Learning Curve in Laparoscopic Colorectal Surgery: Our First 100 Patients

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Abstract

Background: Recent data confirming the oncologic safety of laparoscopic colectomy for cancer as well as its potential benefits will likely motivate more surgeons to perform laparoscopic colorectal surgery.

Objectives: To assess factors related to the learning curve of laparoscopic colorectal surgery, such as the number of operations performed, the type of procedures, major complications, and oncologic resections.

Methods: We evaluated the data of our first 100 elective laparoscopic colorectal operations performed during a 2 year period and compared the first 50 cases with the following 50.

Results: The mean age of the study population was 66 years and 49% were males. Indications included cancer, polyps, diverticular disease, Crohn's disease, and others, in 50%, 23%, 13%, 7% and 7% respectively. Mean operative time was 170 minutes. One patient died (massive pulmonary embolism). Significant surgical complications occurred in 10 patients (10%). Hospital stay averaged 8 days. Comparison of the first 50 procedures with the next 50 revealed a significant decrease in major surgical complications (20% vs. 0%). Mean operative time decreased from 180 to 160 minutes and hospital stay from 8.6 to 7.2 days. There was no difference in conversion rate and mean number of harvested nodes in both groups. Residents performed 8% of the operations in the first 50 cases compared with 20% in the second 50 cases. Right colectomies had shorter operative times and fewer conversions.

Conclusions: There was a significant decrease in major complications after the first 50 laparoscopic colorectal procedures. Adequate oncologic resections may be achieved early in the learning curve. Right colectomies are less difficult to perform and are recommended as initial procedures.

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The adoption of laparoscopy for colorectal surgery was slower to evolve than other laparoscopic procedures due to some early reports on metastatic port site recurrences following laparoscopy for colorectal cancer [1] coupled with the complex nature of these procedures. However, accumulated data in the last decade demonstrated that the actual rate of port site recurrences is below 1%, which is similar to the recurrence rate in the incision scar in open surgeries [2]. Moreover, prospective randomized studies [3,4] have demonstrated that the long-term outcome after laparoscopic resection for colorectal cancer is comparable to that of the open approach. This led to an approved statement by the American Society of Colon and Rectal surgeons (ASCRS), which was endorsed by the Society of American Gastointestinal Endoscopic Surgeons (SAGES) and others [5,6] on the safety of the laparoscopic approach in colon cancer patients.

The recent conclusion of the oncologic debate together with the rapid development of technological means and the increase in public awareness will probably result in a substantial increase in the number of surgeons performing laparopscopic colorectal surgery. Nevertheless, laparoscopic colorectal operations are difficult to perform and necessitate advanced laparoscopic skills and considerable experience. The aim of this study was to assess factors related to the learning curve, such as the number of operations, type of procedures, major complications, and oncologic resections.

Patients and Methods

From September 2003 we began to routinely perform laparoscopic colorectal operations. Short-term data were prospectively collected and served as the database for this study. All operations were performed or directed by one of two attending surgeons with previous experience and training in laparoscopic and colorectal surgery. Operative outcome related to complications, conversions, operative times and immediate oncologic results were evaluated.

Our preoperative workup for cancer patients included colonoscopy, tumor biopsies, computed tomography scan of the abdomen and pelvis, chest X-ray and carcinoembryonic antigen blood level. Patients with mid- and low rectal tumors underwent transrectal ultrasound as well. As a rule, most of the patients with T3, T4 and node-positive tumors on transrectal ultrasound were referred to neoadjuvant treatment followed by open surgery. Open surgery was favored in such patients due to the difficulty in performing laparoscopic total mesorectal exicision for large rectal tumors.

Principles of surgical technique

During the learning curve we adopted a standard surgical approach that we used in most cases. For right colectomies we use a three-port technique with a medial to lateral mesocolon dissection, lateral mobilization, colonic exteriorization, colonic transection and extracorporeal anastomosis. For left-sided resections we use four ports with a medial to lateral dissection, lateral mobilization, intracorporeal distal transection, exteriorization of the proximal colon with proximal transaction, and intracorporal anastomosis using an endoluminal stapler.

Follow-up

All patients were followed in our outpatient clinic. Patients with benign disease were followed for a short time (months) and were

instructed to contact the clinic should any problem arise. Our follow-up protocol for cancer patients includes physical examination and CEA blood level measurement every 3 months in the first year, every 4 months in the second year, and every 6 months from the third year until 5 years after surgery. Colonoscopy is performed 1 and 3 years after surgery. CT scan is performed 1 year after surgery. Our follow-up data are still limited in time and were not included in this study.

Statistics

Statistical analysis was performed using the chi-square test and the Mann-Whitney non-parametric test. $P < 0.05$ was considered significant.

Results

From September 2003 to December 2005 we performed 100 elective laparoscopic colorectal operations. Forty-nine patients (49%) were males and the mean age was 66 years (range 25–94). The most common indications for surgery were cancer, polyps and diverticulosis [Figure 1]. The most frequent procedures performed were right colectomies, sigmoidectomies and anterior resections [Figure 2].

Thirteen of the 50 cancer patients had rectal tumors. In eight of them the lesions were located in the upper third of the rectum and high anterior resection was performed. One patient who was diagnosed preoperatively with high rectal cancer was found to have a lower tumor; one patient underwent palliative diverting colostomy for non-resectable low rectal tumor, one patient underwent laparoscopic low anterior resection for a T2 low rectal tumor, and two patients had laparoscopic abdominoperineal resection – one for a very low T3 tumor following neoadjuvant treatment and the other for recurrent anal cancer after chemoradiation.

Mortality

One patient (1%) died postoperatively. This was an 84 year old man who underwent laparoscopic converted to open anterior resection for a rectal tumor. The patient died 14 days after surgery from a massive pulmonary embolism.

Morbidity

Significant surgical complications occurred in 10% of the patients. These included a leak in a patient with a large rectal tumor that was converted to an open procedure (stoma formation). Three other patients had re-operations for, respectively, a missed perforation of small bowel (segmental small bowel resection with primary anastomosis), non-functioning anastomosis (negative explorative laparotomy), and pelvic bleeding after laparoscopic abdominoperineal resection (hemostasis). A fistula occurred in a Crohn's disease patient and resolved with conservative treatment. There were three postoperative abdominal abscesses, which were treated with ultrasound-guided drainage in one and antibiotic therapy alone in the other two; and two patients developed retroperitoneal hematomas following right colectomy that resolved with blood transfusion alone in the first patient and blood transfusion with an insertion of internal ureter drainage (pigtail) due to hematoma compression in the second. There were 7 wound infections (7%) that were treated with drainage with or without antibiotics.

CEA = carcinoembryonic antigen

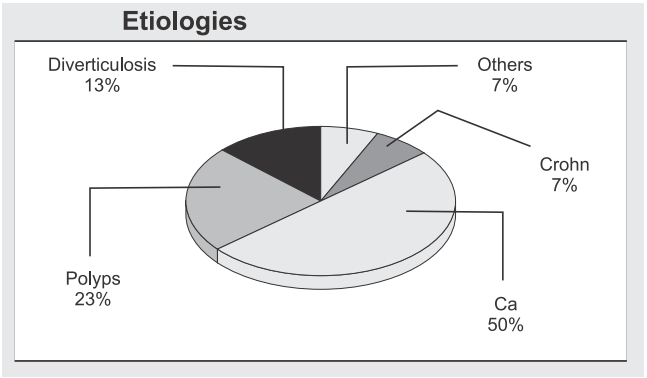

Figure 1. Indications for surgery

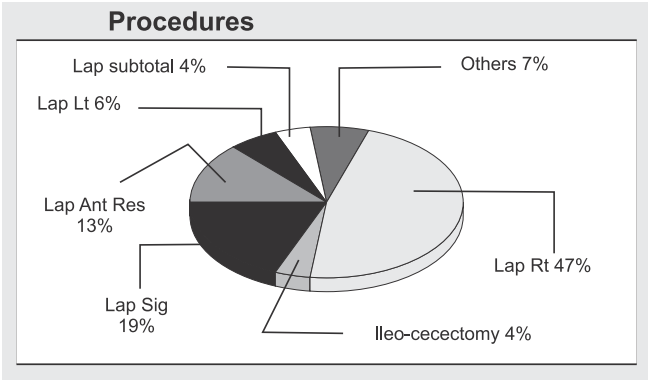

Figure 2. Type of procedures performed. Lap Lt = laparoscopic left colectomy, Lap Ant Res = laparoscopic anterior resection, Lap Sig = laparoscopic sigmoidectomy, Lap Rt = lap right colectomy.

Medical complications occurred in 11% of patients, occurring in only 3.8% of patients under the age of 70 (2/52) versus 18.8% (9/48) in patients over 70 ($P = 0.017$).

Conversions

Sixteen cases (16%) were converted. The reasons for conversion are listed in Table 1. There were significantly less conversions in right colectomies. The conversion rate for right colectomy was 6% compared to 26% in other procedures ($P = 0.005$).

Operative time and hospital stay

Mean operative time was 170 minutes. Right colectomies had shorter operative times than other procedures (143 vs. 203 minutes, $P = 0.001$). The mean hospital stay was 8 days.

Extent of oncologic resection

One patient who was converted to an open surgery due to a very large rectal tumor had a positive left lateral margin. All other

Table 1. Reasons for conversion

No. of patients (%)	Reason for conversion
5 (31%)	Severe diverticular disease
4 (25%)	Low rectal tumors
	Bulky upper rectal tumors
2 (12%)	Severe adhesions due to prior operations
2 (12%)	Lesion not found
1	Large adhered tumor
1	Instrument failure
1	Intraoperative bleeding

patients had negative margins. The mean number of harvested nodes in cancer patients was 16.3.

Comparison of first 50 procedures with the second 50

All significant surgical complications occurred in the first 50 cases (20% vs. 0%, $P = 0.001$). Average operative time decreased from 180 to 160 minutes. In the first 50 cases only 10% of operations lasted less than 120 minutes compared to 36% in the last 50 cases ($P = 0.002$). A trend towards shorter hospital stay was demonstrated in the last 50 cases. Hospital stay decreased from an average of 8.6 days in the first 50 cases to 7.2 days in the second 50 ($P = 0.072$). The mean number of harvested nodes in cancer patients did not change throughout the learning curve. In the first 50 cases it was 16.8 nodes compared to 15.5 in the next 50 cases (P = NS).

Residents, guided by an attending surgeon, performed 20% of the operations in the last 50 cases compared with only 8% in the first 50. The conversion rate did not change significantly between the first and the second 50 cases (18% vs. 14%, P = NS).

Discussion

Laparoscopic colorectal surgery is technically challenging. These procedures include various types of operations that frequently involve two or more abdominal quadrants, control of large blood vessels, identification of extraperitoneal structures such as the ureters, and intra- or extracorporeal reconstruction of intestinal continuity. Moreover, infection and inflammatory processes such as Crohn's disease and diverticulitis may present a hostile environment for the laparoscopic surgeon due to distorted anatomy and handling of friable and inflamed tissue. These factors may affect initial outcome early in the learning curve. The aim of this study was to evaluate the learning curve for these procedures based on the initial outcome of our first 100 elective operations with emphasis on crucial questions such as complications and extent of oncologic resection.

Our overall results are comparable to other reported series in terms of morbidity and short-term outcome [7,8] and thus can serve as a reliable database for evaluating factors related to the learning curve. The learning curve in laparoscopic colorectal surgery should initially reflect the number of cases needed to conduct these procedures with a reasonable rate of significant complications, and only then should other factors be evaluated.

In this series major complications decreased substantially after the first 50 cases. Several other studies have demonstrated the impact of surgeon experience on complications, showing a significant decrease in the complications rate as experience is gained [9-11]. Agachan et al. [11] reported similar results and concluded that at least 50 procedures are necessary to lower the complication rate significantly. Another study by Bennett and co-authors [9] demonstrated fewer complications with surgeons who had performed more than 40 cases. The cumulative intraoperative and postoperative complications were double with the less experienced surgeons (25% vs. 14%). Others have demonstrated the same trend [12].

Nevertheless, the number of operations is not the only factor influencing the complication rate. Other factors such as general experience in laparoscopic surgery, colonic pathology, and type of procedure play a major role as well. Difficult procedures such as resection of low rectal tumors, severe diverticular disease, and more extensive operations such as subtotal colectomy increase the complication risk [11,13,14].

A second very important goal is to set and meet primary oncologic goals in colorectal cancer patients. These goals, as represented by negative surgical margins and adequate number of harvested lymph nodes, can be met early in the learning curve, as demonstrated in our series. This obviously mandates adhering to standard cancer resection techniques as in open surgery [5,15]. A current recommendation of the American Society of Colon and Rectal Surgeons suggests a prerequisite experience of at least 20 laparoscopic colorectal resections for benign diseases or metastatic colon cancer before using laparoscopy to treat curable disease [5].

The operative time in laparoscopic colorectal surgery is somewhat longer than in open procedures even in experienced hands [16]. Nevertheless, operative times do decrease along the learning curve, as shown in our series and others [17]. Right colectomies are significantly shorter than other procedures, have a lower conversion rate and are easier to become skilled at [18]. Our overall 16% conversion rate is in accordance with the 5–20% reported in the literature [19-21]. In our series there was no significant change between the first 50 and the next 50 cases. Generally, about 25% of conversions are associated with intraoperative complications, while the rest represents cases that are too difficult or risky to complete laparoscopically [10,12,21]. Several factors are associated with increased conversion rate, including rectal resections, obesity, severe inflammatory process, and diverticular disease [20,21].

Timely abandonment of the laparoscopic approach should be regarded as good surgical judgment rather than as a surgical failure. We believe that early conversion in appropriate cases would avoid possible complications and unnecessary prolonged operations. When experience is gained it might be easier for the operating surgeon to decide on conversion early in the course of surgery. In two of our cases, the colonic lesions were not found laparoscopically and the cases were converted. The first case was a small tumor located in the sigmoid colon. This patient had a history of previous abdominal surgery and the sigmoid

colon was adhered to the pelvis, which made it difficult to find the tattoo. An intraoperative colonoscopy was performed and the lesion was found; however, the air insufflation caused a substantial large and small bowel distension that prevented a safe laparoscopic resection and the operation was converted. In the second case, the lesion was located in the transverse colon but the tattoo was not found and the case was converted without intraoperative colonoscopy. We believe that tattooing all small lesions (excluding lesions located in the cecal area) in at least three opposite spots would help the surgeon locate the vast majority of lesions. Tattooing in only one or two spots may mark only the mesenteric side of the colon and the inked area might not be noticed laparoscopically.

Intraoperative colonoscopy is time consuming and may complicate the procedure owing to bowel distension; however, when the lesion is not found despite adequate tattooing, colonoscopy may be used. In these cases, CO_2 colonoscopy should be superior to air colonoscopy since CO_2 is absorbed rapidly through the colonic mucosa and bowel distension resolves in a matter of minutes [22].

Guiding residents through a laparoscopic colorectal case is difficult. Compared to open surgery, where the actual surgical work can shift easily between the attending surgeon and the resident, and the control on the surgical procedure is relatively easy, in laparoscopic surgery this is not the case. In our opinion, training residents in laparoscopic colorectal surgery should be implemented only when the attending surgeon masters the procedure (which might take at least 50 cases) and should begin in easier cases such as right colectomy or stoma creation [7].

In conclusion, laparoscopic colorectal surgery becomes safer after performing at least 50 diverse cases. Adequate oncologic resections may be achieved early in the learning curve, providing that surgeons adhere to standard cancer resection methods. Operative times are somewhat longer than open procedures but become shorter along the learning curve. Right colectomies are shorter and easier to perform than left-sided and rectal resections and should be employed for teaching residents. The conversion rate would not necessarily drop after the first 50 cases and should reflect good surgical judgment rather than a surgical failure.

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