

Predicting Conversion to Open Surgery in Laparoscopic Left Hemicolectomy

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Purpose: The objective of this study was to quantify the risk of conversion to open surgery of laparoscopic left hemicolectomy at an early stage of the learning curve.

Methods: A multiple logistic regression analysis of 100 laparoscopic left hemicolectomies completed between April 2001 and May 2004 was performed.

Results: The overall conversion rate was 12%. At univariate analysis, 2 factors were found to be predictive of conversion to open surgery: malignancy (17.2% vs. 5%; $P = 0.046$), and weight level (< 60 kg = 6.1%; 60 to 90 kg = 11.3%; > 90 kg = 28.6%; $P = 0.049$). At multiple logistic regression, the risk of conversion rose only for patients weighing more than 90 kg.

Conclusions: On the basis of the results of this study, the surgeon will be able to quantify the risk of conversion to laparotomy with some precision in order to obtain the informed consent of the first 100 patients to whom laparoscopic left hemicolectomy is proposed.

Key Words: laparoscopic colon resection, left hemicolectomy, conversion rate, informed consent, learning curve

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In a recent editorial concerning laparoscopic colorectal surgery, it was stated that we are now at “the end of the beginning.”¹ The first phase of technical innovation is complete, but much must now be done. The number of laparoscopic colon resections will increase dramatically over the next decade. Many surgeons will begin to undertake this type of surgery. They will certainly be trained to accomplish laparoscopic procedures, but they

will have to go through the various stages of the learning curve to become experts in laparoscopic colorectal resection. The surgeons newly acquiring these laparoscopic skills may wish to select cases in their experience on the basis of a preoperative assessment of the risk for conversion. Moreover, these surgeons will not be able to accurately quantify this risk to obtain the informed consent of the patient.

Several studies have dealt with the problem of predicting conversion to open surgery in laparoscopic colorectal resections,^{2–7} although these studies examined different laparoscopic operations contemporaneously, and often did not examine the early stages of learning the technique.

The aim of our study was to quantify the risk of conversion to open surgery at an early stage in the learning curve of a single technique of laparoscopic colonic resection—left hemicolectomy—and to identify conversion risk factors.

MATERIALS AND METHODS

Between April 2001 and May 2004, a total of 100 patients underwent laparoscopic left hemicolectomy performed by the same surgical team at our university center. The surgeons (L.S., L.R.) were experts both in laparoscopic techniques and in open colorectal surgery and these 100 procedures represent the first laparoscopic left hemicolectomies performed in our university center after a training period at other centers where the technique has been practiced for some time.⁸ During this training period, the surgeons (L.S., L.R.) performed 5 left colectomies that were not used for this study. During the study period, the surgeons also performed other 22 laparoscopic colon resections (12 right colectomies, 3 subtotal colectomies, and 7 proctocolectomies) that were not used for this study. Data prospectively recorded for each patient included patient demographics, indication for surgery, procedure performed, intraoperative complications, and requirement to convert to open surgery.

Patients were assessed preoperatively for the possible use of laparoscopic techniques by the same surgical team; decisions regarding patient suitability for the procedure were made by the surgeon on the basis of the preoperative diagnosis and, in the case of cancer, intraoperative features. Exclusion criteria were very high

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risk for general anesthesia (ASA IV), pregnancy, coagulation disorders, hepatic dysfunction (Child-Pugh class C), ongoing infection, and plasma neutrophil level less than $2.0 \times 10^9/L$. Patients who had previously undergone major abdominal surgery were not considered suitable for laparoscopic colonic resection at this stage of the learning curve. Patients who had undergone appendectomy, cholecystectomy, hysterectomy, or adnexectomy were enrolled in the study and the previous operation was reported in the database. In cases of cancer, only patients with clinical pT1-pT3 or Astler-Coller stage D disease were enrolled in the study, subject to laparoscopic examination. Two cases where laparoscopy showed a T4 cancer and open surgery resection was performed were not taken into consideration for this study. In cases of nonmalignant disease, all patients suitable for laparoscopy were enrolled. Patients affected by complicated diverticulitis were not considered suitable for the laparoscopic approach. None of the operations was performed on an emergency basis.

Patients provided informed consent for the planned laparoscopic procedure in all cases.

Bowel preparation was with 4 L of polyethylene glycol electrolyte solution the day before surgery. Systemic prophylactic antibiotics consisting of 750 mg cefuroxime and 500 mg metronidazole were given intravenously at induction of anesthesia. Urinary catheter and nasogastric tubes were routinely used. Deep vein thrombosis prophylaxis was performed with low-molecular-weight heparin (50 IU/kg/d) in all patients.

A 13-mm Hg pneumoperitoneum was established using a Veress needle; intra-abdominal pressure values were then maintained between 11 and 13 mm Hg. Laparoscopic-assisted left hemicolectomy was a 5-trocar standard technique⁹ with systematic mobilization of the splenic flexure and resection of the rectosigmoid junction. Left hemicolectomy in patients affected by ADK was performed by high ligation of the inferior mesenteric artery; in patients affected by diverticulitis or polyposis the inferior mesenteric artery was cut just below the branch of the left colonic artery. In all patients, the pelvic autonomic nerve was preserved. Mesentery division, distal bowel resection, and a Knight-Griffen mechanical anastomosis between the distal transverse colon and the upper third of the rectum, just under the level of the sacral promontory, were performed intracorporeally; bowel resection was extracorporeal through an enlarged suprapubic trocar site. The specimen was always retrieved in an impermeable bag to prevent tumor spillage and/or wound contamination.

Any case that cannot be completed laparoscopically as planned was considered as being a conversion to open surgery.

Patient-specific, disease-specific, and procedure-specific factors that could have had an impact on the risk of conversion to open surgery were selected on the basis of published reports.^{7,10} Patient-specific factors were age, sex, and weight level (less than 60 kg, 60 kg to less than 90 kg, 90 kg and greater). Disease-specific factors

were diagnoses of diverticulitis, malignancy or benign neoplasm, and history of previous operations on the abdomen. The only procedure-specific factor was team inexperience (less than 50 cases).

All data are presented as means \pm standard deviations. Univariate analysis was performed using Student *t* test, χ^2 test, or Fisher exact test. Multiple logistic regression analysis of conversion to open surgery was performed with the SPSS System for Windows release 11.5 using all variables with stepwise selection of predictive factors. In all cases, a *P* value of 0.05 was considered as being statistically significant.

RESULTS

A completely laparoscopic treatment was performed in 88 of 100 patients. Intraoperative complications were observed in 4 patients (4%). In 2 cases an intra-abdominal hemorrhage occurred: one because of a bleeding from the inferior mesenteric vein and the other because of a bleeding from a lesion of the liver during adhesiolysis. The bleeding was controlled only after conversion to open surgery. Two patients had a small bowel perforation, which required conversion to open surgery. Bleeding in another 2 cases, during the difficult isolation of the splenic flexure in 1 case and of the rectum in the other, required conversion to open surgery, although these were not considered as being operative complications.

The overall conversion rate was 12%. Reasons for conversion are listed in Table 1.

The average age of the patients in this study was 62.2 ± 11.9 years, with no difference in patient ages between converted and nonconverted cases (61.3 ± 11.3 vs. 62.3 ± 12 y; *P* = 0.794). Men accounted for 43% of patients and were not associated with a significantly higher rate of conversion than women (18.6% vs. 7%; *P* = 0.110). The conversion rate rose for patients weighing more than 90 kg (Fig. 1). Men accounted for 85.7% of the patients weighing more than 90 kg, as compared with 3% of the patients weighing less than 60 kg and 56.6% weighing 60 to 90 kg (*P* = 0.092).

Malignancy and diverticulitis were the most common indications for surgery (Table 2). There was a higher rate of conversion to open surgery with malignancy (17.2% vs. 5%; *P* = 0.046).

The conversion rate was not influenced by previous minor abdominal surgery: (12.5% in the group of patients

TABLE 1. Reasons for Conversion to Open Surgery of 100 Laparoscopic Left Hemicolectomies

Reason for Conversion	n	%
Hemorrhage	4	4
Adhesions	3	3
Small bowel injury	2	2
Increase in carbon dioxide	2	2
Difficulty to isolate the rectum	1	1
Total	12	12

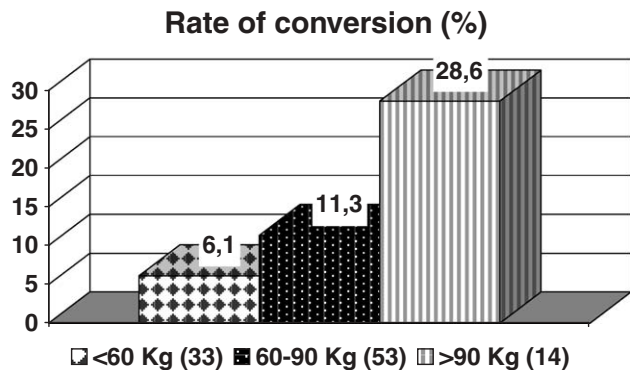


FIGURE 1. Rate of conversion to open surgery of 100 laparoscopic left hemicolectomies for each of the 3 patient weight levels. There was a significant rise in conversion rate for patients weighing more than 90 kg (<60 kg vs. 60 to 90 kg: $P = ns$; 60 to 90 kg vs. >90 kg: $P = 0.049$).

with previous minor surgery, 11.6% in the group of patients without previous abdominal surgery; $P = 0.83$). Neither did the presence of adhesions caused by previous minor abdominal surgery have any significant influence on the frequency of conversion: in the group of 23 patients with adhesions, the conversion rate was 17.3% vs. 10.4% of patients without adhesions; $P = 0.36$).

A trend towards a higher rate of conversion was found when the surgeon's experience was of 50 or fewer cases, but difference was not significant (18% vs. 6%; $P = 0.089$).

On multiple logistic regression analysis, only weight level was found to be predictive of conversion to open surgery (Table 3).

No patient died in the postoperative course. Table 4 shows the overall short-term morbidity rate after left colectomy without conversion.

DISCUSSION

Conversion to open surgery should not be considered as being a complication of surgery. Rather, conversion should be viewed as a wise decision when a laparoscopic procedure exceeds the surgeon's technical ability. For this reason, the rate of conversion to open surgery is not considered as being a measure of the quality of the surgery. However, when the laparoscopic technique is proposed to a patient, he should be informed of the possibility of conversion to open surgery, and, to give his informed consent, he should be aware of the percentage of risk. To provide this information, recourse must be had

TABLE 2. Indication for Laparoscopic Left Hemicolectomy

Malignancy	52
Diverticulitis	40
Polyp	7
Volvulus	1
Total	100

TABLE 3. Multiple Logistic Regression Analysis of Conversion to Open Surgery of 100 Laparoscopic Hemicolectomies

Factor	β	P	Odds Ratio (CI)
Intercept	-6.049	—	—
Weight level	1.004	0.043	2.731 (1.031-7.234)
Malignancy	1.228	0.073	3.626 (0.889-14.796)

CI indicates confidence interval.

to literature data, although the results of numerous studies are rather variable, ranging between 0% and 42%.^{2-7,11-21} There are numerous reasons for such differing results: there is currently no standardized definition of conversion, experience with laparoscopic surgery differs in the various studies, the patient selection criteria are different, and, finally, most of the studies concern several laparoscopic procedures contemporaneously. The same reasons may be cited to account for the fact that current reports are conflicting as to which factors may significantly influence the risk of conversion to open surgery. Resection for cancer led to higher conversion rates in some studies,² but not in others.³ Schwandner et al³ identified age as a risk factor for conversion, but a case-control study by Reissman et al⁵ found no association between age and conversion rate. Finally, inexperience was associated with higher conversion rates in many studies,^{2,22,23} but not in the experience of Wishner et al.²⁴

In the light of these differences, further statistical evaluations are of use to standardize the evaluation criteria. The approach taken in our study aims in this direction. First of all, the study regards a single surgical laparoscopic technique, left hemicolectomy; the only patient selection criterion is the absence of previous major abdominal surgery; it uses a definition of conversion which is simple and easily reproducible: an operation is considered as being converted when a laparoscopic procedure is commenced but could not be completed by

TABLE 4. Number of Patients With Short-term Postoperative Complications After 88 Laparoscopic Left Hemicolectomies Without Conversion to Open Surgery

Complications	Number (Percentage)
Overall	9 (10.2%)
Infectious*	6 (6.8%)
Wound	3 (3.4%)
Urinary tract	2 (2.3%)
Respiratory tract	1 (1.1%)
Noninfectious*	3 (3.4%)
Delayed gastric emptying	1 (1.1%)
Delayed recovery of bowel function	1 (1.1%)
Arrhythmia	1 (1.1%)
Anastomotic leak*†	1 (1.1%)

*Numbers of single types of complication do not add up to the number of overall complications with the 2 groups, in relation to the possible occurrence of more than 1 type of complications in some patients.

†Case number 67.

this approach. In addition, this study refers to an extremely common situation in clinical practice today: a single team of surgeons with previous experience in the laparoscopic technique and in colorectal laparotomy surgery begin carrying out colorectal laparoscopic surgery after a period of training in a center where this technique has been practiced for a number of years.⁸ An evaluation of this type is even more useful nowadays, in a period in which the techniques of laparoscopic colorectal resection have been refined and validated by numerous experiences, and the surgeon who begins to apply them has no need to try out variations or to gain new knowledge as he acquires experience. In agreement with Pappas and Jacobs,¹ we suspect that the number of laparoscopic colon resections will increase dramatically over the next decade.

The results of this study show the overall risk of conversion in the first 100 laparoscopic left hemicolectomy procedures as being 12%. The risk of conversion is greater for patients over 90 kg in weight.

The higher risk of conversion in patients over 90 kg in weight can be explained by the greater technical difficulties owing to the presence of a greater quantity of adipose tissue. The decision to represent patient weight as a 3-level variable was a trade-off for accuracy of the model and simplicity.⁷ It is acknowledged that a better indicator of obesity, such as body mass index, might be more accurate, but again, this would be less simplistic.

The reduction in the risk of conversion after the surgeon's first 50 procedures is not significant in this study. Although this result seems to be in contrast with that of many preceding studies,^{2,22,23} the conditions under which our study was conducted were different from those of many past studies. Our own experience, in fact, is not that of first-generation laparoscopic surgeons who were trained exclusively in open surgery and who acquired their laparoscopic skills in practice. Today, the surgeon trained in open surgery who wishes to use the laparoscopic technique has the possibility to adopt standard operating techniques and to go to specialist centers to learn them. Before performing left hemicolectomy in our university center our 2 surgeons, already trained in laparoscopic surgery, took a training course in laparoscopic colon surgery and performed 5 left colon resections under the supervision of expert surgeons. As previously reported,²⁴ this kind of training could be the reason for the apparent absence of a learning curve. The short-term complication rate we observed is low, even compared with that of much wider experiences,¹⁰ and can be considered as confirming the preceding hypothesis.

We consider an experience like that reported in this study as being very similar to that of the majority of surgeons starting to perform laparoscopic surgery today, and we thus think it likely that in future experiences no significant difference will be noted as to the frequency of conversion between the first 50 laparoscopic colonic resections and subsequent ones.

Malignancy resulted as being a significant risk factor at univariate analysis. In agreement with others,¹⁰

we maintain that for patients undergoing resection for cancer, unexpected tumor fixation, poor visualization, or inability to obtain adequate margins could lead to higher conversion rates. Malignancy ceased to be significant at multiple logistic regression analysis, probably because the sample size is relatively small.

The present study, similarly to others,^{5,23,24} failed to demonstrate a correlation between prior minor abdominal surgery and the requirement for conversion of laparoscopic left hemicolectomy to open surgery. We do not believe that the presence of a prior abdominal incision for minor surgery should be a consideration in planning for a laparoscopic procedure, because the severity or even the presence of adhesions cannot be determined before surgery. We did not propose laparoscopic colorectal resection to patients who had undergone major abdominal surgery, and thus we have no experience of the risk of conversion in these cases. We believe, however, that this experience should be undertaken only on completion of the learning curve.

On the basis of the results of this study, the surgeon will be able to quantify the risk of conversion to laparotomy with some precision, to obtain the informed consent of the first 100 patients to whom laparoscopic left hemicolectomy is proposed.

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