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Comparison of Laparoscopic vs Open Sigmoid Colectomy for Benign and Malignant Disease at Academic Medical Centers

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Abstract
Few studies have examined outcomes of laparoscopic and open sigmoid colectomy performed at US academic centers. Using ICD-9 diagnosis and procedural codes, data was obtained from the University HealthSystem Consortium (UHC) Clinical Database of 10,603 patients who underwent laparoscopic or open sigmoid colectomy for benign and malignant disease between 2003–2006. A total of 1,092 patients (10.3%) underwent laparoscopic sigmoid colectomy. Laparoscopic sigmoid colectomy was associated with a significantly shorter length of stay (5.4 vs 7.4 days), lower overall complication rate (19.7 vs 26.0%), lower 30-day readmission rate (3.4 vs 4.6), and a lower hospital cost ($13,814 vs $15,626). When a subset analysis of malignant and benign groups was performed, a significantly shorter length of stay in both the malignant laparoscopic group (6.4±6.4 vs 7.8±6.6 days) and in the benign laparoscopic groups (5.1±3.5 vs 7.2±7.6) exists. A lower wound complication rate (2.1 vs 5.5%, malignant and 4.0 vs 6.1, benign) is also evident. Laparoscopic sigmoid colectomy was associated with a shorter length of stay, less complications, and a lower 30-day readmission rate. The shorter length of stay and wound infection rate maintain significance when comparing laparoscopic vs open sigmoid resections for malignant and benign disease.

Keywords Laparoscopic sigmoid colectomy · Surgical outcomes · Laparoscopic colectomy-Open colectomy

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Introduction

In the USA, there are approximately 600,000 transabdominal colorectal procedures performed each year,[1] and it is estimated that only 10–15% of those cases are performed laparoscopically. Since the first laparoscopic cholecystectomy was performed by Muhe in 1985, laparoscopic surgery is becoming accepted as the procedure of choice for the treatment of multiple gastrointestinal procedures (e.g., antireflux, cholecystitis, and gastric bypass). Although the first reported series of laparoscopic-assisted colon resection was over 15 years ago, acceptance of laparoscopic resection for colorectal disease has been slow as a result of the technical challenge and the steep learning curve, estimated to be at least 35–50 procedures.[2] Laparoscopic resection for colorectal cancer was slowed by early reports of increased port-site recurrence when compared to the open approach.[3,4] Recent reports have shown that laparoscopic colon resection can be safe and feasible with wound recurrence that does not differ from that of open surgery.[5–10] Despite these reports, laparoscopic colorectal

surgery is still more likely performed at high-volume academic medical centers.[11] Currently both the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons have developed educational and training guidelines to aid in the increasing interest in laparoscopy.[12]

This study focuses on the in-hospital outcome of patients who underwent laparoscopic and open sigmoidectomy for both benign and malignant disease at nationwide academic centers and affiliated hospitals. We hypothesize that patients who underwent laparoscopic sigmoid colectomy for the treatment of benign or malignant disease will have better outcomes when compared to those patients who underwent open sigmoid colectomy.

Materials and Methods

Database

The University HealthSystem Consortium (UHC) Clinical Database is a source of patient-level, hospital, and discharge abstract data from affiliated academic medical centers and community hospitals in the USA. The discharge abstract data contains information regarding patient demographics, length of stay, 30-day re-admission rates, and in-hospital morbidity and mortality. The database also provides risk-adjusted data for comparison of institutions. Approval for the use of the UHC patient-level data in this study was obtained from the Institutional Review Board of the University of California, Irvine Medical Center and the UHC.

Using appropriate diagnosis and procedural codes as specified by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), patients who underwent sigmoid colectomy for both benign and malignant processes between January 1, 2003 and December 31, 2006 were identified (Table 1). Using ICD-9-CM procedural codes for diagnostic laparoscopy and laparoscopic lysis of adhesions, the laparoscopic patient population was identified. Patients undergoing emergent procedures were excluded. All groups were compared with regards to patient characteristics (age, sex, race, and severity class), perioperative outcomes, and in-hospital mortality.

Patient severity class was based on the severity and complexity of the secondary diagnoses (comorbidities and complications). In-hospital mortality was defined as the percentage of patients who died before hospital discharge. Length of stay was defined as the number of days from the index procedure to hospital discharge.

Data Analysis

Statistical analysis was performed using Statistix software, version 8 (Tallahassee, FL). Analyses of differences between groups for categorical data were performed using the chi-square analysis. Differences in length of stay and cost between groups were determined by two-sample *t* tests. Data are expressed as mean±standard deviation and proportions. A *P* value of equal to or less than 0.05 was considered statistically significant.

Results

During the 4-year study period, 10,603 patients underwent either laparoscopic or open sigmoid colectomy. As shown

Table 1 ICD-9 CM Diagnostic and Procedure Codes for Laparoscopic and Open Sigmoid Colectomy

ICD-9 CM	Description
Diagnosis code	
153.0	Malignant neoplasm of colon
153.2	Malignant neoplasm of descending colon
153.3	Malignant neoplasm of sigmoid colon
153.8	Malignant neoplasm of other specified site of large intestine
153.9	Malignant neoplasm unspecified
230.3	Carcinoma in situ of the colon
211.3	Benign neoplasm of colon
562.1	Diverticula of the colon
562.10	Diverticulosis of the colon without mention of hemorrhage
562.11	Diverticulitis of the colon without mention of hemorrhage
562.12	Diverticulosis of the colon with hemorrhage
562.13	Diverticulitis of the colon with hemorrhage
Procedure codes	
457.6	Sigmoid colectomy
542.1	Diagnostic laparoscopy
545.1	Laparoscopic lysis of adhesions

Table 2 Demographics of Patients who Underwent Laparoscopic and Open Sigmoid Colectomy for Benign and Malignant Disease

	Laparoscopic (*N*=1,092)	Open (*N*=9,511)
Total no. of academic centers (N)	83	126
Age (%)		
18–30	2.6*	1.4
31–50	34.9*	26.7
51–64	39.0	37.4
>65	23.5	34.5*
Male gender (%)	52.7	50.3
Race		
White (%)	81.0*	76.9
African–American (%)	5.4	8.8*
Severity class (%)		
Minor/moderate	91.7*	82.4
Major/extreme	8.3	17.5*
Elective case (%)	94.7*	88.6
Benign disease (%)	82.6*	66.6
Malignant cases (%)	17.4	33.5*

*$p<0.05$, compared to open sigmoid colectomy chi-square analysis

in Table 2, 1,092 patients (10.3%) underwent laparoscopic sigmoid colectomy and 9,511 patients (89.7%) underwent open sigmoid colectomy at 83 and 126 academic medical centers, respectively. The proportion of men was similar in both the open and laparoscopic groups (52.7 vs 50.3%). There were a higher proportion of white patients in the laparoscopic group (81.0 vs 76.9%) and a higher proportion of African-American patients in the open group (8.8 vs 5.4%). Severity class also differed between open and laparoscopic groups. There was a higher proportion of minor/moderate severity patients in the laparoscopic groups (91.7 vs 82.4%). There was a higher proportion of major/extreme severity patients in the open groups (17.5 vs 8.3%). A higher proportion of patients underwent laparoscopic sigmoid resection for benign (82.6%) vs malignant (17.4%) disease.

During the 4-year study period, there was no difference found in in-hospital mortality or observed-to-expected in-hospital mortality ratio, which was less than one in all groups. All periopertive outcomes for benign and malignant groups are listed in Tables 3 and 4, respectively. Mean length of hospital stay was shorter, and the rate of wound infections were lower in those patients who underwent laparoscopic sigmoid colectomy when compared to those patients who underwent open sigmoid colectomy regardless of diagnosis (Tables 3 and 4). Pulmonary complications and total hospital cost were only found to be significantly lower in the benign laparoscopic group and not in the malignant groups. There were no significant differences in the rate of

Table 3 Outcomes of Laparoscopic and Open Sigmoid Colectomy for Benign Disease

	Laparoscopic (*N*=902)	Open (*N*=6,337)
Mean length of stay (days)	5.1±3.5**	7.2±7.6
Overall complications (%)	19.1*	25.4
30-day readmission (%)	3.5	4.9
In-hospital mortality (%)	0.2	0.6
Observed-to-expected mortality ratio	0.6	0.5
Total hospital cost	13,507± 8,238**	15,248± 17,373

*$p<0.05$ compared to benign open sigmoid colectomy, chi-square analysis
**$p<0.05$ compared to benign open sigmoid colectomy, two-sample *t* test

postoperative hemorrhagic complications, venous thromboembolic events, anastomotic leaks, or procedure related laceration or perforations (Figs. 1 and 2). There was no difference in 30-day readmission rate between the laparoscopic and open groups. When the benign and malignant groups were stratified by severity class, the mean length of stay difference between laparoscopic and open groups remained statistically significant in all the minor/moderate severity and in the benign major/extreme groups (Tables 5 and 6).

Discussion

Since the first reported series of laparoscopic colon resections over 15 years ago, debate over the appropriateness of open vs laparoscopic colon resection has continued. Multiple reports have shown improved perioperative out-

Table 4 Outcomes of Laparoscopic and Open Sigmoid Colectomy for Malignant Disease

	Laparoscopic malignant (*N*=190)	Open malignant (*N*=3,185)
Mean length of stay (days)	6.4±6.4*	7.8±6.6
Overall complications (%)	22.6	27.3
30-day readmission (%)	3.2	4.1
In-hospital mortality (%)	0.0	1.2
Observed-to-expected mortality ratio	0	0.9
Total hospital cost	15,154±10,644	16,371± 20,382

*p<0.05 compared to malignant open sigmoid colectomy, two-sample *t* test

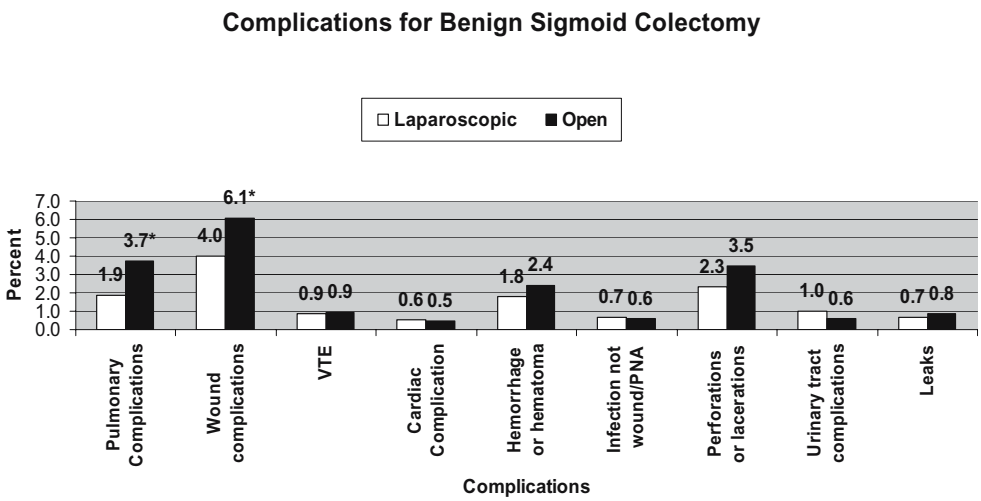

Figure 1 Complications profile for patient who underwent sigmoid colectomy for benign disease. *$p<0.05$ compared to open sigmoid colectomy, chi-square analysis. *VTE* Venous thromboembolic event.

comes in patients treated with laparoscopic colon resection when compared to open resection for diverticular disease.[13–17] Using ICD-9CM codes for laparoscopic lysis of adhesions and diagnostic laparoscopy to isolate laparoscopic sigmoid colectomy patients, Guller et al.[16] showed shorter hospital stay, fewer gastrointestinal complications, and lower overall complications for patients who underwent laparoscopy sigmoid colectomy for diverticular disease as compared to the open approach. In a retrospective review of a prospectively collected database, Schlachta et al.[15] also found no difference in outcomes among patients who underwent laparoscopic sigmoid colectomy or laparoscopic anterior resection for acute or chronic diverticulitis, substantiating claims that laparoscopic resection can be performed safely and for similar indications as open surgery. Laparoscopy colectomy for the treatment of malignant disease has been slow in gaining acceptance. Reports of a high rate of port-site recurrence in early 1994 put a moratorium on laparoscopic colectomy for malignant disease.[3,4] Recent reports have shown that laparoscopic resection for malignant disease can be performed safely, with similar outcomes and incision site recurrence rates as open technique.[5–10]

In this study of academic centers, we found that laparoscopic sigmoid colectomy is safe and has better outcomes when compared to open sigmoid colectomy performed for both benign and malignant disease. Overall mortality was low in all the study groups with an observed-to-expected in-hospital mortality ratio of less than one, which attests to the safety of laparoscopic colon resection. Mean length of hospital stay was found to be significantly shorter in all the laparoscopic groups regardless of diagnosis; these differences persisted after the groups were stratified into malignant and benign disease groups; however, when analyzed by severity of illness, there was no difference in length of hospital stay seen in the

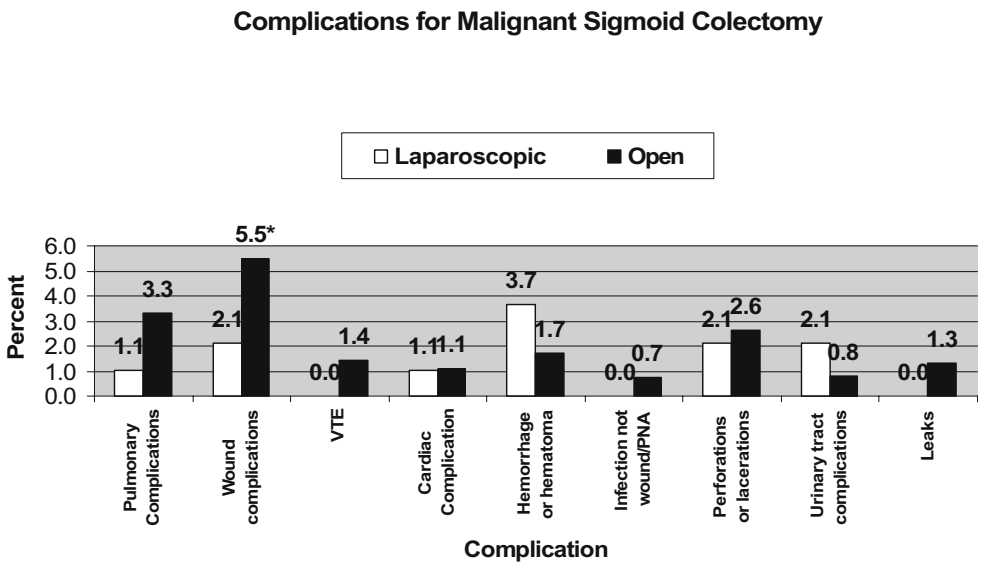

Figure 2 Complications profile for patient who underwent sigmoid colectomy for malignant disease. *$p<0.05$ compared to open sigmoid colectomy, chi-square analysis. *VTE* Venous thromboembolic event.

Table 5 Outcomes of Laparoscopic and Open Sigmoid Colectomy for Benign Disease by Severity Class

	Benign (minor/moderate)		Benign (major/extreme)	
	Laparoscopic (N=833)	Open (N=5,244)	Laparoscopic (N=69)	Open (N=1,093)
Mean length of stay (days)	4.7±2.4**	5.9±2.9	10.1±8.3**	13.8±15.6
Morbidity (%)	15.9*	19.8	58.0	52.5
Mortality (%)	0.0	0.04	2.9	5.6
Observed-to-expected mortality	0.0	0.1	0.8	0.7
30-day readmission (%)	3.3	4.7	6.1	6.0
Total hospital cost ($)	12,529±5,355	12,148±5,354	24,600±19,799	29,925±36,532

* $p<0.05$ compared to benign open sigmoid colectomy, chi-square analysis
** $p<0.05$ compared to benign open sigmoid colectomy, two-sample t test

malignant group with a severity class of major and extreme. Overall morbidity as measured by rate of complications was found to be lower among all laparoscopic groups even after stratification to benign or malignant disease groups; however, the significant difference was lost when these groups were stratified by severity of illness. The 30-day readmission rate was found to be similar between groups regardless of diagnosis. This finding was maintained even after stratification by diagnosis and severity class.

As expected, the largest proportion of patients who underwent a laparoscopic sigmoid colectomy were those treated for benign disease, of which diverticular disease represented approximately 80% of the study cohort. Mean length of hospital stay for the benign laparoscopic group was approximately 2 days shorter than that for the open group. This finding was maintained after stratification by severity class. Patients in the minor/moderate severity class had a 1-day shorter length of stay, and those in the major/extreme severity class had a 3-day shorter hospital stay when compared to the open. Overall complications, pulmonary and wound complication rates were also found to be significantly lower in the laparoscopic benign group. Overall complication rates maintained significance among the minor/moderate severity class, but significance was lost in the major/extreme severity class groups. This difference in overall complication may contribute to the shorter length of hospital stay seen in this group. Collins et al.[18] examined the risk factors to prolonged hospital stay among patients undergoing major abdominal surgery and found a correlation with the number of postoperative complications and the increased length of hospital stay in patient undergoing open colectomy. Cost was also found to be significantly lower in the benign laparoscopic group when compared to the benign open group. Reports in the literature have been conflicting with regards to the cost effectiveness of laparoscopic colon resection.[19–23] In a comparison of the cost effectiveness of laparoscopic vs open colectomy, Salloum et al. in an academic center, found that although operating room costs were higher for the laparoscopic group, total hospital cost was lower, in part due to the shorter length of stay.[23]

In the USA, there are approximately 150,000 colorectal cancer cases diagnosed per year, and surprisingly, only 10–15% of all colorectal resections are preformed laparoscopically. This was consistent with our data in which a larger proportion of patients underwent open, as compared to laparoscopic surgery for the treatment of malignant disease. This may be attributed to the hesitance among surgeons to use laparoscopic colon resection for the treatment of colon cancer.[24] In our study, laparoscopic sigmoid colectomy for

Table 6 Outcomes of Laparoscopic and Open Sigmoid Colectomy for Malignant Disease by Severity Class

	Malignant (minor/moderate)		Malignant (major/extreme)	
	Laparoscopic (N=168)	Open (N=2,610)	Laparoscopic (N=22)	Open (N=575)
Mean length of stay (days)	5.1±2.6*	6.4±2.9	15.8±14.6	14.1±12.6
Morbidity (%)	17.3	20.0	63.6	66.7
Mortality (%)	0.0	0.3	0.0	5.6
Observed-to-expected mortality	0.0	1.0	0.0	0.9
30-day readmission (%)	3.0	3.8	4.6	5.1
Total hospital costs ($)	12,955±5,125	12,807±5,710	31,597±21,815	32,452±42,810

* $p<0.05$ compared to malignant open sigmoid colectomy, two-sample t test

the treatment of malignant disease was associated with a shorter length of hospital stay and a lower rate of wound infections when compared to those patients treated with open surgery. No other differences between open and laparoscopic approach were found. After this patient group was stratified by severity of illness, length of stay remained significant only in the minor/moderate group. There was no significant difference found between laparoscopic and open outcomes in the major/extreme severity group. There was no in-hospital mortality in the malignant laparoscopic group; however, there was no significant difference found because of a low mortality rate in the open surgery malignant group. This finding may be attributed to both the safety of laparoscopic surgery and patient selection. A number of studies have found similar results. The Colon Cancer Laparoscopic or Open Resection Study group reported no difference in mortality, faster return of bowel function, shorter hospital stay, and the need for fewer analgesics compared to the open approach.[7] Similarly, the Clinical Outcomes of Surgical Therapy Study Group found that laparoscopic resection was comparable to open with regards to recurrence, incision site recurrence, postoperative complications, and 3-year survival, while having a shorter median hospital stay and needing less analgesics postoperatively.[6] Lezoche[8] also reported no difference in local recurrence or survival after 5 years of follow-up after laparoscopic colectomy.

This study has several limitations. As expected from a large retrospective administrative database, our patient populations had significant differences. There was a younger patient population and more patients with a lower severity of illness classification in the laparoscopic group, which may contribute to a selection bias. However, subanalysis by severity class after the patients were stratified to benign and malignant groups allowed us to compare a more homogenous group of patient within each diagnosis group. The data utilized in this study was obtained from a voluntary reported administrative database, which is compiled from discharge abstract data and is limited to in-hospital morbidity and mortality without follow-up data. Those complications or deaths arising after discharge are not captured in the database. The coding of certain complications may be inaccurate because postoperative adverse events are subjectively defined by the surgeon and may be coded differently (e.g., anastomotic leaks). However, objective data such as in-hospital mortality, length of stay, and 30-day readmission rates are accurate endpoints. Another limitation is that laparoscopic colectomy ICD-9CM procedural codes currently do not exist; therefore, to identify laparoscopic patients for our analysis, ICD-9CM procedural codes diagnostic laparoscopy and laparoscopic lysis of adhesions were used. This method has been used in other studies to identify laparoscopic procedures in which laparoscopic procedural codes do not exist.[16,25,26] As the codes for diagnostic laparoscopy and laparoscopic lysis of adhesions were used to obtain our laparoscopic cohort, some of the procedures may have been started laparoscopically and converted to open. In this case, the procedure would be captured as a laparoscopic procedure by the database. Estimated conversion rates in the literature are from 2 to 31% of laparoscopic colectomies.[5–10,14–16,18,20, 27] Converted laparoscopic colectomy has been found to have an increased morbidity, specifically wound complications, and a longer length of stay when compared to open or laparoscopic colectomy.[27] Therefore, conversions to open procedure in our study can lead to an overestimation of length of hospital stay and morbidity in the laparoscopic cohorts.

Conclusion

Multiple studies have shown the safety and improved perioperative outcomes of laparoscopic colectomy when compared to open procedures. Our study aims to demonstrate that laparoscopic sigmoid colectomy performed in academic centers is safe, and outcomes are better when compared to open sigmoid colectomy for the treatment of benign or malignant disease. Many of the endpoints examined in our study showed a trend toward better outcome with laparoscopic resection for the treatment of malignant and benign disease; however, not all the findings were statistically significant. Within the context of this analysis of academic centers, laparoscopic sigmoid colectomy for benign and malignant disease was associated with a significantly shorter length of stay, a lower wound infection rate, and similar morbidity, 30-day readmission rate, and mortality when compared to open sigmoid colectomy.

Reference

1. Beck DE, Opelka FG, Bailey HR, Rauh SM, Pashos CL. Incidence of small-bowel obstruction and adhesiolysis after open colorectal and general surgery. Dis Colon Rectum 1999;42:241–248.
2. Wishner JD, Baker JW Jr, Hoffman GC, Hubbard GW, Gould RJ, Wohlegemut SD, Ruffin WK, Melick CF. Laparoscopic assisted colectomy. The learning curve. Surg Endosc 1995;9:1179–1183
3. Berends FJ, Kazemier G, Bonjer HJ, Lange JF. Subcutaneous metastases after laparoscopic colectomy. Lancet 1994;344:58.
4. Johnstone PAS, Rhode DC, Swarz SE, Fetter JE, Wexner SD. Port-site recurrences after laparoscopic and thoracoscopic procedures in malignancy. J clin Oncol 1996;14:1950–1956.
5. Feliciotti F, Paganin AM, Guerrieri M, De Sanctis A, Campagnacci R, Lezoche E. Results of laparoscopic vs open resections for colon cancer in patients with a minimum follow-up of 3 years. Surg Endosc 2002;16:1158–1161.
6. The 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. COLOR Study Group. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of randomised trial. Lancet Oncol 2005;6:477–484.
8. Lezoche E, Guerrieri M, De Sanctis A, Campagnacci R, Baldarelli M, Lezoche G, Paganini AM. Long-term results of laparoscopic versus open colorectal resections for cancer in 235 patients with a minimum follow-up of 5 years. Surg Endosc 2006;20:546–553.
9. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM; MRC CLASICC trial group. Short- term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASSIC trial): multicentre, randomised controlled trial. Lancet 2005;365: 1718–1726.
10. Lacy AM, Garcia-Valdecasas JC, Delgado S, et al. laparoscopic-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomized trial. Lancet 2002;359: 2224–2229.
11. Weber WP, Guller U, Jain NB, Pietrobon R, Oertli D. Impact of surgeon and hospital caseload on the Likelihood of Performing laparoscopic vs Open Sigmoid Resection for diverticular disease. Arch Surg 2007;142:253–259.
12. Fleshman J, Marcello P, Stamos MJ, Wexner SD. Focus Group on Laparoscopic Colectomy Education as endorsed by the American Society of Colon and Rectal Surgeons (ASCRS) and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). Surg Endosc 2006;20(7):1162–1167.
13. Faynsod M, Stamos MJ, Arnell T, Borden C, Udani S, Vargas HA. Case-control study of laparoscopic versus open sigmoid colectomy for diverticulitis. Am Surg 2000;6:841–843.
14. Schwandner O, Farke S, Bruch HP. Laparoscopic colectomy for diverticulitis is not associated with increased morbidity when compared with non-diverticular disease. Int J Colorectal Dis 2005;20:165–172.
15. Schlachta CM, Mamazza J, Poulin EC. Laparoscopic sigmoid resection for acute and chronic diverticulitis. Surg Endosc 1999;13:649–653.
16. Guller U, Jain N, Hervey S, Purves H, Pietrobon R. Laparoscopic vs. open colectomy; outcomes comparison based on large nationwide databases. Arch Surg 2003;138:1179–1186.
17. 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.
18. Collins TC, Daley J, Henderson WH, Khuri SF. Risk Factors for Prolonged Length of Stay after Major Elective Surgery. Annals Surgery 1999;230(2):251–259.
19. Liberman MA, Phillips EH, Carroll BJ, Fallas M, Rosenthal R. Laparoscopic colectomy vs. traditional colectomy for diverticulitis outcome and costs. Surg Endosc 1996;10:15–18.
20. Janson M, Bjorholt I, Carlsson P, Haglind E, Henriksson M, Lindholm E, Anderberg B. Randomized trial of the costs of open and laparoscopic surgery for colonic cancer. Br J Surg 2004;91:409–417.
21. Franks PJ, Bosanquet N, Thorpe H, Brown JM, Copeland J, Smith AMH, Quirke P, Guillou PJ. Short-term costs of conventional vs. laparoscopic assisted surgery in patients with colorectal cancer (MRC CLASSIC trial). Br J Cancer 2006;95:6–12.
22. Delaney CP, Kiran RP, Senogore AJ, Brady K, Fazio VW. Case matched comparison of clinical and financial outcome after laparoscopic or open colorectal surgery. Ann Surg 2003;238:67–72.
23. Saloum RM, Butler DC, Schwartz SI. Economic evaluation of minimally invasive colectomy. J Am Coll Surg 2006;202:269–274.
24. Mavrantois C, Wexner SD, Nogueras JJ, Weiss EG, Pikarsky AJ. Current attitudes in laparoscopic colorectal surgery. Surg Endosc 2002;16:1152–1157.
25. Varela JE, Wilson SE, Nguyen NT. Outcomes of bariatric surgery in the elderly. Am Surg 2006;72(10):865–869.
26. Nguyen NT, Zainabadi K, Mavandadi S, Paya M, Stevens CM, Root J, Wilson SE. Trends in utilization and outcomes of laparoscopic versus open appendectomy. Am J Surg 2004;188(6):813–820.
27. Belizon A, Sadinha CT, Sher ME. Converted laparoscopic colectomy. Surg Endosc 2006;20:947–951.

Discussion

David Shibata, M.D. (Tampa, FL): Congratulations, too, on this paper. Thank you very much for submitting the manuscript to me in advance. That was much appreciated. This is a very interesting paper in that this is kind of data that supports what has been borne out by multiple prospective randomized trials done in North America as well as in Europe, and it is kind of comforting to know that the data is very similar to what we see in those trials. Some of the things that come across is that this is more of a view from 30,000 feet as this study makes use of what appears to be a mini-SEER type database for academic centers.

The limitations are quite clear, as you have pointed out. It certainly does not allow you to focus on tumor-specific factors, on previous operations, the specific nature of the patient's illnesses, and once again, it is really very difficult to tease out what is going on with the conversion rates.

First question. In terms of the codes for the procedures, I agree that there is no ICD-9 coding data, but it appears as if you have some financial data from this database. Can you actually look at the CPT codes that are associated with these billings and procedures?

Number two, in terms of the morbidity, I was a little surprised to see that in the sicker patients, even though this was just statistically non-significant, there was higher morbidity in some cases with laparoscopy than with open. This was one of your findings that I found to be a little discordant with some of the current data in the literature. And I was also wondering, did you actually stratify out parameters like pulmonary and cardiac complications when you analyzed the severity of the patients' illnesses and comorbidities?

Finally, one of the interesting things that I found, when looking at the manuscript, was that of all sigmoid colon cancers in your dataset, only 5% of these cases were actually done laparoscopically; and these were at academic centers. Was this surprising to you? And furthermore, when you were looking at some of these institutions where these procedures were done, were the volumes heavily weighted in terms of a small number of institutions or were they evenly spread across many academic centers. From your data, it appears as if one-third of the academic centers did not do any laparoscopic colon surgery whatsoever.

And finally, I think this database also includes community centers, is that correct?

Marcelo W. Hinojosa, M.D. (Orange, CA): Yes, but only those that are affiliated with academic centers are included in the database.

Dr. Shibata: As we know from the history of laparoscopic cholecystectomy, oftentimes community surgeons led the way in popularizing some of these procedures. I would be curious to see, if you separated out the community centers whether the same percentages would hold out.

Thank you very much.

Dr. Hinojosa: Thank you, Dr. Shibata for your discussion and questions. In response to your first question regarding CPT codes. The UHC database does not list CPT codes. They use ICD-9 procedure and diagnostic codes exclusively. Therefore, there would be no way for us to find the CPT codes that were associated with the billings and procedures within the database.

In response to your second question regarding the higher morbidity seen in patients with the higher severity score that underwent laparoscopic resection, we were able to stratify by individual complications. However we believe that complications can be a somewhat subjective end point and may be a limitation within the database. Also, the groups of patients with higher severity of illness who underwent laparoscopic resection were a very small group compared to patients who underwent open resections. Patient selection can also have something to do with our findings.

In response to your third question as to whether we were surprised to find that about 5% of all cancer cases were done laparoscopically? The answer is not completely. As you know, the majority of laparoscopic colon resections performed for colon cancer up until a few years ago were performed only in randomized clinical trials. Therefore, we expected the numbers of laparoscopic resection for colon cancer to be lower than that of benign disease.

In response to your final question regarding procedure volume within each institution, we did not perform a volume analysis comparison between institutions. We will attempt to do the volume analysis comparison in a future study.

Steve Sentovich, M.D. (Boston, MA): I have a question related to surgeon volume. I would argue that you cannot make the conclusions that you do without stratifying for surgeon experience. If only very experienced surgeons are doing the laparoscopic cases then that could explain all of the differences that you found in terms of length of stay and morbidity. Did you look at specific surgeon volume and experience?

Dr. Hinojosa: Unfortunately, we are not able to stratify by specific surgeon or by surgeon experience using the UHC database.

Jonathan F. Critchlow, M.D. (Boston, MA): I think the sequel to that question is the selection bias. Are you cherry-picking? Are only the most experienced surgeons doing the cases, and of the ones they are doing, are they cherry-picking the ones that are going to be easy to do laparoscopically and then leaving the hard ones to be done open? You can't tease out those specifics of each case. So it is interesting stuff, but I think we can say it is safe in selected circumstances.

Dr. Hinojosa: You are correct. Selection bias is a limitation of the study. From this database we can not tease out the specifics of each case and the experience of each surgeon. It is perceivable and even likely that the more experienced surgeons are performing laparoscopic cases. We do not know whether surgeons are "cherry picking". However, we did stratify patient by severity of illness, which factors in patient comorbidities and secondary diagnoses.