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The learning curve for hand-assisted laparoscopic colectomy: a single surgeon's experience

J.-C. Kang,[1] S.-W. Jao,[2] M.-H. Chung,[3] C.-C. Feng,[2] Y.-J. Chang[1]

[1] Division of Colorectal Surgery, Buddhist Tzu Chi General Hospital, Hualien, Taiwan, ROC
[2] Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan, ROC
[3] School of Nursing, Air Force General Hospital, Taipei, Taiwan, ROC

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Abstract
Background: Surgical experience and outcomes for hand-assisted laparoscopic colectomy were evaluated to define a learning curve.
Methods: This study included 60 patients who underwent hand-assisted laparoscopic colectomies performed by a single surgeon. They were analyzed as three consecutive equal groups: A, B, and C. Pearson's chi-square test and one-way analysis of variance (ANOVA) were used to compare differences in demographics and perioperative parameters. Operative times were analyzed to document the learning curve for the procedure.
Results: There were no significant differences between the three groups in terms of age, sex, operative procedure, or comorbidity. Groups B and C showed significantly shorter operative times, significantly earlier recoveries of gastrointestinal function, less blood loss, and shorter hospital stays than group A. The incidence of operative complications was not significantly different among the three groups (35% vs 5% vs 15%; $p = 0.07$).
Conclusions: Approximately 21 to 25 cases were needed to achieve proficiency in this series.

Key words: Hand-assisted laparoscopic colectomy — Learning curve — Surgical experience

Although laparoscopically assisted colectomy has been used for colon resection over more than a decade, this procedure has not been as well accepted by surgeons as laparoscopic cholecystectomy. The limitations of traditional laparoscopic colectomy include lack of tactile feedback, a steep learning curve [4, 22], a potential risk for the development of metastasizing malignancies at the port site, and poor surgical access [13, 21].

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Correspondence to: J.-C. Kang

These limitations with the laparoscopic procedure stimulated surgeons and engineers to develop hand-assisted laparoscopic surgery. This technique involves insertion of the hand through the abdominal wall to facilitate dissection and retraction without compromising pneumoperitoneum. Several practitioners claim that it can simplify technically complex operations. In addition, it has the benefits of reducing operation time and shortening the learning curve in comparison with traditional laparoscopic surgery [6, 7, 10, 11, 14, 20]. However, there is no information on the relationship between a surgeon's experience and the clinical outcomes for hand-assisted laparoscopic colectomy (HALC).

This study aimed to define a learning curve for HALC in terms of operative time, complications, estimated blood loss, time to first bowel movement, time to first flatus, time to oral intake, and length of hospital stay.

Patients and methods

Between January 2002 and October 2002, 60 consecutive hand-assisted laparoscopic colectomies were performed for patients with benign and curable malignant colorectal disease. The patient demographics analyzed included age, sex, disease pattern, operative procedure, comorbidity, and perioperative parameters such as operative time, estimated blood loss, recovery of postoperative gastrointestinal function, length of hospital stay, and intraoperative and postoperative complications. The patients were divided chronologically into three equal groups of 20 patients for further evaluation.

We classified five different operative procedures and times into low- and high-difficulty types on the basis of their complexity. The low-difficulty group included right hemicolectomy (lesions of the cecum, ascending colon, and hepatic flexure), left hemicolectomy (lesions of the distal transverse colon, splenic flexure, and descending colon), anterior resection (lesions of the sigmoid colon and upper rectum), and low anterior resection (lesions of the middle and low rectum). The high-difficulty approach consisted of subtotal colectomy.

The times for each operative procedure were recorded. The mean times for five sequential cases were plotted to form a learning curve for each group. The learning curve was defined as the operative time (from skin incision to skin closure) required for each procedure to reach a nadir at which the times of the subsequent procedures did not vary by more than 30 min [19].

Table 1. Comparison of demographic data for groups A, B, and C

Variables	Group A (n = 20)	Group B (n = 20)	Group C (n = 20)	χ^2 Value	p Value[a]
Age (years)[b]	46.3 ± 21.7	45.6 ± 16.6	42.9 ± 18.4		0.86
Sex: n (%)					
Male	8 (35)	7 (30)	8 (35)	0.14	0.93
Female	12 (32)	13 (35)	12 (32)		
Operative procedure: n (%)					
Low difficulty	10 (37)	9 (33)	8 (30)	0.40	0.82
High difficulty	10 (31)	11 (33)	12 (36)		
Comorbidity: n (%)					
No	12 (27)	17 (38)	16 (36)	3.73	0.16
Yes	8 (53)	3 (20)	4 (27)		

[a] Chi-square test for independence
[b] One-way test; values are expressed as mean ± standard deviation

Table 2. Comparison of mean perioperative parameters for groups A, B, and C

Variables	Group A	Group B	Group C	F	p Value
Operative time (min)[a]	159.8 ± 31.1	135.0 ± 14.6	126.0 ± 12.3	13.7[b]	0.00
Estimated blood loss (ml)[a]	140.0 ± 34.8	110.0 ± 20.5	110.0 ± 20.5	8.8[b]	0.00
First bowel movement (days)[a]	3.5 ± 1.2[c]	2.9 ± 0.3	2.9 ± 0.3	4.78[b]	0.01
Passage of flatus (days)[a]	3.0 ± 1.2[c]	2.3 ± 0.7	2.4 ± 0.7	3.41[b]	0.04
Oral intake (days)[a]	3.8 ± 1.3[c]	3.2 ± 0.4	3.2 ± 0.4	3.83[b]	0.03
Length of stay (days)[a]	10.0 ± 3.9[c]	7.6 ± 1.2	7.5 ± 1.2	6.60[b]	0.00
Complications[d]: n (%)					
No	13 (26)	19 (39)	17 (35)	5.28	0.07
Yes	7 (64)	1 (9)	3 (27)		

[a] One-way analysis of variance (ANOVA)
[b] $p < 0.05$
[c] Groups B and C compared with group A
[d] Chi-square test

Operative procedure

Routine HALC consisted of the intracorporeal ligature of vascular pedicles and mobilization of the mesocolon lesion. The mobilized bowel segment was brought through the hand-port device for transaction and retrieval of the specimen. An end-to-end anastomosis was performed extracorporeally. Bowel anastomoses of right and left hemicolectomies were performed by hand suturing. Anterior resection, low anterior resection, and subtotal colectomy were performed by stapling. A 7-cm transverse incision was made in the left or right iliac fossa or the suprapubic region depending on the site of the colon and rectum affected, and the hand-port device was inserted. We used the Lap Disc (Hakko, Nagano, Japan).

All the operations were performed by the first author (J.C.K.). Before the study, the author had performed five HALC procedures: right hemicolectomy for two patients, left hemicolectomy for two patients, and low anterior resection for one patient.

Statistical analysis

Statistical analyses were performed using one-way ANOVA and chi-square methods for comparison of the variables among the three groups. Significance was assumed at a p value less than 0.05. The least significant difference method was used for further examination of differences in perioperative parameters among the groups.

Results

The 60 consecutive patients were divided into three successive groups (A, B, and C) of 20 each for analysis. The operations included right hemicolectomy (n = 6), left hemicolectomy (n = 7), anterior resection (n = 6), low anterior resection (n = 8), and subtotal colectomy (n = 33). Indications for surgery included malignancy (n = 18), diverticulitis (n = 6), arteriovenous malformation (n = 4), ischemic colitis (n = 2), inflammatory bowel disease (n = 8), and slow-transit constipation (n = 22).

There were no significant differences in the male-to-female ratio, patient age, operative procedure, or comorbidity among the three groups (Table 1). One intraoperative complication of hemorrhage occurred in group A, but no open surgery was required. Postoperative complications including pneumonia, prolonged ileus, wound infection, urinary tract infection, anastomotic bleeding, and leakage were more frequent in group A than in the other two groups, but this difference was not statistically significant (p = 0.07: Table 2). The mean operative times and blood losses were significantly lower in groups B and C than in group A ($p < 0.05$: Table 2). There were significant decreases in the times taken to first flatus, first bowel movement, and first oral intake, as well as the length of hospital stay for groups B and C, as compared with group A, but there were no significant differences between groups B and C (Table 2).

The mean operative times were 125 min (range, 90–135 min) for right hemicolectomy, 133 min (range, 115–150 min) for left hemicolectomy, 128 min (range, 85–150 min) for anterior resection, 142 min (range, 125–180 min) for low anterior resection, and 182 min (range, 130–300 min) for subtotal colectomy. The low-difficulty

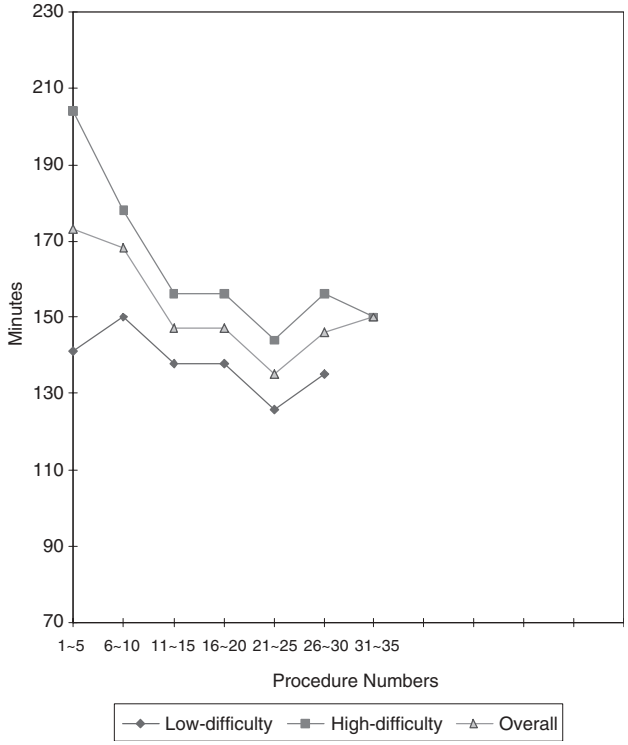

Fig. 1. The learning curve for hand-assisted laparoscopic colectomy. Low-difficulty procedures ($n = 27$) included right hemicolectomy ($n = 6$), left hemicolectomy ($n = 7$), anterior resection ($n = 6$), and low anterior resection ($n = 8$). High-difficulty procedures involved subtotal colectomy ($n = 33$).

operation group ($n = 27$) included right hemicolectomy ($n = 6$), left hemicolectomy ($n = 7$), anterior resection ($n = 6$), and low anterior resection ($n = 8$). The high-difficulty group consisted of 33 patients requiring subtotal colectomy.

The operative time for each group is shown in Fig. 1. In the low-difficulty group, the mean operative times dropped to a low point of 126 min between cases 21 and 25. In the high-difficulty group, the mean operative time declined to a nadir of 146 min between cases 21 to 25 as well. Thus, in both sets, 21 to 25 HALC operations were required for adequate learning. The overall mean operating time was 136 min.

Discussion

Several studies show better clinical outcomes when surgeons have developed their own expertise in laparoscopic procedures. In this study, the patients in the later groups (B and C) had significantly shorter times to first flatus and bowel movement, earlier commencement of oral intake, and shorter hospital stay times than those in earliest group (A). To define the learning curve for mastering laparoscopic colectomy on the basis of the operation time required, it was important to take into account operative complications and conversion rates. Others have suggested that the learning curve for traditional laparoscopic colorectal resections varies from 11 to 50 cases [1, 2, 15, 17, 22].

Hand-assisted laparoscopic colectomy is an alternative to the conventional laparoscopic technique. Although several authors believe that HALC is easier to learn and can reduce operation times, complications, and conversion rates, the optimum rate for learning this procedure has not been defined.

Laparoscopic cholecystectomy became the gold standard treatment for treating gallstone disease, and fewer operative complications were found for surgeons who performed greater numbers of procedures. Moore et al. [9] suggested that surgeons who had performed more than 20 laparoscopic cholecystectomies could be predicted to have a lower rate of bile duct injury. Similarly, urologists who have performed more than eight laparoscopic urologic procedures have lower complication rates than those with less experience [16]. With regard to operative complications with traditional laparoscopic colectomy, Bennett et al. [2] analyzed 1,194 cases and suggested that high-volume surgeons who had performed more than 40 cases experienced significantly lower postoperative complication rates. In our study, group A had a high frequency of complications, and there was a nonsignificant trend toward lower rates for groups B and C.

In an attempt to produce a homogeneous and well-defined model, the five procedures were divided into low- and high-difficulty groups on the basis of their complexity. The low-difficulty group included right and left hemicolectomies as well as anterior and low anterior resections. These procedures differed in complexity, but our experience in this study and that of others [11, 14, 20] show that they are comparable procedures, with operative times varying by less than 30 min. We categorized subtotal colectomy as a high-difficulty procedure. This categorization is different from the model reported by Geis et al. [3].

Various factors can affect operation times including setup time, expertise of the operating team, operative procedure (e.g., right hemicolectomy vs total colectomy), complication with inflammatory diseases, and type of anastomosis used (e.g., hand-sutured vs stapled). Several studies have claimed that HALC can reduce the operating time, but only a few reports have specifically noted such times. Targarona et al. [20] reported a mean operation time of 120 min (range, 70–300 min) for 12 right hemicolectomies and 15 left hemicolectomies. These data are similar to ours (mean operative time, 129 min), but no attempt was made to plot a learning curve.

Some surgeons do not accept HALC because they prefer to perform the entire procedure without laparoscopic assistance through a small minilaparotomy incision. This approach may work for slender patients and simple procedures (e.g., right hemicolectomy or anterior resection). However, with this approach, it is difficult to mobilize the splenic flexure, and splenic bleeding may result [7].

Concerning conversion rates, the rate of conversion to open surgery for traditional laparoscopic colectomy has varied from 17% to 42% [12, 18]. By comparison, the reported conversion rate for HALC has ranged from 0% to 22% [6, 7, 10, 11, 14, 20]. In our study, there was no need for conversion to open surgery. The most common rea-

sons stated for traditional laparoscopic colectomy include diverticular inflammation, intraabdominal adhesion, and the need for distal rectal resection. These difficulties could be overcome using HALC because it retains tactile feedback and is performed as an open procedure.

From 2002 to the present, we have managed more than 120 cases of HALC and 90 cases of traditional laparoscopic surgery. Of these, 70 cases of HALC with subtotal colectomy were undertaken for slow-transit constipation. Because most such slow-transit constipation occurred in young females, cosmetic outcome and quality of life were major concerns. Hand-assisted laparoscopic colectomy can retain the minilaparotomy benefits of laparoscopic colectomy and reduce operative times to the approximate time required for open colectomy. Thus, HALC in subtotal colectomy to manage slow-transit constipation currently is a standard procedure at our institution.

In this study, the mean operating time for HALC in subtotal colectomy was 182 min, but with the development of instruments and experience, this procedure currently requires 150 min as well as only two trocars (10 mm) and one hand-port [5].

In its initial development, HALC, was considered to be a bridge from open colectomy and traditional laparoscopic surgery, but several reports have postulated that HALC is likely to replace the traditional laparoscopic surgery with challenging procedures such as total colectomy and restorative proctocolectomy [10, 14]. Most of the operative procedures at our institution, such as right hemicolectomy, left hemicolectomy, anterior resection, low anterior resection, and abdominoperineal resection, were performed with traditional laparoscopic surgery because we thought HALC could not achieve the most benefits considering that it involved a larger incision and greater cost than traditional laparoscopic surgery. We also used HALC for concomitant dual organ resection, closure in Hartmann's procedure, and complicated diverticulitis.

With regard to the use of HALC for malignancy, there is yet no report of large series or long-term outcomes. In our personal experiences, we compared HALC and traditional laparoscopic surgery for colorectal malignancy. The initial results showed that HALC could reduce the conversion rate and operative times, but did not reflect any difference in the postoperative recovery or morbidity [8].

Conclusion

As with other laparoscopic procedures, a surgeon who performs HALC with more experience produces fewer operative complications and better clinical outcomes. About 21 to 25 cases of HALC are needed to learn this procedure effectively.

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