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The learning curve for laparoscopic colectomy in colorectal cancer at a new regional hospital

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Summary *Background:* Laparoscopic colorectal surgery has been extensively used, although mostly performed in medical centers or university hospitals. We analyzed the learning curve of laparoscopic colectomy in a new regional hospital and determined the experience necessary to achieve proficiency.

Methods: From July 2008 to December 2013, the retrospective clinical study enrolled 240 patients who underwent laparoscopic colectomy. They were sequentially divided into Group A (Patients 1—80), Group B (Patients 81—160), and Group C (Patients 161—240). Patient demographics and perioperative parameters were analyzed. Operation time, as a measure of learning time, was analyzed using the moving-average method.

Results: All patients were comparable for age, gender, body mass index, tumor location, cancer stage, length of hospital stay, intraoperative complication, morbidity, and mortality. Group A experienced more blood loss ($p < 0.01$) and longer operation time ($p < 0.001$). All laparoscopic operation time stabilized after 85 cases. Subgroup analysis showed that operation time stabilized after 15 cases for right hemicolectomy, 15 cases for sigmoidectomy, and 22 cases for low anterior resection with total mesorectal excision.

Conflicts of interest: The authors have no conflicts of interest.
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Conclusion: Laparoscopic colectomy for colorectal cancer in a new regional hospital is feasible and safe. It does not need additional time for learning. Laparoscopic sigmoidectomy can be considered as the initial surgery for a trainee.

1. Introduction

Laparoscopic colectomy was first presented in 1991,[1] and is now considered as the standard treatment for benign or malignant colorectal disease. The benefits of laparoscopic colectomy include shorter hospital stay, shorter duration of postoperative narcotics use, and faster recovery to a normal life.[2–9]

Laparoscopic colectomy is technically more difficult than open surgery, and the procedure includes vessel ligation, colon mobilization, and bowel anastomosis under laparoscopy. The complexity of the techniques used in this procedure requires more training time for surgeons to gain adequate experience compared with that required for traditional open surgery. In addition, well-trained operation teams and camera operators are beneficial for learning advanced laparoscopic surgical techniques.

Previous reports describe a highly variable learning curve for laparoscopic colectomy, requiring an experience ranging from 20 cases to 70 cases.[10–16] Most of the authors of these reports are well-experienced laparoscopic surgeons, and the procedures were performed in medical centers or university hospitals and rarely in new or regional hospitals. There is no report on the learning curve of advanced laparoscopic procedures in a new or local hospital setting. Our hospital began clinical operations in July 2008. Many of our operation room staff had little experience in laparoscopic surgery before working at our hospital. In this study, we evaluated the learning curve of laparoscopic colectomy for colorectal cancer in a new regional hospital setting and determined the necessary surgical experience to achieve suitable proficiency in this specific procedure.

2. Materials and methods

From July 2008 to December 2013, 278 consecutive patients with primary malignant colorectal neoplasms underwent laparoscopic colorectal surgery. Twenty-two patients who underwent other additional abdominal surgeries were excluded (10 patients received laparoscopic cholecystectomy, 6 patients received hepatectomy, and the other patients received partial gastrectomy, additional intestinal resection, uterine myomectomy, oophorectomy, nephrectomy, and polypectomy). We also excluded six patients because of intraoperative conversion and 10 patients who received single-incision laparoscopic surgery. A total of 240 patients were analyzed. All laparoscopic colorectal surgeries were performed by a single surgeon. This surgeon just finished a fellowship in colorectal surgery in 2008 and subsequently worked at our hospital.

A retrospective analysis was performed to determine patient demographics, which included diagnosis, tumor factors (tumor diameter, tumor stage according to the American Joint Committee on Cancer/The Union for International Cancer Control (AJCC/UICC) TNM classification), body mass index (BMI), American Society of Anesthesiologists (ASA) classification, type of surgery, operation time, intraoperative blood loss, total number of lymph node harvested, morbidity, mortality, and length of hospital stay. The patients were divided into Group A (Patients 1–80), Group B (Patients 81–160), and Group C (Patients 161–240) by the sequential order of surgery. Statistical analyses for three-group comparisons were performed by applying one-way independent analysis of variance (ANOVA) for continuous variables and the Pearson Chi-square test for categorical variables. Results with $p < 0.05$ were considered statistically significant.

3. Results

Between July 2008 and December 2013, 240 patients underwent laparoscopic colectomy for colorectal cancer without conversion, which included 44 right hemicolectomies, 17 left hemicolectomies, 121 sigmoidectomy, 39 low anterior resections plus total mesorectal excision (TME) and diverting ostomy, two Hartmann's operation, and 17 abdominal perineal resections. The mean age of the 240 patients was 65.3 years (range: 38–96 years), and there were 128 males and 112 females. Only one patient who had a Stage III rectal carcinoid underwent laparoscopic low anterior resection with TME and loop ileostomy; the other patients all had colorectal adenocarcinomas. The mean BMI of these patients was 24.6 kg/m^2 (range: 15.0–39.2 kg/m^2). Two hundred and seven patients had ASA scores of < 3. The mean tumor size was 3.9 cm (range: 0–10 cm). Fifty-seven patients had Stage 0 or I colorectal cancer, 69 patients had Stage II, 96 patients had Stage III, and 18 patients had Stage IV.

The operation times for all patients are shown in Fig. 1. A five-patient moving-average curve showed stabilization of the operation times after 85 patients and that the average operation time was < 200 minutes after the 85th patient. A subanalysis of the types of operation method performed showed that the operation time gradually decreased with increasing case number. The operation time stabilized after 15 patients for right hemicolectomy (Fig. 2), 15 patients for sigmoidectomy (Fig. 3), and 22 patients for low anterior resection with TME (Fig. 4). The number of cases performed with other methods was too small to analyze.

There were no significant differences in age, gender, BMI, ASA score, and operation method among the three groups (Table 1). The mean tumor size of Group A