, bleeding, and failure to visualize the ureter.

Patients who underwent laparoscopy were similar to those who had the open procedure in age, sex, history of intra-abdominal abscess during their prior episode of diverticulitis, or history of abscess requiring percutaneous drainage before the operation. However, patients who underwent open sigmoid colectomy had a higher Charlson comorbidity index (**Table 1**).

Intraoperatively, patients undergoing laparoscopy were 4 times more likely to have a splenic flexure mobilization (82.8% vs 26.7%; $P < .001$) and nearly 5 times more likely to have a double-stapled end-to-end anastomosis instead of an extracorporeal handsewn anastomosis (91.8% vs 21.3%; $P < .001$). However, the length of colon resection, derived from the pathology report (19.9

Table 1. Comparison of Patients Undergoing Laparoscopic vs Open Sigmoid Colectomy by Preoperative Factors

Variable	Laparoscopic (n=127)	Open (n=122)	*P* Value
Age, mean (SD), y	52.4 (10.5)	52.9 (12.3)	.56
Male sex, No. (%)	51 (40.2)	46 (37.7)	.32
Charlson comorbidity index, mean (SD)	1.2 (2.3)	1.6 (1.9)	.04
Preoperative intraabdominal abscess, No. (%)	12 (9.4)	15 (12.3)	.68
History of percutaneous abscess drainage before surgery, No. (%)	5 (3.9)	6 (4.9)	.81
Presence of peritonitis at any point before resection, No. (%)	2 (1.6)	2 (1.6)	.96

Table 2. Comparison of Postoperative Complications: Univariate Analysis

	No. (%)		
Variable	Laparoscopic (n=127)	Open (n=122)	*P* Value
Anastomotic leak	3 (2.4)	10 (8.2)	.04
Postoperative wound infection	12 (9.4)	18 (14.8)	.29
Early small-bowel obstruction or ileus	3 (2.4)	7 (5.7)	.22
Cardiac complications	3 (2.4)	1 (0.8)	.29
Renal complications	6 (4.7)	8 (6.6)	.64
Postoperative sepsis	0	2 (1.6)	.16
Reexploration	3 (2.4)	1 (0.8)	.29
Readmission	7 (5.5)	14 (11.5)	.13
Intraabdominal abscess	2 (1.6)	9 (7.4)	.04
Respiratory complications	1 (0.8)	3 (2.5)	.33
Neurologic complications	0	2 (1.6)	.15

cm vs 19.1 cm), and the need for a diverting ileostomy (0.4% vs 0.1%) were similar.

Ultimately, on univariate analysis, our 30-day postoperative outcomes were largely similar between groups (**Table 2**). Patients had similar rates of wound infections, early small-bowel obstructions, ileus, and renal and cardiac complications. However, patients who underwent laparoscopy had lower rates of anastomotic leaks and intra-abdominal infections.

These differences held true on multivariate logistic regression analysis. Patients who underwent laparoscopy had a statistically significant decrease in their rates of anastomotic leaks compared with those who had the open procedure (odds ratio [OR], 0.67; 95% confidence interval, 0.008-0.567; $P=.01$), even when controlling for age (OR, 1.11; $P=.90$), Charlson comorbidity index (OR, 0.67; $P=.20$), splenic flexure takedown (OR, 0.94; $P=.40$), and length of resected bowel (OR, 0.94; $P=.90$).

COMMENT

Numerous studies[27-31] have shown laparoscopic colon operations to be equivalent to open operations in terms of safety profile, while also offering patients the advantage of shorter lengths of hospital stay, smaller incisions, less pain, and quicker return to full activity. Our data, taken together with the NSQIP database, challenge this assertion that postoperative complication rates are equivalent across surgical techniques.

Fortunately, anastomotic leaks are uncommon, but they are a serious complication after colectomy. On average, the occurrence of anastomotic leaks after sigmoid resection is between 0% and 8.2%.[15,16,32,33] Unfortunately, this means that surgical studies are either underpowered to detect differences in leak rates between competing surgical techniques or the incidence of leaks is underreported because authors fail to accurately establish a precise definition for their criteria for postoperative anastomotic leak. For example, a study by Dwivedi et al[15] described 66 patients who underwent laparoscopic sigmoid colectomy and 88 patients who underwent open sigmoid colectomy for diverticulitis. One patient (1.5%) in the laparoscopic group had an anastomotic leak compared with 3 patients (3.4%) in the open group. The authors concluded that the rates of postoperative complications (including all subsets) were similar. A study by Hinojosa et al[32] comparing 7239 patients who underwent sigmoid colectomy for benign disease reported a nearly equal leak rate (0.7% vs 0.8%) in their series. Although this was a very large study, the authors did not comment on their criteria for defining anastomotic leaks. Kasparek et al[16] and Faynsod et al[33] reported no occurrences of anastomotic leaks in either group in their series, with both including 20 patients.

In our study, we defined anastomotic leaks in a more rigorous fashion. Patients were considered to have had an anastomotic leak if they had peritonitis requiring reexploration and if they had a postoperative abscess near their anastomosis, with communication to the anastomosis proved upon injection of contrast medium into the abscess cavity. Using this more precise definition, we were able to show that the laparoscopic procedure is superior to the open procedure in important postoperative outcomes. We found an 8.2% rate of anastomotic leaks in patients who underwent open colectomies. Patients who underwent laparoscopy had only a 2.4% rate of anastomotic leaks. Interestingly, the rates of leaks requiring reexplorations were similar between the 2 arms.

Our data have some limitations. Patients selected for laparoscopy may differ from those who are offered an open operation. As seen in our cohort, patients offered laparoscopy tended to be healthier; their Charlson comorbidity index was significantly lower. We attempted to control for differences that we could measure (ie, body mass index, age, sex, and comorbidities); however, subtle differences between the 2 groups might have been missed. Although the Charlson comorbidity index is not the ideal tool to control for comorbidities in this study population, we opted to use it given that it was the best validated instrument that we could find. Nevertheless, we believe that this study, along with the NSQIP database, supports the argument that laparoscopic sigmoid colectomy is associated with lower morbidity and may become a preferred approach for patients who are candidates for elective laparoscopic procedures.

CONCLUSIONS

Anastomotic leaks are less common after elective laparoscopic sigmoid resection than open sigmoid resection. Although patients treated with open operations had more comorbidities, the rate of anastomotic leaks remained higher in that group even when these differences were accounted for. Based on our study results, as well as the large NSQIP database, laparoscopic sigmoid resection is associated with lower morbidity.

Accepted for Publication: January 25, 2010.
Correspondence: Liliana Bordeianou, MD, Division of Gastrointestinal Surgery, Massachusetts General Hospital, 15 Parkman St, Bldg ACC 460, Boston, MA 02114 (lbordeianou@partners.org).
Author Contributions: *Study concept and design:* Levack, Berger, and Bordeianou. *Acquisition of data:* Levack, Sylla, and Bordeianou. *Analysis and interpretation of data:* Levack, Rattner, and Bordeianou. *Drafting of the manuscript:* Levack, Rattner, and Bordeianou. *Critical revision of the manuscript for important intellectual content:* Levack, Berger, Sylla, and Bordeianou. *Statistical analysis:* Bordeianou. *Administrative, technical, and material support:* Levack, Sylla, Rattner, and Bordeianou. *Study supervision:* Berger, Rattner, and Bordeianou.
Financial Disclosure: None reported.
Previous Presentations: This study was presented as a poster at the 50th Annual Meeting of the Society for Surgery of the Alimentary Tract; June 1, 2009; Chicago, Illinois; and at the 56th Annual Meeting of the Massachusetts Chapter of the American College of Surgeons; December 5, 2009; Boston, Massachusetts.

REFERENCES

1. Kang JY, Hoare J, Tinto A, et al. Diverticular disease of the colon—on the rise: a study of hospital admissions in England between 1989/1990 and 1999/2000. *Aliment PharmacolTher*. 2003;17(9):1189-1195.
2. Ambrosetti P, Jenny A, Becker C, Terrier TF, Morel P. Acute left colonic diverticulitis--compared performance of computed tomography and water-soluble contrast enema: prospective evaluation of 420 patients. *Dis Colon Rectum*. 2000;43(10):1363-1367.
3. Rafferty J, Shellito P, Hyman NH, Buie WD; Standards Committee of American Society of Colon and Rectal Surgeons. Practice parameters for sigmoid diverticulitis. *Dis Colon Rectum*. 2006;49(7):939-944.
4. Janes SE, Meagher A, Frizelle FA. Management of diverticulitis. *BMJ*. 2006;332(7536):271-275.
5. Bordeianou L, Hodin R. Controversies in the surgical management of sigmoid diverticulitis. *J Gastrointest Surg*. 2007;11(4):542-548.
6. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc*. 1991;1(3):144-150.
7. Köckerling F, Schneider C, Reymond MA, et al; Laparoscopic Colorectal Surgery Study Group. Laparoscopic resection of sigmoid diverticulitis: results of a multicenter study. *Surg Endosc*. 1999;13(6):567-571.
8. Berthou JC, Charbonneau P. Elective laparoscopic management of sigmoid diverticulitis. Results in a series of 110 patients. *Surg Endosc*. 1999;13(5):457-460.
9. Perniceni T, Burdy G, Gayet B, Dubois F, Boudet MJ, Levard H. [Results of elective segmental colectomy done with laparoscopy for complicated diverticulosis]. *Gastroenterol Clin Biol*. 2000;24(2):189-192.
10. Smadja C, Sbai Idrissi M, Tahrat M, et al. Elective laparoscopic sigmoid colectomy for diverticulitis: results of a prospective study. *Surg Endosc*. 1999;13(7):645-648.
11. Siriser F. Laparoscopic-assisted colectomy for diverticular sigmoiditis. A single-surgeon prospective study of 65 patients. *Surg Endosc*. 1999;13(8):811-813.
12. Slim K, Pezet D, Stencl J Jr, et al. Prospective analysis of 40 initial laparoscopic colorectal resections: a plea for a randomized trial. *J Laparoendosc Surg*. 1994;4(4):241-245.
13. Schlachta CM, Mamazza J, Poulin EC. Laparoscopic sigmoid resection for acute and chronic diverticulitis: an outcomes comparison with laparoscopic resection for nondiverticular disease. *Surg Endosc*. 1999;13(7):649-653.
14. Alves A, Panis Y, Slim K, Heyd B, Kwiatkowski F, Mantion G; Association Français de Chirurgie. French multicentre prospective observational study of laparoscopic versus open colectomy for sigmoid diverticular disease. *Br J Surg*. 2005;92(12):1520-1525.
15. Dwivedi A, Chahin F, Agrawal S, et al. Laparoscopic colectomy vs. open colectomy for sigmoid diverticular disease. *Dis Colon Rectum*. 2002;45(10):1309-1314, discussion 1314-1315.
16. Kasparek MS, Müller MH, Glatzle J, et al. Postoperative colonic motility in patients following laparoscopic-assisted and open sigmoid colectomy. *J Gastrointest Surg*. 2003;7(8):1073-1081, discussion 1081.
17. Regenet N, Pessaux P, Tuech JJ, et al. Prospective evaluation of the quality of laparoscopic sigmoid resection for diverticular disease. *Hepatogastroenterology*. 2005;52(65):1427-1431.
18. Seitz G, Seitz EM, Kasparek MS, Königsrainer A, Kreis ME. Long-term quality-of-life after open and laparoscopic sigmoid colectomy. *Surg Laparosc Endosc Percutan Tech*. 2008;18(2):162-167.
19. Schlachta CM, Mamazza J, Gregoire R, Burpee SE, Poulin EC. Could laparoscopic colon and rectal surgery become the standard of care? A review and experience with 750 procedures. *Can J Surg*. 2003;46(6):432-440.
20. Kennedy GD, Heise C, Rajamanickam V, Harms B, Foley EF. Laparoscopy decreases postoperative complication rates after abdominal colectomy: results from the National Surgical Quality Improvement Program. *Ann Surg*. 2009;249(4):596-601.
21. Guillou PJ, Quirke P, Thorpe H, et al; MRC CLASICC Trial Group. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet*. 2005;365(9472):1718-1726.
22. Hazebroek EJ; Color Study Group. COLOR: a randomized clinical trial comparing laparoscopic and open resection for colon cancer. *Surg Endosc*. 2002;16(6):949-953.
23. World Health Organization. *International Classification of Diseases, Ninth Revision (ICD-9)*. Geneva, Switzerland: World Health Organization; 1977.
24. de Groot V, Beckerman H, Lankhorst GJ, Bouter LM. How to measure comorbidity: a critical review of available methods. *J Clin Epidemiol*. 2003;56(3):221-229.
25. Hall WH, Ramachandran R, Narayan S, Jani AB, Vijayakumar S. An electronic application for rapidly calculating Charlson comorbidity score. *BMC Cancer*. 2004;4:94. doi:10.1186/1471-2407-4-94.
26. Damrauer SM, Bordeianou L, Berger D. Contained anastomotic leaks after colorectal surgery: are we too slow to act? *Arch Surg*. 2009;144(4):333-338.
27. Weeks JC, Nelson H, Gelber S, Sargent D, Schroeder G; Clinical Outcomes of Surgical Therapy (COST) Study Group. Short-term quality-of-life outcomes following laparoscopic-assisted colectomy vs open colectomy for colon cancer: a randomized trial. *JAMA*. 2002;287(3):321-328.
28. Tong DK, Law WL. Laparoscopic versus open right hemicolectomy for carcinoma of the colon. *JSLS*. 2007;11(1):76-80.
29. Steele SR, Brown TA, Rush RM, Martin MJ. Laparoscopic vs open colectomy for colon cancer: results from a large nationwide population-based analysis. *J Gastrointest Surg*. 2008;12(3):583-591.
30. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med*. 2004;350(20):2050-2059.
31. Veldkamp R, Kuhry E, Hop WC, et al; COlon cancer Laparoscopic or Open Resection Study Group (COLOR). Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol*. 2005;6(7):477-484.
32. Hinojosa MW, Murrell ZA, Konyalian VR, Mills S, Nguyen NT, Stamos MJ. Comparison of laparoscopic vs open sigmoid colectomy for benign and malignant disease at academic medical centers. *J Gastrointest Surg*. 2007;11(11):1423-1430.
33. Faynsod M, Stamos MJ, Arnell T, Borden C, Udani S, Vargas H. A case-control study of laparoscopic versus open sigmoid colectomy for diverticulitis. *Am Surg*. 2000;66(9):841-843.