WISCONSIN MEDICAL JOURNAL

A Comparison of Open and Laparoscopic Techniques in Elective Resection for Diverticular Disease

Stephen B. Shapiro, MD, FACS; Pamela J. Lambert, RN; Michelle A. Mathiason, MS

ABSTRACT

Introduction: This study examines the outcomes of patients who underwent elective sigmoid resection for diverticular disease during the transition period from open to laparoscopic surgery.

Methods: The medical records of patients who underwent elective sigmoid resection from July 1, 1993 to June 30, 2005 at a community-based teaching hospital were retrospectively reviewed. Data collected included age, sex, duration of surgery, estimated blood loss (EBL), postoperative day of diet, length of stay (LOS), postoperative complication rate, and readmission rate. Data were compared using Wilcoxon rank sum and chi-square tests. Recurrence rates were evaluated.

Results: The medical records of 246 patients who had elective sigmoid resections were reviewed. One hundred sixty-six of the procedures were planned open operations, and 80 were initiated with laparoscopy. Of these 80 procedures, 10 were converted to open surgery. Overall, laparoscopic surgery was associated with shorter LOS (median: 4 days versus 8 days, $P<0.001$; mean: 4.8 days versus 9.3 days), less EBL (median: 100 cc versus 200 cc, $P<0.001$; mean: 167 cc versus 255 cc), and longer operative time (median: 185 minutes versus 153 minutes, $P<0.001$; mean: 201.4 minutes versus 157.1 minutes). No mortalities occurred in either group. Readmission and recurrence rates were similar in the open and laparoscopic groups. Subset analyses to adjust for changes in practices over time did not account for improved LOS, EBL, or recurrence rate.

Conclusion: Compared with open surgery, laparoscopic surgery for elective sigmoid resection is associated with a significantly shorter hospitalization and similar safety and recurrence rates.

Author Affiliations: Department of Surgery, Gundersen Lutheran Health System, La Crosse, Wis (Shapiro); Department of Research, Gundersen Lutheran Medical Foundation, La Crosse, Wis (Lambert, Mathiason).

Corresponding Author: Stephen B. Shapiro, MD, FACS, Department of Surgery, Gundersen Lutheran Health System, 1900 South Ave, C05-001, La Crosse, WI 54601; phone 608.775.2345; fax 608.775.4460; e-mail sbshapir@gundluth.org.

BACKGROUND

Diverticular disease is an acquired condition that occurs frequently in industrialized countries. While it is uncommon in people under 40 years of age, nearly two-thirds of 80 year olds are affected.[1] No etiology is certain, but a diet high in fat and low in fiber is linked to formation of colonic diverticula.[2] For most people, diverticular disease is asymptomatic and will not lead to illness. It is estimated that 10%-20% will experience problems attributable to diverticular disease, such as bleeding, perforation, diverticulitis, stricture formation, or fistulization.[3] Without treatment, the risk of recurrent episodes is approximately 45%.[3] With elective sigmoid resection and primary intestinal anastomosis, the recurrence rate can be reduced to between 3% and 13%.[4-5]

Redwine and Sharpe performed the first laparoscopic colon resection in 1990.[5] In 1999, surgeons at Gundersen Lutheran Medical Center in La Crosse, Wis, introduced laparoscopic sigmoid colon surgery and currently initiate all elective sigmoid colectomies using this minimally invasive approach. Minimally invasive surgery is associated with less pain and a quicker recovery.[6] This review evaluates our hypothesis that laparoscopic sigmoid colectomy can be adapted with safety and effectiveness comparable to that of open sigmoid colectomy and with shorter length of stay (LOS) and reduced blood loss, as reported in recent literature.[7-12]

METHODS

In this retrospective review, all patients who had sigmoid colectomies from July 1, 1993 through June 30, 2005 at a single community-based teaching hospital were identified by querying the electronic medical record database using a billing code specific to sigmoid colectomy. The medical records of these patients were further reviewed to identify the subset of patients who

Table 1. Preoperative ASA Scores, Mean BMI, and Antibiotic Use Among 246 Patients Undergoing Laparoscopic or Open Elective Sigmoid Resection for Diverticular Disease

	American Society of Anesthesiologists Score *P*=0.005				Mean BMI, kg/m²	Preoperative Antibiotic Use
Surgical Technique	**1**	**2**	**3**	**4**	***P*=0.311**	***P*=0.546**
Open (%)	16 (9.6)	102 (61.4)	44 (26.5)	4 (2.4)	29.2	162 (97.7)
Laparoscopic (%)	9 (11.3)	64 (80.0)	7 (8.8)	0 (0.0)	29.9	79 (98.8)
Overall (%)	25 (10.2)	166 (67.5)	51 (20.7)	4 (1.6)	29.4	241 (98.0)

ASA=American Society of Anesthesiologists; BMI=body mass index.

underwent elective sigmoid resection for diverticular disease. The study period was chosen to coincide with 6 years prior to and 6 years after initiation of laparoscopic colon surgery at this medical center. Emergency sigmoid resections, resections for neoplastic disease, and left colon resections were excluded. Data collected included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, preoperative antibiotic use, resident year in training, location of anastomosis, stapled or sewn anastomosis, duration of surgery, estimated blood loss (EBL), length of specimen, postoperative day of diet, oral analgesic doses, LOS, postoperative complications, mortality, and readmissions. Conversions from laparoscopic to open surgery were recorded. Recurrence was determined by review of the electronic medical record and from a simple patient questionnaire. LOS comparisons were adjusted by ASA score, age, and sex. Variables were compared using chi-square and Wilcoxon rank sum tests, with $P<0.05$ considered significant.

Based on initial operative approach, cases were grouped as either laparoscopic or open. Cases converted from laparoscopic to open surgery were identified as laparoscopic to full open. A third type of procedure, hand access surgery, is an extension of minimally invasive surgery. A hand access device is a port that seals in pneumoperitoneum and allows the surgeon to slide a hand into the abdomen through a small incision in order to add tactile feedback to a minimally invasive procedure. The hand access incision is similarly sized to that required to remove the specimen in pure laparoscopic surgery and much smaller than that of full open laparoscopy. Hand access surgery and total laparoscopic surgery were grouped together in the laparoscopic arm. Under the supervision of the attending surgeon, surgery residents participated in the preoperative, operative, and postoperative care of all patients in the study.

RESULTS

Three hundred fifty sigmoid resections were identified from the electronic medical record database; 246 cases met study criteria. One hundred sixty-six sigmoid resections began as open surgery, and 80 began laparoscopically. There were 124 (51%) men and 122 (49%) women. Distribution of men and women in the open and laparoscopic groups was significantly different, with 75 (60.5%) men and 91 (74.6%) women having open procedures ($P=0.018$). Median age of patients in the laparoscopic arm was 55.5 years (range 39-92), compared with 63 years (range 28-81) in the open group ($P=0.005$).

Patient comorbidity as assessed by ASA score was significantly greater in the open group, as 29% of patients had ASA scores ≥3 versus 9% in the laparoscopic group ($P=0.005$). Neither BMI nor use of appropriate preoperative antibiotics was significantly different between groups (Table 1).

Intraoperative variables revealed similar rates of splenic flexure mobilization in the laparoscopic and open groups (54% versus 48%, $P=0.365$; Table 2). Median specimen length was shorter in the laparoscopic group, at 17.0 cm compared with 19.6 cm in the open group ($P<0.001$).

No significant difference was identified in the rates of bleeding, enterotomy, or urinary tract injury when analyzed as single complications or when grouped as major complications, at 6.3% in the laparoscopic group and 7.8% in the open group. Mortality was 0 in both groups.

Laparoscopic surgery required significantly longer median operative time at 185 minutes compared with a median of 153 minutes for open surgery ($P<0.001$). Mean operative times were 201.4 minutes for laparoscopic surgery versus 157.1 minutes for open procedures. Median EBL was less for laparoscopic surgery: 100 cc compared with 200 cc for open surgery ($P<0.001$). Mean EBL values were 167 cc in the laparoscopic group versus 255 cc in the open group. Laparoscopic patients were more likely than open patients to have colorectal versus colosigmoidal anastomosis (laparoscopic=89%, open=72%, $P<0.001$).

Postoperative variables are summarized in Table 3.

Table 2. Intraoperative Variables for 246 Patients Undergoing Laparoscopic or Open Elective Sigmoid Resection

Variable	Overall N=246	Open N=166	Laparoscopic N=80	*P* Value
Splenic flexure mobilization (%)	122 (49.6)	79 (47.6)	43 (53.8)	0.365
Ureter visualization (%)	159 (64.6)	101 (60.8)	58 (72.5)	0.073
Specimen length, cm[a]	18.0	19.6	17.0	<0.001
Major complications[b] (%)	18 (7.3)	13 (7.8)	5 (6.3)	0.656

[a] Median value for specimen length reported.
[b] Bleeding, enterotomy, urinary tract injury.

Table 3. Postoperative Outcomes for Patients Undergoing Laparoscopic or Open Elective Sigmoid Resection

Outcome	Overall (%) N=246	Open (%) N=166	Laparoscopic (%) N=80	*P* Value
Extent of disease, severe	159 (64.6)	116 (69.9)	43 (53.8)	0.013
Anastomotic leak	1 (0.4)	0 (0.0)	1 (1.3)	0.325
Readmission within 30 days	18 (7.3)	13 (7.8)	5 (6.3)	0.656

LOS was significantly reduced for laparoscopic sigmoid colectomies in a model adjusted by ASA score, age, and sex ($P<0.001$). Mean LOS was 4.8 days in the laparoscopic group versus 9.3 days in the open group. Anastomotic leak rate was low overall (0.4%) and not significantly different between groups. Readmission within 30 days was required in 7.8% of patients following open surgery, versus 6.3% of patients treated laparoscopically ($P=0.656$). Recurrence rates for diverticular disease were not significantly different between groups at 6.6% in the open group and 8.8% in the laparoscopic group ($P=0.549$).

Thus far, data have been grouped and analyzed by the initial surgical approach employed. When the surgery began laparoscopically, it was completed that way 87.5% of the time. Compared with patients in the pure laparoscopic group, patients whose procedures were converted to open had greater median EBL during surgery (250 cc versus 100 cc, $P=0.001$). Median LOS was significantly longer in those patients whose procedures were converted to open (6 days versus 4 days, $P=0.012$). Initiation of diet was delayed after conversion to open (day 4 versus day 3, $P=0.006$).

To consider differences in practice styles regarding LOS over the 12-year study period, we divided the groups into different eras. Between July 1993 and June 1999, all 111 patients underwent open resection with a median LOS of 9 days. During the second era (July 1999-June 2005), 55 patients underwent open resection with a median LOS of 7 days, and 70 patients had completely laparoscopic procedures with a median LOS of 4 days. The remaining 10 patients had open procedures converted from laparoscopic and had a median LOS of 6 days.

DISCUSSION

This study compares the outcomes of 246 consecutive patients undergoing diverticular surgery as we transitioned from an open to a laparoscopic approach. We believe this report supports our hypothesis that laparoscopic surgery can be completed as safely and effectively as traditional open surgery with outcomes comparable to those of other published series (Table 4). Compared with open surgery, laparoscopic surgery at our teaching institution between July 1993 and June 2005 was associated with slightly longer operative time, significantly shorter LOS, similar readmission rates, and comparable recurrence rates.

This study showed a dramatic reduction in LOS after laparoscopic surgery. Mean LOS in the laparoscopic group was 4.8 days. Other studies have reported an average LOS from 4 to 6 days following laparoscopic colon resection.[7-11] This series includes totally laparoscopic and hand-assisted laparoscopic surgery. Available reports, including prospective randomized trials, find similar outcomes with pure laparoscopic and hand-assisted laparoscopic surgery when analyzing LOS, operative time, return of bowel function, and complication rates.[10-11]

Reduced EBL appears to be another benefit supported by this study and has been reported previously by Blake et al, Lee et al, and Noel et al.[7-8,12] Through a systematic review of published reports in the world literature, Noel et al found that EBL for laparoscopic colon surgery for diverticular disease averaged 177 cc versus 313 cc for open surgery.[12] In this study, average EBL for the laparoscopic group was 167 cc.

Mean operative time with open colon resection averaged 157 minutes in this study, whereas the laparoscopic resection averaged 201 minutes. In this study, laparo-

Table 4. Benchmark Comparisons for Reported Open and Laparoscopic Operative Time, Length of Stay, and Estimated Blood Loss[a]

	Operative Time, Min		Length of Stay, Days		Estimated Blood Loss, cc	
Series	**Open**	**Laparoscopic**	**Open**	**Laparoscopic**	**Open**	**Laparoscopic**
Gundersen Lutheran, N=246	157[b]	201[b]	9.3[b]	4.8[b]	255[b]	167[b]
Noel,[12] N=11,910[c]	142	191	9.6	5.5	313	177
Lee,[8] N=42	NA	197	NA	5.0	NA	200
Blake,[7] N=100	NA	196	NA	NA	NA	138
Lawrence,[9] N=270	140	170	9.1	4.1	NA	NA

NA=not available.
[a] All values presented are means.
[b] Comparison of open versus laparoscopic procedure results, $P<0.001$.
[c] Pooled results of a systematic review of 88 published studies.

scopic operative time is slightly longer than previous reports, which range from 170 to 197 minutes.[7-9,12] Interestingly, operative time of open operations in this study was also slightly longer at 157 minutes versus the 142 minutes reported in the world literature summary by Noel et al. The authors believe this may be explained by the additional time necessary for medical education.

Anastomotic leak rate was low overall (0.4%), with 1 in the laparoscopic group and none in the open group. Leak rates reported by Noel et al were from 1.6% to 2.4%.[12] In a prospective multicenter study by Scheidbach and colleagues, the anastomotic leak rate was from 1.8% to 3.3%.[13]

A significantly greater percentage of women than men had open procedures. While there is no clinical evidence to account for this difference, a possible explanation is that women are more likely to have had prior pelvic surgeries, creating a higher incidence of adhesions requiring an open procedure. This study was designed to evaluate consecutive patients and did not focus on comparing the distribution of women and men in the open and laparoscopic groups.

The main purpose of elective sigmoid resection for diverticular disease is prevention of recurrent disease. This study reviewed electronic medical records and patient questionnaires that inquired whether the patient had experienced either a recurrence of their disease or a hernia at their wound site. A weakness of this approach is the lack of standardized, objective criteria by which to determine recurrence rates. In a review by the Cleveland Clinic Florida, rates of recurrent diverticulitis have been reported to be between 4% and 10%.[14] With recognition of the limitations of the approach in this study, the recurrence rate of 8.8% using laparoscopic techniques compares favorably with benchmarks. Colorectal anastomosis has been important in reducing rates of recurrence. We report an 88% rate of stapled colorectal anastomosis in the laparoscopic group.

Since acceptance of the laparoscopic approach, surgeons in this medical center have initiated all elective sigmoid surgery with laparoscopy. The overall rate of conversion from laparoscopic surgery to open surgery was 12.5%, which compares favorably with the rates of 7% and 24% that others have previously reported.[7,9-10,15-16] The subgroup of patients converted from laparoscopic to open surgery tended to be sicker, as gauged by ASA score. Only 9% of the patients in the laparoscopic group had ASA scores ≥3, compared with 29% of the patients in the open group. Not surprisingly, patients with intraoperative hemorrhage requiring conversion to open elevated the mean EBL in the laparoscopic to open group from 140 cc to 345 cc. Severe adhesions from prior surgery and severe inflammation from advanced diverticular disease were other indications for conversion.

CONCLUSION

Surgeons at our institution have adopted laparoscopic sigmoid colectomy as the primary surgical approach for patients in need of elective sigmoid colectomy for diverticular disease. Compared with open surgery, laparoscopic sigmoid colectomy demonstrates a similar complication rate, a comparable recurrence rate, and a significant reduction in LOS.

Funding/Support: None declared.
Financial Disclosures: None declared.

REFERENCES

1. Hughes LE. Postmortem survey of diverticular disease of the colon. II. The muscular abnormality of the sigmoid colon. *Gut.* 1969;10:344-351.
2. Floch MH, White JA. Management of diverticular disease is changing. *World J Gastroenterol.* 2006;12:3225-3228.
3. Neri V, Ambrosi A, Di Lauro G, Valentino TP. Elective laparoscopic-assisted colectomy for sigmoid diverticulitis. *JSLS.* 2006;10:66-69.
4. Thaler K, Baig MK, Berho M, et al. Determinants of recurrence after sigmoid resection for uncomplicated diverticulitis. *Dis Colon Rectum.* 2003;46:385-388.

5. Redwine DB, Sharpe DR. Laparoscopic segmental resection of the sigmoid colon for endometriosis. *J Laparoendosc Surg.* 1991;1:217-220.
6. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med.* 2004;350:2050-2059.
7. Blake MF, Dwivedi A, Tootla A, Tootla F, Silva YJ. Laparoscopic sigmoid colectomy for chronic diverticular disease. *JSLS.* 2005;9:382-385.
8. Lee SW, Yoo J, Dujovny N, Sonoda T, Milsom JW. Laparoscopic versus hand-assisted laparoscopic sigmoidectomy for diverticulitis. *Dis Colon Rectum.* 2006;49:464-469.
9. Lawrence DM, Pasquale MD, Wasser TE. Laparoscopic versus open sigmoid colectomy for diverticulitis. *Am Surg.* 2003;69:499-503.
10. Anderson J, Luchtefeld M, Dujovny N, Hoedema R, Kim D, Butcher J. A comparison of laparoscopic, hand-assist, and open sigmoid resection in the treatment of diverticular disease. *Am J Surg.* 2007;193:400-403.
11. Albers AGJ, Biere SSAY, van Berge Henegouwen MI, Bemelman WA. Hand-assisted laparoscopic surgery versus standard laparoscopic surgery for colorectal disease: a prospective randomized trial. *Surg Endosc.* 2000;14:896-901.
12. Noel JK, Fahrbach K, Estok R, et al. Minimally invasive colorectal resection outcomes: short-term comparison with open procedures. *J Am Coll Surg.* 2007;204:291-307.
13. Scheidbach H, Schneider C, Rose J, et al. Laparoscopic approach to treatment of sigmoid diverticulitis: changes in the spectrum of indications and results of a prospective, multicenter study on 1545 patients. *Dis Colon Rectum.* 2004;47:1883-1888.
14. Thaler K, Weiss EG, Nogueras JJ, Arnaud JP, Wexner SD, Bergamaschi R. Recurrence rates at minimum 5-year follow-up: laparoscopic versus open sigmoid resection for uncomplicated diverticulitis. *Surg Laparosc Endosc Percutan Tech.* 2003;13:325-327.
15. Dwivedi A, Chahin F, Agrawal S, et al. Laparoscopic colectomy versus open colectomy for sigmoid diverticular disease. *Dis Colon Rectum.* 2002;45:1309-1314.
16. Alves A, Panis Y, Slim K, et al. French multicentre prospective observational study of laparoscopic versus open colectomy for sigmoid diverticular disease. *Br J Surg.* 2005;92:1520-1525.

Wisconsin Medical Journal

The mission of the *Wisconsin Medical Journal* is to provide a vehicle for professional communication and continuing education of Wisconsin physicians.

The *Wisconsin Medical Journal* (ISSN 1098-1861) is the official publication of the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in Wisconsin. The managing editor is responsible for overseeing the production, business operation and contents of *Wisconsin Medical Journal*. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic or organizational articles. Although letters to the editor are reviewed by the medical editor, all signed expressions of opinion belong to the author(s) for which neither the *Wisconsin Medical Journal* nor the Society take responsibility. The *Wisconsin Medical Journal* is indexed in Index Medicus, Hospital Literature Index and Cambridge Scientific Abstracts.

For reprints of this article, contact the *Wisconsin Medical Journal* at 866.442.3800 or e-mail wmj@wismed.org.

© 2008 Wisconsin Medical Society