Impact of Laparoscopic Resection for Colorectal Cancer on Operative Outcomes and Survival

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Objective: This study aimed to compare the outcomes of patients who underwent laparoscopic and open resections for colorectal cancer. Comparison of colectomy in 2 consecutive periods (period 1: January 1996–May 2000; period 2: June 2000–December 2004), with laparoscopic surgery being a surgical option in period 2, was also performed.

Summary Background Data: Prospective data of 1134 patients (448 in period 1; 656 in period 2) who underwent elective resection for colon and upper rectal cancer (above 12 cm from anal verge) were analyzed.

Methods: The operative outcome and survival were compared between patients who underwent laparoscopic and open resection in period 2. The outcomes of colorectal resections in the 2 periods were also compared.

Results: During period 2, the operative mortality rates of patients with laparoscopic (n = 401) and open resection (n = 255) were 0.8% and 3.7%, respectively ($P = 0.022$), and the morbidity rates were 21.7% and 15.7%, respectively ($P = 0.068$). The patients who underwent laparoscopic resection had significantly earlier return of bowel function, earlier resumption of diet, and shorter hospital stay. The 3-year overall survivals in those with nondisseminated disease were 74.4% and 78.8% for open and laparoscopic resection, respectively ($P = 0.046$). The operative morality rates were 4.4% and 2.6% in period 1 and period 2, respectively ($P = 0.132$). The 3-year overall survivals for patients with nondisseminated disease were 69.7% and 76.1% for period 1 and period 2, respectively ($P = 0.019$). The overall survivals in patients who underwent open resection in the 2 periods were similar ($P = 0.284$).

Conclusions: The short-term favorable outcome of laparoscopic resection for colorectal cancer was confirmed and improvement of survival was observed with the practice of laparoscopic resection.

(*Ann Surg* 2007;245: 1–7)

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ISSN: 0003-4932/07/24501-0001

DOI: 10.1097/01.sla.0000218170.41992.23

Laparoscopic colectomy was first reported in 1991.[1,2] The procedure, however, has not been widely accepted because it was regarded as a complicated procedure with a steep learning curve.[3,4] Initial concerns on the radicality of the resection and the oncologic outcomes as well as the early reports on the high incidence of wound recurrence[5,6] limited the wide application of laparoscopic colectomy for malignancy.

However, favorable postoperative results in terms of less pain, less consumption of analgesia, early return of bowel function, and shorter hospital stay in patients who underwent laparoscopic colorectal surgery have been persistently reported, both in series with benign and malignant colorectal diseases.[7–10] Recently published randomized trials comparing laparoscopic and open colon resection did not show inferior oncologic results in patients who underwent laparoscopic surgery.[11–13] There are only few reports on comparison of a large number of patients with open and laparoscopic colorectal resection for malignancy and patients with rectal cancer are usually excluded. Laparoscopic colorectal resection was adopted as an option for colorectal cancer from June 2000 in our institution. The present study aimed firstly to compare the short-term outcomes and survival of patients who underwent laparoscopic and open resection for colorectal cancer during the period when laparoscopic resection was practiced (June 2000 to December 2004). In the second part of the study, the outcomes of consecutive patients operated on before and during the practice laparoscopic resection were compared.

METHODS

Consecutive patients who underwent elective resection of primary colon and upper rectal cancer from January 1996 to December 2004 in Department of Surgery, University of Hong Kong Medical Centre were included in the study. Those patients with tumors within 12 cm from the anal verge, emergency operations, surgery without resection, and tumors associated with familial adenomatous polyposis or inflammatory bowel diseases were excluded. In period 1 (January 1996 to May 2000), the resections were performed with open surgery while in period 2 (June 2000 to December 2004), laparoscopic resection was adopted as a surgical option for colorectal malignancies.

During the study period, the majority of the operations were performed or closely supervised by 3 staff colorectal

surgeons. Two performed both laparoscopic and open surgery, while the other performed only open operations. The 2 laparoscopic surgeons had experience in laparoscopic procedures in abdominoperineal resection and colon resection for benign diseases in period 1. The decision to adopt laparoscopic resection for colorectal cancer in period 2 was based on the maturation of laparoscopic techniques.

The diagnosis of colorectal malignancy was confirmed with colonoscopy and biopsy. Preoperative workup included blood tests, chest x-rays, and serum carcinoembryonic antigen. CT scan was not a routine and depended on the availability of the test, especially in the early part of the study. During the latter part, more patients had preoperative CT scan. The surgical approach was decided with the consent of the patients, after thorough discussion on the pros and cons of the approach. The decision also depended on the availability of operating time and laparoscopic surgeons. Patients with large, fixed tumors with invasion to other organs were advised against laparoscopic resection. The patient received mechanical bowel preparation with polyethylene glycol electrolytes solution the day before surgery and prophylactic intravenous antibiotics were administered at the induction of anesthesia. A urinary catheter was inserted after the patient was put under general anesthesia. Nasogastric tube was not used as a routine. Open resections were performed through a midline incision. The extent of resection was determined by the site of the tumor and the method of anastomosis was decided by the surgeon. In surgery for upper rectal cancer, the rectum was mobilized by sharp perimesorectal dissection to keep the visceral pelvic fascia, which enveloped the mesorectum, intact. Total mesorectal excision was not performed for upper rectal cancer. Instead, the rectum and mesorectum was transected 4 to 5 cm below the distal extent of the tumor.[14]

In patients who underwent attempted laparoscopic resections, the peritoneal cavity was accessed by open method and carbon dioxide was insufflated to maintain the intraperitoneal pressure of 10 to 12 mm Hg. Dissection was performed in the majority of patients by ultrasonic dissectors. Vessels were controlled with endoscopic staplers or absorbable clips intracorporeally in most circumstances. Following bowel mobilization and vessel division, the tumor-bearing segment was retrieved through an incision at a convenient site with adequate wound protection. In case of a right-sided colonic lesion, resection and anastomosis would be performed extracorporeally, either by sutures or by linear staplers. A left-sided or rectal anastomosis was performed using a circular stapler, which was inserted transanally. Rectal mobilization and transection followed the same principle as in open surgery.

Conversion was defined as the need for prematurely making the abdominal incision for bowel mobilization and/or vascular control. The necessity for an abdominal incision to deal with any intraoperative complication was also considered conversion.

Operative mortality was defined as deaths that occurred during the same hospital stay or within 30 days following the primary operation. Operative morbidities were defined as complications that contributed to prolonged hospital stay or led to additional interventions or procedures.

Adjuvant Therapy

The policy of adjuvant therapy for patients with upper rectal cancer was similar to those with colon cancer during the study period. Radiation therapy was not given to patients with complete removal of the local disease. Selected patients with fixed T4 cancer would receive preoperative chemoradiation. Chemotherapy was the mainstay of adjuvant therapy in the patients in the study. It was offered to those with stage III disease and patients with stage II disease in the presence of other risk factors. The decision was made jointly by the surgeons, the patients, and the clinical oncologists. The policy of adjuvant therapy did not change during the study period, and 5-fluorouracil-based regimens were used in the majority of patients.

Postoperative Surveillance

Patients were followed up at an interval of 2 to 3 months during the first 2 years and at 4- to 6-month intervals from the third to fifth year. Thereafter, the patients were seen yearly. Follow-up surveillance was performed by history, physical examination, blood tests, and serum carcinoembryonic antigen. If recurrences were suspected, endoscopic examination and CT scan would be performed to determine whether salvage surgery could be performed.

Data Collection and Statistical Analysis

Data on the patients' demographics, medical comorbidities, locations of the tumors, operative details, postoperative outcomes, and follow-up status were collected prospectively and entered into a database for colorectal malignancy. In the comparison of data on patients with laparoscopic and open resection, the analysis was performed according to the intention-to-treat principle. Patients with conversion were analyzed in the laparoscopic resection group.

Comparison of the categorical or ordinal variables was performed using χ^2 test or Fisher exact test where appropriate. Continuous variables were presented in median values and were compared using Mann-Whitney *U* test. Survival was analyzed using Kaplan-Meier method and comparison of variables was performed with log-rank test. Multivariate analysis was performed with Cox regression. *P* values of less than 0.05 were regarded statistically significant.

RESULTS

During period 2 (June 2000 to December 2004), when laparoscopic resection was practiced, 656 patients underwent elective resection for colon and upper rectal cancer. There were 460 men (70.1%) and the median age was 71 years (range, 25–94 years). A total of 255 resections (38.9%) were performed by the laparoscopic approach, whereas 401 patients underwent open resections (61.1%). There were no differences in gender, age, body weight, locations of the tumor, presence of previous surgery, or comorbidities between the 2 groups (Table 1).

The types of operations are shown in Table 2 and the operative details and the postoperative outcomes are shown in Table 3. Palliative resection was performed in 139 patients (21.2%), because of residual local disease (n = 17), the presence of unresectable distant metastasis (n = 118), or the

TABLE 1. Comparison of Demographic and Preoperative Data on Patients With Open and Laparoscopic Colorectal Resection in Period 2

	Open Resection (n = 401)	Laparoscopic Resection (n = 255)	*P*
Gender (M:F)	231:170	129:126	0.091
Median age (yr)	71 (25–94)	71 (29–91)	0.443
Median body weight (kg)	55 (25–96)	55 (25–96)	0.332
Tumor location			0.753
Colon	329 (82.0%)	212 (83.1%)	
Rectum and rectosigmoid	72 (18.0%)	43 (16.9%)	
Medical comorbidity	238 (59.4%)	150 (58.8%)	0.935
Previous abdominal surgery	109 (26.9%)	61 (23.9%)	0.362
ASA 1	66 (16.5%)	44 (17.3%)	0.472
ASA 2	223 (55.6%)	159 (62.3%)	
ASA 3	86 (21.4%)	45 (17.6%)	
ASA 4	3 (0.7%)	1 (0.4%)	
Unknown	23 (5.7%)	6 (2.4%)	

ASA indicates American Society of Anesthesiologists Class.

TABLE 2. Types of Operations Performed With Open and Laparoscopic Approach

	Open Resection (n = 401)	Laparoscopic Resection (n = 255)
Right colectomy	140 (34.9)	100 (39.2)
Left colectomy	34 (8.5)	24 (9.4)
Sigmoid resection	57 (14.2)	28 (11.0)
Anterior resection	136 (33.9)	90 (35.3)
Low anterior resection	12 (3.0)	10 (3.9)
Subtotal colectomy	14 (3.5)	3 (1.2)
Other resections	8 (2.0)	0 (0)

Values are no. (%).

TABLE 3. Comparison of the Operative Details and Results of Patients With Laparoscopic and Open Colorectal Resection

	Open Resection (n = 401)	Laparoscopic Resection (n = 255)	*P*
Palliative resection	85 (21.2%)	54 (21.2%)	1.000
Median operating time (min)	115 (35–464)	162.5 (81–360)	<0.001
Median blood loss (mL)	120 (10–2500)	100 (10–1150)	0.075
Median time to pass first flatus (days)	3 (0–25)	2 (1–9)	<0.001
Median time to pass first bowel motion (days)	4 (0–30)	4 (1–10)	<0.001
Median time to tolerate fluid diet (days)	3 (1–26)	2 (0–10)	<0.001
Median time to tolerate solid diet (days)	4 (2–30)	3 (0–17)	<0.001
Operative mortality	15 (3.7%)	2 (0.8%)	0.022
Overall morbidity	87 (21.7%)	40 (15.7%)	0.068
Reoperation	9 (2.2%)	4 (1.6%)	0.775
Median hospital stay (days)	7 (2–99)	6 (3–72)	<0.001
Stage of disease*			0.101
Stage I	29 (7.2%)	31 (12.1%)	
Stage II	168 (41.9%)	94 (36.8%)	
Stage III	131 (32.7%)	76 (29.8%)	
Stage IV	73 (18.2%)	54 (21.2%)	
Median size of tumor (cm)	4.5 (0.3–18)	4.0 (0.5–15.0)	0.076
Median no. of lymph nodes examined	11 (1–58)	11 (0–38)	0.858

*Staging according to the American Joint Committee on Cancer.

presence of both residual local and distant diseases (n = 4). The operating time for patients who underwent laparoscopic colectomy was significantly longer; however, the median blood loss was less, although it did not reach statistical significance. In those patients with successful laparoscopic procedures, the median length of the incision was 5.0 cm (interquartile range, 5.0–5.9 cm).

Seventeen patients died in the postoperative period (2–99 days) and the operative mortality was 2.6%. The operative mortality rates of the open and the laparoscopic group were 3.7% and 0.8%, respectively ($P = 0.022$). In those with open surgery, the causes of postoperative mortalities were pulmonary embolism (n = 2), ischemic heart disease (n = 1), pneumonia (n = 4), bowel ischemia (n = 2), anastomotic leakage (n = 1), intra-abdominal abscess (n = 1), liver failure (n = 1), sepsis of unknown source (n = 1), spinal cord compression (n = 1), and advanced malignancy (n = 1). Two patients with attempted laparoscopic resection died 22 and 30 days after the operation. One patient with conversion died of liver failure and pneumonia, while the other developed bleeding duodenal ulcer, which required reoperation, and he subsequently died of multiorgan failure. The operative mortality of the patients with laparoscopically completed operations and those with conversion were 0.4% and 4.3%, respectively ($P = 0.173$, Fisher exact test).

Patients with laparoscopic resection had an earlier return of bowel function and an earlier resumption of diet intake. There was no difference in the stage of the diseases between patients with open and laparoscopic resections. The size of the tumor and the number of lymph nodes harvested were also similar in the 2 groups. The hospital stay, however, was significantly shorter in patients who underwent laparoscopic resection.

In patients with rectal and rectosigmoid cancer, the majority had anastomosis above 5 cm from the anal verge and only 11 patients (8 in open and 3 in laparoscopic group) had an anastomosis within 5 cm from the anal verge. The median distal resection margins (before fixation) of the open and laparoscopic groups were 4.75 cm and 5.0 cm, respectively ($P = 0.155$).

Twenty-three patients who underwent initial laparoscopy required conversion. The reasons for conversion were advanced tumors invading neighboring organs (n = 9), adhesions (n = 8), inability to locate the tumors (n = 2), positive leakage test (n = 2), bleeding (n = 1), and presence

TABLE 4. Complications Following Colorectal Resection for Cancer During Period 2

	Open Resection (n = 401)	Laparoscopic Resection (n = 255)	*P*
Cardiopulmonary	37 (9.2)	16 (6.3)	0.189
Anastomotic leak	5 (1.2)	1 (0.4)	0.389
Deep vein thrombosis/ pulmonary embolism	4 (1.0)	3 (1.2)	1.000
Wound complications	9 (2.2)	5 (2.0)	0.519
Ileus/intestinal obstruction	14 (3.5)	9 (3.5)	1.000
Intra-abdominal sepsis without leakage	3 (1.7)	0 (0)	0.286
Gastrointestinal bleeding	1 (0.3)	3 (1.2)	0.305
Bowel ischemia	2 (0.5)	0 (0)	0.524
Perforated peptic ulcer	0 (0)	1 (0.4)	0.389
Sepsis without documented sources	3 (0.8)	1 (0.4)	1.000
Renal failure	2 (0.5)	0 (0)	0.524
Cerebrovascular accident	2 (0.5)	0 (0)	0.524
Pancreatitis	1 (0.3)	0 (0)	1.000
Urinary tract infection	3 (0.8)	6 (2.4)	0.097
Cholangitis	1 (0.3)	0 (0)	1.000
Urinary retention	2 (0.5)	6 (2.4)	0.061
Spinal cord compression	1 (0.3)	0 (0)	1.000
Liver failure	1 (0.3)	0 (0)	1.000

Values are no. (%).

of multiple tumors (n = 1). Those patients with conversion had a higher incidence of complications (43.5% vs. 12.9%, $P = 0.001$) and the hospital stay was significantly longer than those with laparoscopically successful operations (8.5 days vs. 6.0 days, $P = <0.001$).

Complications occurred in 127 patients (19.3%). The details of the complications are shown in Table 4. The overall morbidity rate of patients with attempted laparoscopic resection was lower than those with open resection, although it did not reach statistical significance. The complication rates of open surgery, laparoscopically completed operations, and laparoscopic surgery with conversion were 21.7%, 12.9%, and 43.5%, respectively. The overall morbidity of laparoscopically completed operations was significantly less than that of open surgery ($P = 0.006$) or surgery with conversion ($P = 0.001$).

Survival Analysis

In patients with stage IV disease, the median survival of patients with laparoscopic surgery and open surgery were 15.13 months and 15.03 months, respectively ($P = 0.65$). The median follow up of the surviving patients with nondisseminated disease (stage I–III) was 22.1 months. Comparison of the survival is shown in Figure 1. The 3-year survivals were 74.4% and 78.8% for open and laparoscopic resection, respectively ($P = 0.046$). The survivals of patients with stage I to stage III disease are shown in Figures 2 to 4. Other factors that affected the overall survival of the patients were the presence of lymph nodes metastasis ($P = 0.007$), and age over 70 years ($P = 0.010$). On multivariate analysis, the

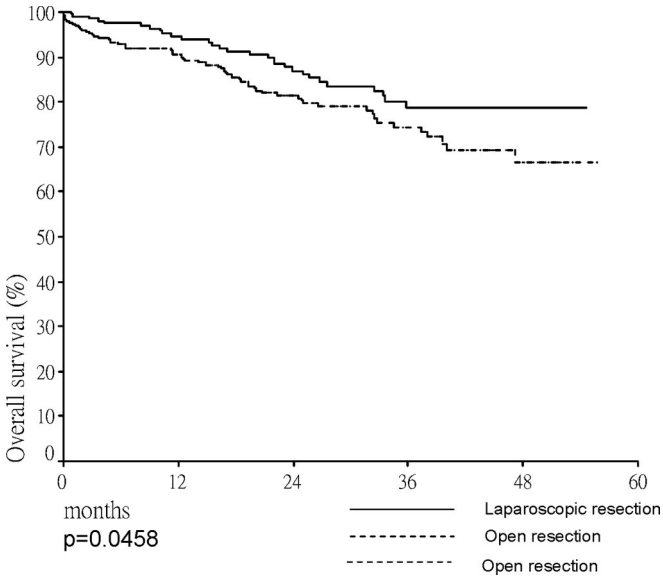

FIGURE 1. Comparison of survival of patients with stage I to stage III disease who underwent open and laparoscopic surgery.

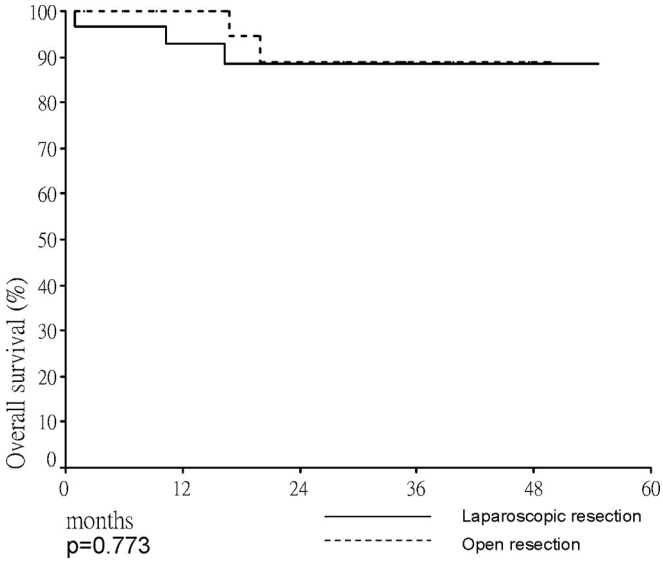

FIGURE 2. Comparison of survival of patients with stage I disease who underwent open and laparoscopic surgery.

surgical approach ($P = 0.036$, hazard ratio = 1.606; 95% confident interval, 1.032–2.499), the presence of lymph nodes metastasis ($P = 0.007$, hazard ratio = 0.568; 95% confident interval, 0.377–0.858), and age over 70 years ($P = 0.008$, hazard ratio = 0.561; 95% confident interval, 0.364–0.863) were independent factors affecting overall survival.

Comparison of Outcome of Surgery of 2 Successive Periods

When the patients of the 2 periods were compared, there were no differences in the gender, sites, and stage of tumors (Table 5). The operative mortality was lower in the

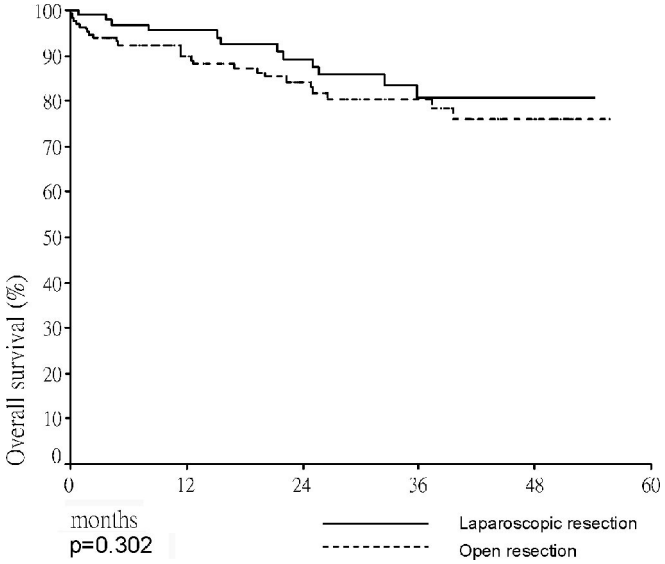

FIGURE 3. Comparison of survival of patients with stage II disease who underwent open and laparoscopic surgery.

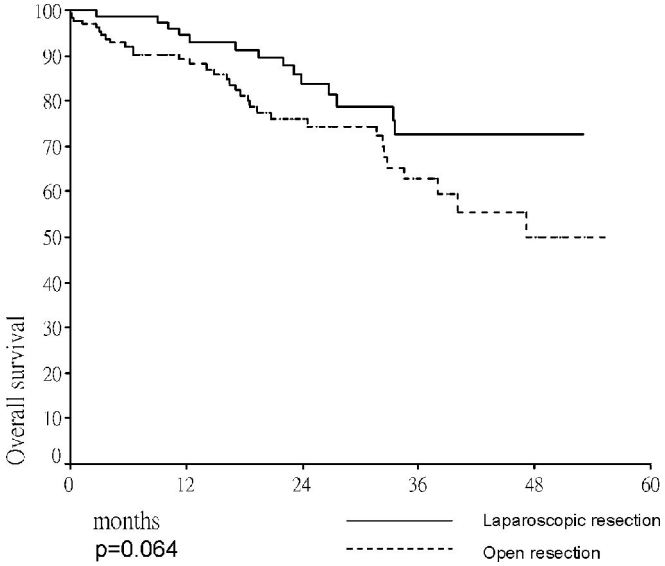

FIGURE 4. Comparison of survival of patients with stage III disease who underwent open and laparoscopic surgery.

second period, although it did not reach statistical significance. However, the operative mortality of those with laparoscopic surgery was significantly lower than that of open surgery in period 1 (4.4% vs. 0.8%, $P = 0.007$) and period 2 (3.7% vs. 0.8%, $P = 0.022$). The mortality of open surgery did not show any difference between the 2 periods (4.4% vs. 3.7%, $P = 0.733$).

The operative morbidity was similar was in the 2 groups. There was no significant difference between open resections of the 2 periods. Although the morbidity of laparoscopic resection was lower in patients with laparoscopic resection, it did not reach statistical significance.

TABLE 5. Comparison of Patients' Characteristics and Operative Outcomes in the 2 Periods

	Period 1 (n = 478)	Period 2 (n = 656)	*P*
Gender (M:F)	271:207	360:296	0.546
Median age (yr)	71 (26–91)	71 (25–94)	0.911
Site of tumor			0.437
Colon	385 (80.5%)	541 (82.5%)	
Rectum and rectosigmoid	93 (19.5%)	115 (17.5%)	
Palliative resection	96 (20.1%)	141 (21.5%)	0.605
Operative mortality	21 (4.4%)	17 (2.6%)	0.132
Operative morbidity	97 (20.3%)	127 (19.4%)	0.655
Median hospital stay (days)	9 (5–52)	7 (2–99)	0.001
Stage I	49 (10.3%)	60 (9.1%)	0.278
Stage II	204 (42.7%)	262 (39.9%)	
Stage III	152 (31.8%)	207 (31.6%)	
Stage IV	72 (15.1%)	127 (19.4%)	

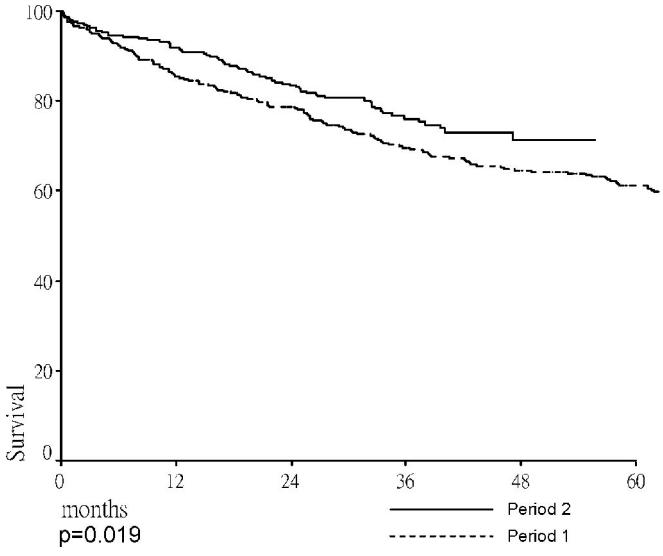

FIGURE 5. Comparison of overall survival of patients during period 1 and period 2.

The median survivals of patients with stage IV disease were 7.63 and 15.13 months in period 1 and period 2, respectively ($P = 0.076$). In those patients with nondisseminated disease, the survival curves are shown in Figure 5. The 3-year survivals were 69.7% and 76.1% for period 1 and period 2, respectively ($P = 0.019$). When only patients with open surgery were considered, there was no difference in the survival (Fig. 6). However, survivals of patients with laparoscopic resection were better than those with open surgery, both in period 1 ($P = 0.041$) and period 2 ($P = 0.046$).

DISCUSSION

In contrast to other studies on laparoscopic surgery for large bowel cancer, which usually excluded rectal neoplasm,[11,12] patients with upper rectal cancer were included in the current study. This was because previous reports showed

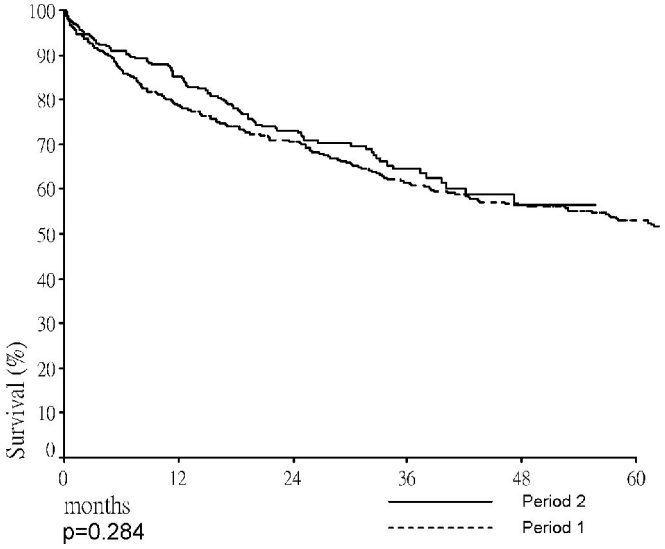

FIGURE 6. Comparison of survival of patients with open surgery during period 1 and period 2.

that the pattern of recurrence and survival of patients with upper rectal cancer were similar to those of sigmoid cancer[15] and technically anterior resection for upper rectal cancer does not differ significantly from surgery for a sigmoid cancer. In our institution, the treatment protocol and the policy of adjuvant therapy for upper rectal cancer (cancer with lower border more than 12 cm from the anal verge) were similar to those of colon cancer.[14] We performed sharp mesorectal dissection and partial mesorectal excision for upper rectal cancer and adjuvant radiation was only offered preoperatively to those with fixed T4 disease or postoperatively to those with residual disease. Adjuvant therapy was based on chemotherapy with the regimen similar to that for colon cancer.

In the current study, consecutive patients were included instead of performing a case-controlled study because in addition to comparing the outcomes of laparoscopic and open resections for colorectal cancer performed in the same period, we would also like to investigate the impact of adopting the laparoscopic approach by comparing the results of colorectal resection in 2 successive periods. By including consecutive patients, the impact of the practice of laparoscopic resection on outcome in a center with a large volume of colorectal resection could be evaluated.

In the period when laparoscopic resection was practiced, it was shown, in consistence with other studies, that the laparoscopic resection was associated with more favorable short-term outcomes. Patients who underwent laparoscopic resection had a shorter duration of ileus and an earlier resumption of diet. The hospital stay was also significantly shorter in the laparoscopic group. Although we did not experience tremendous pressure for a short hospital stay and early discharge, the median hospital stay in our patients with laparoscopic resection was 6 days, which is similar to that of studies in the North America with patients of similar age.[9,11,16]

The overall operative mortality of all the patients was 3.4%, and this is comparable to other high-volume centers with analysis of large number of patients.[17] The operation mortality is the result of our aggressive policy toward surgical resection and very few patients were declined of surgery. Moreover, the majority of operations were performed on elderly patients with concomitant medical diseases and over 20% of resections were palliative operations performed in patients with advanced local or distant diseases. Indeed, the majority of the mortalities were due to medical causes.

Although there was no change in operative mortality in open resection in the 2 periods, a significantly lower mortality was found in patients with laparoscopic resection. The operative mortality of laparoscopic resection was 0.8%, which was significantly lower than that of open surgery in both periods. Selection bias is certainly difficult to avoid in this nonrandomized study; however, the adoption of laparoscopic resection in period 2 helped to reduce the operative mortality from 4.4% in the first period to 2.6% during the second period. The favorable postoperative outcome was probably the main reason that helped to reduce the mortality of patients, particularly those of elderly age and those with advanced disease. The better cardiopulmonary recovery and few cardiopulmonary complications following laparoscopic resection have been well documented.[16,18,19]

The morbidity also tended to be lower in the laparoscopic group, although it did not show any significant statistical difference when the data were analyzed according to the intention-to-treat principle. When the morbidity of the laparoscopically successful procedures was considered, the morbidity is actually significantly lower than that of open surgery or those with conversion. The conversion rate in this series was 9.0%, which compared favorably with other studies.[11,13,16] Whether conversion affects surgical outcome is controversial. Casillas et al[20] found that the outcome of patients with conversion was similar to those with open surgery. However, others reported worse outcome in patients with conversion.[21,22] In this study, patients with conversion were found to have a higher complication rate and a longer hospital stay. What is definitely certain is that patients with conversion cannot derive the benefit of laparoscopic surgery, and the result will only be comparable to that of open resection. A better selection of patients to avoid conversion is definitively necessary to improve the operative outcome of laparoscopic surgery. An early conversion in case of difficulty is also recommended to save the operating time and the cost of the instrument, as well as to avoid complication due to difficult dissection.

We adopted an aggressive policy for stage IV diseases, and resection of the primary lesion was usually performed except in those with very high operative risk to avoid bleeding and obstruction due to the primary cancer. In addition, during the study period, new chemotherapeutic agents were not widely available to patients with stage IV diseases. In patients with stage IV disease, no difference in the survival of patients with laparoscopic or open resection could be demonstrated. However, the favorable short-term outcome and early discharge from hospital can help to improve the quality of life of patients who have advanced disease and limited life expectancy.

The better survival of patients who had nondisseminated disease and underwent laparoscopic resection was an unexpected finding. In most of the case studies or randomized trials, the long-term survival of patients with laparoscopic resection was similar to those who underwent open procedures.[11,13,23] However, better long-term survival in patients with laparoscopic resection has been also reported. In the Lacy et al study,[12] which randomized 219 patients to either open or laparoscopic surgery for colon cancer, the probability of survival was better in the laparoscopic group. The improvement was attributed to the better survival of patients with stage III disease. Capussotti et al[24] also found that in lymph node-positive patients who underwent laparoscopic colonic resection, a better survival could be achieved. The better results might be attributed to the favorable immunologic response and less stress response in patients with laparoscopy. The current study also showed that patients who underwent laparoscopic resection had better survival and the surgical approach was found to be an independent factor associated with better survival in multivariate analysis. Although we could not fully explained the better survival in the patients with laparoscopic resection, the improvement in survival was most obvious in patients with stage III disease and this confirmed others' results.[12,24]

In this study, we also demonstrated that the overall survival was better in the period when laparoscopic resection was practiced. The improvement is mainly due to better outcome in patients with laparoscopic surgery as the survival was similar in patients who underwent open resection during the 2 study periods. The similarity in outcome in open surgery is not unexpected as the patients' demographics, operative techniques, and adjuvant therapy were similar during the 2 periods.

Admittedly, the present study suffers from all the drawbacks of a nonrandomized trial. Selection bias might exist despite similar patients' demographics in the open and laparoscopic groups. However, by including consecutive patients with elective surgery, the operative results of the patients could be obtained. Moreover, by including consecutive patients in the 2 periods, the favorable outcomes following the adoption of laparoscopic surgery could be demonstrated.

CONCLUSION

This study confirmed the favorable short-term operative results in patients who underwent laparoscopic resection of colon and upper rectal cancer. The operative mortality of laparoscopic resection was 0.8%, and this contributed to the reduction of operative mortality in the period with the practice of laparoscopic resection. Better survival of patients with nondisseminated disease who underwent laparoscopic resection was also demonstrated and this contributed to the improved overall survival of patients in the period when laparoscopic resection was practiced. These favorable findings of laparoscopic resection for colorectal malignancy certainly warranted further investigations and studies.

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