Original Article

Improving Result of Laparoscopic Colorectal Surgeries in a Training Hospital

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Key Words
Laparoscopic surgery;
Colon;
Rectum

Background. Several large randomized control trials on colorectal cancer have shown compatible short-term and long-term oncological outcomes between laparoscopic and open surgery. However, the process of incorporating such practice in a major medical center in Taiwan has not been explored. We described our 2-year experience of developing laparoscopic colorectal surgery at our training hospital.
Methods. From July 2007 to December 2009, total 432 patients underwent laparoscopic colorectal surgery in Taipei Veterans General Hospital. We compared the outcomes during two 6-month periods: July 2007 to December 2007 (initial phase) and July 2009 to December 2009 (later phase).
Results. After gaining experience, the surgeons were able to perform laparoscopic colorectal surgeries in more patients with a history of abdominal surgery, and the rate of conversion to open surgeries significantly decreased ($p = 0.03$). In addition, the operative time for laparoscopic right hemicolectomy and anterior resection significantly reduced in the later phase ($p = 0.01$). An increase in the number of harvested lymph nodes was observed ($p < 0.01$). No significant differences were observed in the postoperative morbidity, mortality, and duration of hospital stay for the 2 phases.
Conclusion. Laparoscopic colorectal surgeries could become a standardized procedure in a major training hospital in Taiwan without increasing morbidity and mortality.
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Colorectal cancer is one of the most prevalent cancers in the world. In 1991, Jacobs and Verdeja[1] reported that laparoscopic segmental colectomy can be performed to treat patients with sigmoid colon cancer. Since then, results of several large randomized controlled trials on colon cancer have shown that laparoscopic surgery has compatible short-term and long-term oncological outcomes compared to open surgery.[2-9] Regarding cancers of the rectum, several randomized trial have shown that, unlike open surgery, laparoscopic surgery does not compromise the oncological effect in low or middle rectal cancer, comparing with open surgery.[10-12]

The first laparoscopic colectomy was performed in 1993 at Taipei Veterans General Hospital. However, the indication for such procedure was restricted

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to only benign colon diseases such as large benign colon tumors or diverticular disease. In 2007, the National Health Insurance in Taiwan started to cover the partial costs of several laparoscopic surgeries, including laparoscopic colectomy. In addition, evidence for the equivalence of laparoscopic surgery to open surgery for treating malignant colorectal diseases became well established. Thus, the proportion of patients with malignant diseases who underwent laparoscopic surgeries increased from 6.4% in 2006 to 35.5% in 2009. However, we were concerned whether the quality of our laparoscopic surgery was maintained with this rapid increase in case volume. Furthermore, we aimed to identify the issues that should be addressed while standardizing laparoscopic colorectal surgery in a teaching hospital. Therefore, we reviewed our cases of laparoscopic colorectal surgery in this 2-year duration. To obtain a better comparison and exclude the influence of the initial learning period and team member training, we divided the cases into 2 groups on the basis of the period when the surgery was performed: initial phase (from July 2007 to December 2007) and later phase (from July 2009 to December 2009). Short-term outcomes were compared on the basis of parameters, including the operative parameters, pathologic results, hospital course, morbidity, and mortality.

Materials and Methods

The medical records of patients who underwent laparoscopic colorectal surgery at Taipei Veterans General Hospital from July 2007 to December 2007 (initial phase) and from July 2009 to December 2009 (later phase) were thoroughly reviewed. Data were collected for the following 4 categories: 1) demographic data, including patients' age, gender, body mass index (BMI), history of abdominal surgery, and preoperative American Society of Anesthesiologist (ASA) classification, 2) surgical data including the date of surgery, location of the tumor, surgical method, concomitant resection of an other organ, operative time, blood loss, and cause of conversion, 3) pathology data, including tumor size, invasion depth of the tumor, total number of harvested lymph nodes, resection margins (proximal, distal and lateral), pathological stage, and status of distant metastasis, and 4) data on hospital course, including time of first flatus, time of the first bowel movement, time to resumption of oral intake, postoperative hospital stay, complications, mortality, and the causes of re-intervention and re-admission. Surgical mortality was defined as the mortality after surgery during the same hospital stay or within 30 days after discharge. Re-intervention and re-admission were defined as any re-operation or re-admission as a result of surgical complication that developed within 30 days after surgery. Pathological tumor staging was determined according to the TNM criteria proposed in the 5th edition American Joint Committee on Cancer (AJCC) cancer staging manual.

The analysis was performed according to the principle of intention-to-treat. Any conversion of laparoscopic surgery was included in the final analysis. Statistical analyses were performed using the SPSS software package (version 16.0 for Windows; SPSS Inc., Chicago, IL, USA). Chi-square or Fisher's exact test was performed for analyzing categorical variables. Student's *t* test was performed to compare numerical variables between the 2 groups. Statistical significance was set at $p < 0.05$.

Results

Patients' characteristics

During the initial phase, 69 patients underwent laparoscopic colorectal resection; this number increased to 117 during the later phase. The differences in the gender, age, BMI, preoperative carcinoembryonic antigen (CEA) levels between the 2 groups were not significant. The proportion of ASA grade II increased from 55.1% in the initial phase to 64.1% in the later phase. The proportion of patients who had previously undergone an abdominal surgery in the later phase was more than that in the initial phase (Table 1).

Operation details

The number of our senior residents who could perform laparoscopic colorectal surgery increased in

Table 1. Demographic data of the patients who underwent laparoscopic colorectal surgeries in the initial and later phases

	Initial phase (%) (n = 69)	Later phase (%) (n = 117)	*p* value
Gender			
Male	38 (55.1)	64 (54.7)	1.00
Female	31 (44.9)	53 (45.3)	
Age			
Mean ± S.D.	62.9 ± 12.5	67.6 ± 11.8	0.62
Range	(33-88)	(39-89)	
BMI			
Mean ± S.D.	23.7 ± 3.2	24.6 ± 3.4	0.16
Range	18-29	17-38	
Preoperative CEA level (ng/mL)			
Median	2.2	2.4	0.49
Range	1.1-51	0.7-1812	
ASA classification			
I	19 (27.5)	12 (10.3)	**0.02**
II	38 (55.1)	75 (64.1)	
III	11 (15.9)	29 (24.8)	
IV	1 (1.4)	1 (0.9)	
Previous abdominal surgery			
No	59 (86)	82 (70)	**0.02**
Yes	10 (14)	35 (30)	
Disease status			
Benign	6 (8.7)	6 (5.1)	0.37
Malignant	63 (91.3)	111 (94.9)	

CEA: carcinoembronic antigen; SD: standard deviation.

the later phase (2.9% vs. 17.2%, $p < 0.01$). The type of operation and amount of blood loss were not significantly different between the two groups. The reasons for conversion to an open surgery during the initial phase were as follows: locally advanced tumors belonging to clinical stage T4 (2 patients), unclear dissection plane of the lesser sac (1 patient), difficulty in applying a stapler (1 patient), poor view of the surgical field (2 patients), difficulty in tumor localization (1 patient), severe adhesions (2 patients), appendectomy with the lesion located at cecum (1 patient), and massive intraoperative bleeding caused by accidental injury to the presacral plexus. In the later phase, the reasons for conversions were T4 lesions, difficulty in tumor localization, severe adhesions, and bleeding; however, the conversion rate had dramatically decreased (14.5% vs. 5.1%; $p = 0.03$). However, there was no conversiocal field.

Operative time for right hemicolectomy (RH) and anterior resection (AR) was significantly reduced in the later phase while that for left hemicolectomy (LH), low anterior resection (LAR), abdominal-perineal resection (APR), transverse colectomy (T-colectomy) and segmental resection was not significantly for the 2 groups. The increase in the number of resections of other organs in the later phase was not significant (1.4% vs. 7.7%, $p = 0.09$, Table 2). For the only case of resection of another organ in the initial phase, an appendectomy was performed during an LAR after converting to open method because of dense adhesions. Of the 9 patients who underwent resections of other organs in the later phase, thre patients underwent resection due to the presence of T4 lesions. Of the remaining 6 patients, 1 underwent laparoscopic cholecystectomy for gallbladder stone, 1 underwent appendectomy for appendicitis, 1 underwent a laparoscopic ileocecal resection for mucocele, 1 underwent reversal of colostomy, 1 underwent a liver metastectomy, 1 underwent a laparoscopic partial resection of the urinary bladder because of suspicious tumor invasion intraoperatively, which was proved to be T3 lesion later.

In the initial phase, the reasons for re-admission were urinary tract infection (1 case), intestinal obstruction (1 case), anastomosis leakage (1 case), ileus

Table 2. Operative details of the laparoscopic surgeries performed in the initial and later phases

	Initial phase (%) (n = 69)	Later phase (%) (n = 117)	*p* value
Operator			
Attending	67 (97.1)	97 (82.9)	**< 0.01**
Senior resident	2 (2.9)	20 (17.2)	
Operative procedure			
RH	16	24	
LH	5	9	
AR	20	44	
LAR	21	33	0.43
APR	1	1	
T-colectomy	1	2	
Segmental resection	5	4	
Conversion	10 (14.5)	6 (5.1)	**0.03**
Locally advanced tumor	2	3	
Unclear dissection plane	1	0	
Difficulty in applying stapler	1	0	
Poor view of the surgical field	2	0	
Difficulty in tumor localization	1	1	
Severe adhesion	2	1	
Bleeding	1	1	
Operative time (min, mean ± SD)			
RH	301 ± 95	232 ± 55	**< 0.01**
LH	313 ± 83	316 ± 110	0.96
AR	302 ± 82	236 ± 83	**< 0.01**
LAR	352 ± 80	324 ± 104	0.30
APR	375	390	-
T-colectomy	250	295 ± 64	0.67
Segmental resection	255 ± 80	231 ± 54	0.63
Blood loss (ml, mean ± SD)	88 ± 11	103 ± 15	0.48
Resection of other organ			
Yes	1 (1.4)	9 (7.7)	0.09
No	68 (98.6)	108 (92.3)	

RH: right hemicolectomy; LH: Left hemicolectomy; AR: anterior resection; LAR: low anterior resection; APR: abdominal-perianal resection; T-colectomy: transverse colectomy; SD: Standard deviation.

(1 case), and cholecystitis (2 cases). Cases of re-admissions in the later phase consisted of 1 case each of urinary tract infection, intestinal obstruction, anastomosis leakage, chyle leakage, enterocutaneous fistula, and epididymitis. The intergroup difference in re-admission rate was not significant (8.7% vs. 5.1%, $p = 0.37$).

Postoperative course

The postoperative recovery in the later phase was faster than that in the initial phase; the time to first flatus (2.9 ± 1.1 vs. 2.3 ± 1.6, $p = 0.02$) and resumption of oral intake (3.1 ± 1.1 vs. 2.2 ± 1.3, $p < 0.01$) in the later phase was significantly lesser than that in the initial phase. However, this did not lead to shorter hospital stay (8.4 ± 3.8 vs. 8.8 ± 7.5, $p = 0.72$). The intergroup differences in the complication rate, re-intervention rate, and re-admission rate were not significant. In the initial phase, 1 patient had anastomosis leakage, and the patient underwent an LAR and developed a rectovesical fistula. In the later phase, 6 patients had anastomosis leakage. Of these, 1 underwent an RH and had massive intraoperative bleeding, which resulted in ischemic change of bowel anastomosis, 1 underwent an AR and had clinical obstruction, while the other 4 underwent LARs. Of these patients, 1 was converted to an open surgery because of invasion to the retroperitoneum, small bowel, and urinary bladder, whereas 1 patient underwent coloanal anastomosis along with creation of a protective stoma after a complete course of concurrent chemoradiation therapy and the remaining 2 patients underwent transverse loop colostomy for middle rectal tumors.

There was no surgical mortality in both groups (Table 3). No mortality was recorded within after 30 days of the surgery. In the initial phase, the reasons for re-intervention within 30 days were anastomosis leakage and intestinal obstruction. In the later phase, the reasons for re-intervention within 30 days were anastomosis leakage (6 cases), chyle leakage (1 case), and intestinal obstruction (1 case).

Tumor characteristics

The result for the tumor stage, T-stage, N-stage, tumor size, proximal and distal margins were not significantly different for the 2 groups. Positive lateral margin was detected for 1 case in the later phase (invasion of viseral serosal layer). The number of harvested lymph nodes in the later phase was higher than that in the initial phase (14.3 ± 8.2 vs. 18.1 ± 9.2, $p < 0.01$, Table 4).

Discussion

Laparoscopic colectomy has been a widely accepted and practiced treatment method for colon cancer since the COST study and COLOR trial showed that the oncological outcomes of laparoscopic surgery and open colectomy are similar.[6,7] Recently, the COREAN trial showed that laparoscopic surgery is feasible after preoperative chemoradiation therapy for middle or low rectal cancer.[12] In 2006, 10.4% of all colorectal resections in the United Kindom, and 32.6% in the United States, were performed laparoscopically.[13] These numbers have probably increased since then. In Taipei Veteran's General Hospital, we have been performing laparoscopic colorectal resection since 1993. This technique is now performed regularly; in addition, an increasing number of patients prefer laparoscopy-assisted surgery. In the first 5 years (1993-1998), 98 patients underwent laparoscopic surgery and 34 (34.7%) of them had malignant diseases. During 2004-2009, 570 laparoscopic colorectal surgeries were performed, and 539 (94.7%) of them had malignancy. The proportion of patients with malignant diseases who underwent laparoscopic surgeries increased from 6.4% in 2006 to 35.5% in 2009; this showed increasing preference for laparoscopic surgery.

Table 3. Postoperative course of the patients who underwent laparoscopic surgery in the initial and later phases

	Initial phase (%) (n = 69)	Later phase (%)(n = 117)	*p* value
First flatus (days, mean ± SD)	2.9 ± 1.1	2.3 ± 1.6	**0.02**
First bowel movement (days, mean ± SD)	4.2 ± 1.4	3.6 ± 2.0	0.12
Resume oral intake (days, mean ± SD)	3.1 ± 1.1	2.2 ± 1.3	**< 0.01**
Post-operative hospital stay (days, mean ± SD)	8.4 ± 3.8	8.8 ± 7.5	0.72
Complications	17 (24.6)	25 (21.4)	0.61
Wound infection	4	7	
Urinary tract infection/retention	3	4	
Ventral hernia	2	1	
Pneumonia	1	2	
Anastomosis leakage	1	6	
Intestinal obstruction	2	2	
Chyle leakage	0	7	
Anastomosis bleeding	0	2	
Deep vein thrombosis/rhabdomyolysis	1	2	
Acute cholecystitis	2	0	
Ureter injury	1	0	
Enterocutaneous fistula	0	1	
Surgical mortality	0	0	-
Re-intervention	2 (2.9)	8 (6.8)	0.33
Re-admission	6 (8.7)	6 (5.1)	0.37

SD: Standard deviation.

Table 4. Tumor characteristics of the patients who underwent laparoscopic surgery in the initial and later phases

	Initial phase (%) (n = 63)	Later phase (%) (n = 111)	*p* value
Tumor stage			0.11
Stage 0	11 (17.5)	10 (9.0)	
Stage I	12 (19.0)	28 (25.2)	
Stage II	11 (17.5)	34 (30.6)	
Stage III	25 (39.7)	31 (27.9)	
Stage IV	4 (6.3)	8 (7.2)	
T-stage			0.31
Tis	11 (17.5)	10 (9.0)	
T1	14 (22.2)	22 (19.8)	
T2	5 (7.9)	8 (7.2)	
T3	33 (52.4)	68 (61.3)	
T4	0 (0)	3 (2.7)	
N-stage			0.37
N0	34 (54.0)	72 (64.9)	
N1	21 (33.3)	28 (25.2)	
N2	8 (12.7)	11 (9.9)	
Tumor size (maximum diameter in cm) (mean ± SD)	3.4 ± 1.8	3.7 ± 1.7	0.32
Number of harvested lymph node number (mean ± SD)	14.3 ± 8.2	18.1 ± 9.2	**< 0.01**
Proximal margin (cm) (mean ± SD)	9.2 ± 6.0	10.2 ± 5.8	0.47
Distal margin (cm) (mean ± SD)	7.1 ± 4.0	8.0 ± 5.8	0.26
Positive lateral margin	0	1 (0.9%)	1.00

SD: Standard deviation.

Intergroup differences for demographic variables, except for ASA scores, were not significant. A trend of higher ASA score was observed in the later phase (Table 1). Kirchhoff et al. showed that an ASA score $\geqq 3$ is an independent predictive risk factor of intra- and postoperative complications.[14] Further, the conversion rate significantly increases with the ASA score.[13] However, in our study, the intergroup difference in the complication rate was not significant and the conversion rate remarkably decreased in the later phase. Hemandas reported good results for laparoscopic resection of colorectal tumor in high-risk patients.[15] Our result are consistent with those of the above-mentioned study and suggest an improved management of high-risk patients in our institution.

The large randomized trials – CLASICC and COLOR, which were conducted during July 1996 to July 2002, and March 1997 to March 2003, respectively, reported conversion rates of 29% and 17%, respectively.[3,5] A conversion rate of 5-10 percent is considered acceptable by experienced laparoscopic surgeons.[8] The conversion rate at our hospital was 14.5% in the initial phase and it reduced to 5.1% in the later phase (Table 2). This result revealed an improved capability of performing laparoscopic surgery.

The proportion of patients who had a previous abdominal surgery increased from 14% in the initial phase to 30% in the later phase ($p = 0.02$, Table 1). In the initial phase, 2 of the 10 patients who had a history of abdominal surgery were converted to open surgery because of dense adhesions; in contrast, in the later phase only 1 of the 35 patients with a history of abdominal surgery was converted (Tables 1, 2). Although the number of cases of resection of other organs in the later phase was higher than that in the initial phase, this difference was not significant (1.4% vs. 7.7%, $p = 0.09$). In the later phase, 4 out of 9 patients underwent laparoscopic surgery for resection of other organs.(a cholecystectomy, an appendectomy, an ileocecal resection and a partial excision of urinary bladder). The reduction of the conversion rate and attempts to manage more difficult cases show our improved competency.

The operative time for RH as well as AR was reduced in the later phase, whereas that for LAR remained similar. Significant differences were not

observed in the operative times for LH, APR, T-colectomy, and segmental resection, likely because too few patients underwent these procedures to produce statistically significant differences. Sigmoid colectomy appears to be the easiest procedure among laparoscopic colorectal surgeries, because the technique for vascular ligation, dissection, and resection are relatively standardized. RH with extracorporeal anastomosis, which is performed at our institute, is thought to be more technically challenging than a sigmoidectomy. These two procedures (RH and sigmoidectomy) have been rated easiest among all laparoscopic colorectal surgeries.[16] The learning curve of these 2 procedures flattened out after about 40 cases; however a similar change in the learning curve for LAR was not observed.[17] This indicates that the operative times of RH and sigmoid colectomy decline with operative experience. There are several possible explanations for the lack of change in the operative time for LAR. First, mobilization of the rectum and splenic flexure requires greater manual dexterity.[16] Second, the practical skills of the assistants and nurses also influence an operation. It is not uncommon for a complex procedure to be slowed due to unfamiliarity of the ancillary staff for the procedure. Third, in the later phase, we attempted more complex surgeries, as evidenced by: more cases had received abdominal surgery before (Table 1) and more synchronous surgeries were done at the same time (Table 2) in the later phase. These reasons may explain why no statistically reduction of operative time for LAR was recorded in the later phase. A similar result was observed in a Korean study.[18]

Time to first flatus (2.9 ± 1.1 vs. 2.3 ± 1.6, $p = 0.02$) and resumption of oral intake (3.1 ± 1.1 vs. 2.2 ± 1.3, $p < 0.01$) in the later phase was lesser than that in the initial phase. However, this did not lead to shortening of hospital stay (8.4 ± 3.8 vs. 8.8 ± 7.5, $p = 0.72$). This can be explained by our patient pool, mostly middle class, who can afford the extra cost of laparoscopic surgery, would prefer to receive postoperative care at the hospital rather than being discharged as soon as possible. The rates of complication, re-intervention and re-admission did not differ in the 2 phases. This may be due to that more difficult cases were attempted in the later phase, thus canceling the benefits of improved skills and experiences.[18]

In the later phase, a positive lateral margin was detected in a patient with a T4aN0 lesion in the sigmoid colon, but no local recurrence developed until now. An insignificant difference in the positive circumferential resection margin of an AR was observed in the Classic trial, which did not lead to any difference in the general oncological effect; however, surgeons should be mindful of the possibility of local recurrences.[5,9] According to the National Cancer Institute (NCI) and AJCC, at least 12 lymph nodes should be harvested and examined for proper staging of colorectal cancer.[20] Laparoscopic surgery been shown feasible to harvest similar number of lymph nodes compared to open surgery.[21,22] Our result showed that adequate number of lymph nodes, in accordance with NCI and AJCC guidelines, was harvested in our institution. More lymph nodes were retrieved in the later phase, which may show improved skills and dexterity.

Another observation was that, in the later phase, chief resident and fellows are allowed more opportunities to perform laparoscopic surgery as the operator under senior supervision (2.9% vs. 17.2%, $p < 0.01$, Table 2). However, the conversion rate, operative time, and amount of blood loss did not significantly change, and some improved. One study showed that similar clinical outcomes were obtained by trainees performing laparoscopic surgery when supervised by experienced surgeons.[13] It is one of the aims of our institution to train colorectal specialist competent in laparoscopic surgery.

Conclusion

Laparoscopic colorectal surgery is widely accepted, and is practiced regularly at Taipei Veteran's General hospital. After the surgeons gained experience, the operative time and conversion rate significantly improved, without any increase in the morbidity and mortality rate. Further, we were able to attempt and manage more difficult cases. The postoperative recovery in the later phase was better and quicker than that in the initial phase. These results indicate that laparoscopic colorectal surgery with

acceptable safety steadily developed in this 2-year period at our training hospital.

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原　著

教學醫院之腹腔鏡手術結果改善

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目的　已有數個大型隨機對照實驗證明，腹腔鏡手術具有和開腹手術相同的短期或長期腫瘤學效果。目前尚未有台灣本地之醫學中心相關研究，本文將敘述本院在發展腹腔鏡大腸直腸手術之兩年經驗。

方法　自民國 96 年 12 月至 98 年 12 月，共 432 位患者於台北榮民總醫院接受腹腔鏡大腸直腸手術。我們選出兩個以半年為期的區段：96 年 7 月至 12 月 (前期) 以及 98 年 7 月至 12 月 (後期) 作為比較。

結果　經驗累積之後，更多有腹部手術史的患者可接受腹腔鏡手術，且在術中轉為傳統開腹手術的比例大為下降 ($p = 0.03$)。除此之外，後期的腹腔鏡右半結腸切除術以及腹腔鏡前位切除術之手術時間明顯縮短 ($p < 0.01$)。淋巴結採樣數目亦有提升 ($p < 0.01$)。前後期之術後致病率，死亡率以及住院天數均無顯著差異。

結論　腹腔鏡手術可成為台灣本土教學醫院之標準作業，而不會增加致病率或死亡率。

關鍵詞　腹腔鏡手術、大腸直腸。