Laparoscopic Colectomy for Colon Cancer: Comparable to Conventional Oncologic Surgery?

Ricardo M. Bonnor, M.D.¹ and Kirk A. Ludwig, M.D.¹

ABSTRACT

As a result of the obvious benefits of laparoscopic cholecystectomy, minimally invasive techniques have been applied to more complex gastrointestinal procedures, including colorectal resections. The goal in adapting laparoscopic techniques for colorectal surgery is to offer an operation that results in less pain, shorter hospital stay, more rapid return to normal activities, and improved cosmesis compared with conventional operation. The challenge has been to show that this can be done safely and efficiently and that for cancer patients there is no detrimental oncologic effect. The major issues that have been and continue to be addressed are (1) whether an adequate resection can be performed laparoscopically, (2) whether there is a high rate of wound or port site recurrence following these operations, and (3) whether, by using these techniques, we are trading short-term benefits for a poor long-term oncologic outcome. To answer these fundamental questions, several prospective randomized trials have been conducted and several more are under way. The results of these trials indicate that, in terms of cancer outcome, there is no difference in overall survival, disease-free survival, and wound recurrences in patients treated using laparoscopic techniques compared with conventional operation. In addition, there are short-term benefits associated with the use of these techniques. It can now be said that from an oncologic standpoint, in experienced hands, laparoscopic colectomy for curable colon cancer is equivalent to conventional therapy, and it is superior to conventional operation regarding short-term outcomes. Laparoscopic colectomy for colon cancer should be offered to appropriately selected patients.

KEYWORDS: Laparoscopy, colon cancer, laparoscopic colectomy

Objectives: Upon completion of this article, the reader should be able to understand the evolution and current role of minimally invasive surgery in the treatment of colon cancer.

Worldwide, colon cancer is the second most common gastrointestinal malignancy.¹ Surgery is the basis of treatment for most patients with colon cancer and the primary component of any curative treatment

plan. Overall, more than 50% of colon cancer patients are cured by surgery alone. It is no surprise, then, that a basic and critical issue in the care of colon cancer patients is the conduct of the colon cancer operation. Since the

Colon Cancer; Editor in Chief, David E. Beck, M.D.; Guest Editor, Kirk A. Ludwig, M.D. *Clinics in Colon and Rectal Surgery*, volume 18, number 3, 2005. Address for correspondence and reprint requests: Kirk A. Ludwig, M.D., Department of Surgery, Duke University Medical Center, Duke Hospital North, Rm. 3454B, Durham, NC 27710. E-mail: ludwi002@mc.duke.edu. ¹Department of Surgery, Duke University Medical Center, Durham, North Carolina. Copyright © 2005 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: + 1(212) 584-4662. 1531-0043,p;2005,18,03,174,181,ftx,en;ccrs00226x.

introduction of laparoscopy for the management of gallbladder disease, surgeons have gradually applied this minimally invasive technique to treat other conditions of the gastrointestinal tract. Because of the proven benefits of minimally invasive surgery, there was great initial enthusiasm for the treatment of colonic malignancy.² However, application of minimally invasive techniques to the treatment of colon cancer has not proceeded at a rate comparable to their application and adoption for treatment of other intra-abdominal disease processes.^{2,3} Several early reports documented safety and efficacy; however, there were fundamental issues centered on oncologic concerns.²⁻⁵ Reports of early port site and wound recurrences led to the speculation that this minimally invasive approach might be harmful rather than beneficial.⁶⁻⁹ Very basic concerns over oncologic issues led to a near moratorium on applying these techniques to the treatment of curable colon cancer outside clinical trials. Early results from these trials are encouraging, and it is becoming increasingly clear that in the hands of experienced surgeons, for appropriately selected patients, laparoscopic techniques can be applied to the treatment of colon cancer patients with short-term benefits and equivalent long-term oncologic outcomes.

This article traces the evolution of laparoscopic surgery for colon cancer, highlighting the concerns and how they have been addressed. The major issues addressed are whether adequate resections can be performed using these techniques, whether wound or port site recurrence is the major issue that early reports suggested it was, and, finally, whether these techniques result in short-term benefit for patients while achieving a good long-term oncologic outcome.

LAPAROSCOPIC COLECTOMY

Laparoscopic colon surgery is different from most other types of intra-abdominal laparoscopic surgery and would definitely fall within the category of an "advanced" laparoscopic procedure. These operations take place in multiple quadrants. Even a rather straightforward right colectomy requires work in the right lower and upper quadrants and can involve work in the left upper quadrant, depending on the extent of the resection. The multiquadrant nature of these procedures has implications for port placement and positioning of the patient, the monitors, and the surgical team. Second, these procedures involve control and ligation of major, named mesenteric vessels located at the base of the mesentery, where exposure can be problematic. For the right colon, the ileocolic vessels must be controlled and the short and often multiple middle colic vessels must be managed. For the left colon the surgeon must manage the inferior mesenteric artery, the superior hemorrhoidal vessels, the left colic artery, and often the inferior mesenteric vein. These major mesenteric vessels are particularly problem-

atic as they are often hidden in a thick, fatty, and frequently inflamed mesentery. The surgeon must be keenly aware of normal and variant mesenteric vascular anatomy to facilitate efficient dissection. And finally, at the end of the procedure, there is a large specimen that needs to be removed and an anastomosis that needs to be fashioned.

Because this is an advanced laparoscopic procedure, there appears to be a steep learning curve.¹⁰ During this learning curve, operative times may be prolonged, technique-associated complication rates may be higher, and conversion rates may be significant. Factors such as the operator's experience with more basic laparoscopic procedures, the types of cases selected, and the experience of the assistants have an impact on the learning curve. It appears from several studies that a leveling takes place somewhere between the 20- to 50-case mark, although some would argue that at least 50 cases are needed before a breakpoint in efficiency is reached.¹¹⁻¹³ Although the exact number of cases needed to overcome the learning curve is debatable, both the Clinical Outcomes of Surgical Therapy (COST) trial group and the Colon Carcinoma Laparoscopic or Open Resection (COLOR) trial group decided that each participating surgeon had to demonstrate experience with at least 20 laparoscopic cases to be included as an investigator.^{14,15}

Adequacy of Laparoscopic Colon Cancer Resection

An oncologic colon cancer operation involves proximal lymphovascular pedicle ligation and complete lymphadenectomy, wide en bloc resection of the tumor-bearing bowel segment with adjacent soft tissue and mesentery, and utilization of measures to minimize the chances of intraluminal tumor spread and/or spillage of tumor in the abdomen or the wound. In addition, a thorough intra-abdominal exploration must be conducted. A very basic initial concern was whether these objectives could be achieved using laparoscopic techniques. To answer this question, Milsom and Fazio conducted cadaver dissections and resections.¹⁶ These investigators reported that, based on their cadaver work, they felt that for right and left laparoscopic colectomy, the anatomic extent of resection did not differ from that obtained by using conventional resection techniques. This served, at least initially, as evidence that an adequate oncologic resection could be performed successfully through a laparoscopic approach.

Several clinical studies followed that supported their contention.¹⁷⁻²³ Ultimately, the adequacy of any cancer operation is measured by short- and long-term oncologic results. Lacking this type of information, several early studies used surrogate markers such as length of bowel resected, number of lymph nodes retrieved, estimated blood loss, and early morbidity and

Table 1 Lymph Node Yield of Laparoscopic versus Open Colectomy

Author	Laparoscopic, Mean (Range)	Open, Mean (Range)
Lujan ⁴³	6.6 (0–22)	7.44 (0–28) NS
Stage ⁴⁸	7 (3–14)	8 (4–15) NS
Lord ²⁴	Right 11.6	10.1 NS
	Left 7.8	8.9 NS
Bokey ²³	17	16 NS
Buchman ¹¹	Right 13	13 NS
	Sigmoid 16	10 NS
	Left 12.5	9.5 NS
Peters ⁵	Right 9.0	8.5 NS
	Sigmoid 7.3	4.7 NS
Gellman ³⁷	9.3	9.5 NS

NS, not statistically significant.

mortality in an attempt to prove that equivalent operations could be performed laparoscopically.¹⁸ In a multicenter retrospective study of 66 patients, Falk and coworkers found no statistically significant difference in the number of lymph nodes removed in sigmoid and right colectomy specimens compared with conventional controls.²² A study by Bokey et al demonstrated no clinically significant difference in resection margins and lymph node harvest when comparing open and laparoscopic right colectomies.²³ Lord et al also reported on a 3-year experience showing that the mean number of lymph nodes harvested in laparoscopic resection for carcinoma was 8.5 and the average closest tumor margin was 4.5 cm.²⁴ These numbers were not different statistically from those reported for open or converted laparoscopic colectomies performed during the same time period. Results of these and other studies examining these issues are included in Table 1.

Regarding the issue of whether laparoscopic surgery allows an adequate intra-abdominal exploration, it appears that the answer is yes.²⁵ Certainly, peritoneal disease can be identified and biopsied, and using very sensitive preoperative computed tomography imaging (which should be obtained for any patient being considered for a laparoscopic colon cancer operation) and/or intraoperative laparoscopic ultrasonography, the liver can also be well evaluated.^{26,27}

PORT SITE AND WOUND RECURRENCE

The initial enthusiasm for minimally invasive approaches to the treatment of colon cancer was tempered by early reports of port site recurrences.^{28,29} The presence of exfoliated cells in the abdominal cavity during and after colectomy for colon cancer was known, but reports of port site recurrences raised concerns that the laparoscopic approach itself somehow altered the pattern of tumor cell dissemination.³⁰ This prompted major

research efforts aimed at defining potential mechanisms for port site metastases and potential significant alterations in immune function brought about by pneumoperitoneum.^{31,32} For example, the adherence of tumor cells to surgical instruments had been previously demonstrated; therefore, it was thought that repeated passes of laparoscopic instruments through ports may have led to implantation to exfoliated cells.³⁰ Also, it was surmised that the pressure of the pneumoperitoneum itself might facilitate dissemination of tumor cells through either a direct pressure effect or alteration of peritoneal or systemic immune function, resulting in a survival advantage for implanted cells.³³ The journal letter of Berends et al reporting a 21% incidence of port site recurrence in 14 patients was the final red flag raised on this issue.³³ Thus, in the mid-1990s the American Society of Colon and Rectal Surgeons (ASCRS) issued a position statement recommending that laparoscopic colectomy for curable colon cancer be conducted only under the auspices of controlled trials or in the setting of meaningful prospective evaluation.³⁴

The issue took on great importance and received much attention, and, in time, early fears were allayed. Data from the ASCRS laparoscopic database looking at results of more than 500 patients treated laparoscopically for colon cancer showed that port site or wound recurrence occurred in only 1.1% of patients.¹⁴ During the same year, data from the COST study group were published. These were data collected for 372 patients treated over a 3-year period leading up to the start of the National Institutes of Health (NIH)-sponsored prospective COST trial.³⁴ With a mean follow-up of 22 months, the authors reported a 1.1% incidence of port or wound site recurrence. One of the four patients with recurrences died of cancer, and three of the four recurrences were resected. A series of reports followed in the late 1990s in the form of both large prospective and retrospective reviews, indicating that wound recurrence following laparoscopic colon cancer surgery ranged from 0% to 2.5%^{14,35–45} (Table 2). These data, along with a reappraisal of the incidence of wound recurrence following open colectomy, which was between 1% and 1.5%, began to reduce concern somewhat.

The initial high rates of port or wound site recurrence were probably a result of technical issues with these new techniques. With time, it became clear that the risk of these recurrences did not appear to be higher after laparoscopic compared with open colectomy. This effectively disproved the role of pneumoperitoneum in tumor cell dissemination because a similar recurrence pattern took place in open cases. Similarly, other investigators suggested, on the basis of data from animal studies, that wound recurrences are more likely a consequence of direct tumor manipulation and poor technique.⁴⁰ Dissemination and/or parietal inoculation has been observed for all intra-abdominal malignancies.

Table 2 Wound Recurrence (WR) after Laparoscopic Resections

Author (year)	N/Total	Follow-up (mo)	WR (%)
Fleshman (1996) ³⁶	4/372	—	1.1
Gellman (1996) ³⁷	1/56	—	1.8
Franklin (1996) ³⁸	0/191	31	0.0
Lacy (1997) ³⁹	1/106	6	0.9
Leung (1999) ⁴⁰	1/154	20	0.6
Bohm (1999) ⁴¹	0/63	—	0.0
Poulin (1999) ⁴²	0/135	24	0.0
Lechaux (2002) ^{42a}	1/206	—	0.5
Lumley (2002) ^{42b}	1/181	71	0.6
Lujan (2002) ⁴³	2/182	—	1.0
Lacy (2002) ⁴⁴	1/106	44	0.9
Patankar (2003) ⁴⁵	3/176	53	1.7
COST (2004) ¹⁴	2/435	52	0.5

COST, Clinical Outcomes of Surgical Therapy.

Wounds provide an environment rich in factors that can support tumor cell growth. If tumor cells are delivered to wounds in large enough numbers, they may grow. It seems that the key to avoiding this problem is to avoid delivering the inoculum. The following rather simple measures to avoid port or wound site recurrence are recommended: (1) secure ports so that they do not move in and out of the abdominal wall during the case; (2) do not directly grasp the tumor; (3) do not open the tumor-bearing segment of bowel within the abdomen; (4) before extracting a specimen or removing ports, evacuate pneumoperitoneum through open ports so that it comes out through the ports rather than rushing out through port wounds; (5) protect extraction wounds with a wound protector or remove the specimen in a bag; and (6) irrigate wounds with a cytotoxic solution before closing.

SHORT-TERM BENEFITS OF LAPAROSCOPIC COLECTOMY

Theoretic advantages of laparoscopic colorectal surgery include a reduction in postoperative morbidity and

mortality, less pain, quicker recovery of intestinal motility, shorter hospital stay, quicker return to a normal lifestyle, and an improved cosmetic result leading to a better body image. There are data to support laparoscopic advantages in each of these areas.⁴¹ Much of the short-term benefit data comes from retrospective and case-control studies. There are, however, several prospective, randomized trials that have borne out the advantages of the minimally invasive approach in relation to all of the preceding variables. A critical review of these studies shows that the benefits, while favoring the laparoscopic approach, have been relatively modest compared with the dramatic differences demonstrated for other intra-abdominal laparoscopic procedures. The short-term benefit data from the large prospective, randomized trials are outlined in the following (Table 3).^{45a-d}

Do these short-term benefits lead to a better quality of life (QOL) for patients after laparoscopic compared with open colectomy? One case-control study involving elderly patients showed that a significantly larger percentage of patients in the laparoscopic group retained their independent status on dismissal from the hospital. Again, however, a critical review of the literature shows that there has been some difficulty in demonstrating dramatic advantages for the laparoscopic approach, the best example being the short-term QOL results published by the surgeons participating in the National Cancer Institute (NCI) trial.³⁵ The preliminary report for short-term QOL outcomes in this study of 448 patients showed only minimal short-term QOL benefits of laparoscopic colectomy for colon cancer compared with standard open colectomy.⁴⁶ One must remember, however, that data for this study were evaluated on an intent-to-treat basis and there was a fairly high (> 20%) conversion rate. When the data are analyzed on the basis of how the operation was completed, the differences become more clear. Although the science of proving the short-term and QOL advantages of laparoscopic colectomy has been a bit disappointing, in our opinion, the bedside postoperative visit test is clearly in favor of laparoscopy. It may be that we simply do not have the proper tools or sensitive enough tests to quantify this impression.

Table 3 Short-Term Benefit Data after Laparoscopic Colectomy

Author (year)	Number of Patients	Less Pain	Significantly Less Pain than Open	Length of Stay	Significantly Less than Open
Stage (1997) ⁴⁸	15	Yes	Yes	5	Yes
Schwenk (1998) ^{45a}	30	Yes	Yes	10.1	Yes
Milsom (1998) ^{45b}	54	Yes	Yes	5.2	No
Curet (2000) ^{45c}	18	—	—	5.2	Yes
Lacy (2002) ⁴⁴	111	—	—	5.6	Yes
Hasegawa (2003) ^{45d}	29	Yes	Yes	5	Yes
COST (2004) ¹⁴	345	Yes	Yes	5	Yes

ONCOLOGIC OUTCOMES

Until recently, only nonrandomized clinical trials supported the role of laparoscopy for malignant disease. Initially, retrospective studies examined cancer outcomes to establish that laparoscopy was not potentially harmful prior to conduct of randomized trials. Investigators from the COST trial retrospectively analyzed data for 372 patients for survival endpoints and compared these results with the most authoritative information on cancer incidence and survival in the United States, the National Cancer Data Base of the American College of Surgeons Commission on Cancer and the Survey of Epidemiology and End Results (SEER) Database.⁴⁶ With a mean follow-up of ~22 months, stage-specific survival curves for laparoscopic colectomy were similar to those following open colectomy, and there was a low (1.1%) incidence of port or wound site recurrence.

Furthermore, prospective data were being gathered by several investigators in the United States and Europe. Lujan et al⁴³ reported good oncologic results of 122 consecutive patients undergoing laparoscopic resection for colon cancer at a single institution.

Franklin et al³⁸ analyzed results for 415 patients (191 laparoscopic). With a follow-up of approximately 3 years for stage I–III patients in the laparoscopic group and approximately 2 years in the open group, the recurrence rate for the laparoscopic group was 13% compared with 19% for the open group. In 2002, Anderson et al,⁴⁷ examining prospectively collected data on 100 laparoscopically treated patients, reported a 5-year survival rate of 75%. There were data suggesting that laparoscopic colectomy was safe and effective for the treatment of colon cancer. However, randomized data representing long-term results were needed to provide firm proof.

The first randomized prospective trial comparing laparoscopic colectomy with open surgery was by Stage and coworkers in Denmark.⁴⁸ Although this study was small, the oncologic safety and feasibility of laparoscopic surgery were demonstrated. The first large study reported was from Lacy and colleagues from Barcelona.⁴⁹ In 2002 they reported the results of a prospective randomized trial conducted over a 5-year period from 1993 to 1998. There were 111 patients in the laparoscopic group and 108 in the open group. Patients with rectal cancer, transverse colon cancer, T4 or obstructing tumors, or metastatic disease and those who had undergone previous colon surgery were excluded. Data were analyzed on an intent-to-treat basis. Statistically significant benefits for short-term variables such as intraoperative blood loss, return of bowel function, initiation of oral intake, and length of hospital stay were demonstrated for the laparoscopic group. Morbidity was lower in the laparoscopic group, although laparoscopic treatment did not affect perioperative mortality. There was no difference in perioperative morbidity, and one port

site implant was reported. With a median follow-up of 43 to 44 months, there was no difference in overall survival; however, there was a difference in cancer-specific survival (91% versus 79%, $p=0.03$). When analyzed by stage, this difference was accounted for by a significant survival advantage only for stage III patients who had been treated laparoscopically. Probability of cancer-related survival was higher in the laparoscopic group ($p=0.02$), and the Cox model showed that laparoscopic treatment was independently associated with reduced risk of tumor relapse, death from any cause, and death from a cancer-related cause compared with open colectomy. Again, the superiority of laparoscopy was due to differences in patients with stage III tumors. The authors concluded that laparoscopic colectomy is more effective than open colectomy for treatment of colon cancer in terms of morbidity, hospital stay, tumor recurrence, and cancer-related survival.

This was an important report containing some very interesting data and argued strongly for the use of laparoscopic techniques to treat colon cancer. However, the study was criticized on several fronts. The primary endpoint was cancer-related survival, and this assumes a 100% detection rate for recurrences, which is unlikely. From a statistical standpoint the study was designed so that a 15% difference was accepted to indicate equivalence (different from the standard 5%), yet when the survival curves are examined, the differences seem less than this 15%, bringing into question the contention that laparoscopic colectomy is “more effective.” Finally, the authors’ final conclusion, based on a cancer-related survival advantage for laparoscopic patients, was based on a difference observed in a fairly small group of only 37 patients. With these fairly small numbers, from a single institution experience, there were concerns about the generalizability of the data.

In May 2004, the long awaited results of the NCI-sponsored, multi-institutional COST study were published (Table 4). This was a noninferiority trial conducted by 66 surgeons at 48 institutions. The primary hypothesis was that disease-free survival and overall survival are not inferior for laparoscopic colectomy compared with open colectomy. The goals of the study were to evaluate cancer outcomes, both disease-specific and overall survival, and patients’ safety in terms of morbidity and mortality and to evaluate patient-related benefits (QOL and cost-effectiveness). A total of 872 patients with adenocarcinoma of the colon were randomly assigned to undergo open or laparoscopically assisted colectomy. Patients with rectal or transverse colon cancer were excluded, as were those with stage IV disease or T4, perforated, or obstructing tumors. From a statistical standpoint, this was a noninferiority trial with an assumed conversion rate of 20%, a standard 3-year survival rate of 80%, and an estimated accrual of 1200 patients over 3 years. It was powered such that the probability of

Table 4 Randomized Trials Investigating Laparoscopic versus Open Resection

Country	Name of Study	Investigator	Start Date	Target Accrual
United States	NIH (COST) trial	H. Nelson	1994	1200
Great Britain	CLASICC	P.J. Guillou	1996	1000
Australia	—	P.J. Hewett	1998	1200
Spain	—	A.M. Lacy	1993	250
Germany	LAPKON	B. Bohm	1998	1200

CLASICC, Conventional versus Laparoscopic-assisted Surgery in Colorectal Cancer; COST, Clinical Outcomes of Surgical Therapy; NIH, National Institutes of Health.

Based on data from Lacy,⁴⁹ and Pikarsky AJ. Updated on prospective randomized trials of laparoscopic surgery for colorectal cancer. *Surg Oncol Clin N Am* 2001;10:639–653.

erroneously concluding that laparoscopic colectomy was worse (when it was really equivalent) was 20% and the probability of erroneously concluding equivalence (when it was really inferior) was only 3% to 10%. The primary endpoint was the time to tumor recurrence. Secondary endpoints included disease-free survival, overall survival, complications, variables related to recovery, and QOL.

Quality control was strict. To participate, a surgeon had to demonstrate expertise with laparoscopic techniques. Each had performed at least 20 laparoscopic colectomies and each had to submit an unedited videotape of a case that was reviewed to assess the adequacy of the oncologic technique. Ongoing quality control included periodic random audits of videotaped cases. All laparoscopic colectomies were performed according to protocol guidelines.

Eligibility criteria included clinical diagnosis of curable colon cancer, consenting adult older than 18 years, no prohibitive scars, and availability of the patient for follow-up. Overall, 872 patients were randomly assigned, and after a small number of exclusions, there were 428 open colectomy patients to compare with 435 laparoscopic patients. The groups were well matched for age, gender, ASA (American Society of Anesthesiologists) classification, number of previous operations, and stage of disease. The median operative time was significantly less for open colectomy (95 versus 150 minutes, $p < 0.001$); however, there were no differences regarding other intraoperative factors such as length of bowel resected, number of lymph nodes harvested, or length of mesentery from bowel wall to proximal point of the pedicle ligation. The conversion rate was ~21%, about what was expected during the study design.

The laparoscopic group fared better in length of hospital stay (5 versus 6 days), use of parenteral narcotics (3 versus 4 days), and use of oral analgesia (1 versus 2 days). Although these differences may seem modest, the hospital stay was 20% shorter after laparoscopy, the laparoscopic patients had a 33% reduction in parenteral narcotic use, and they had a 100% reduction in the use of oral analgesics.

There was no difference between groups for 30-day mortality or intraoperative, postoperative, or

overall complications. There were no between-group differences in overall or stage-specific local recurrence rates, time to recurrence, or overall or stage-specific survival rates. There were three wound recurrences, two in laparoscopic patients and one in an open patient.³⁵

With regard to intra-abdominal staging, although laparoscopy may be perceived as inferior to open operation because of loss of tactile sensation, in this trial the percentage of patients found intraoperatively to have metastatic disease was the same in both groups.³⁵ In addition, overall and in the subset of patients with stage III disease, there was no trend to higher recurrence rates in the laparoscopic group.³⁵ These observations suggest that the technique is not inferior in terms of intra-abdominal staging.

In summary, this important study showed that laparoscopic colectomy, in experienced hands, with selected patients, is similar to open colectomy in terms of safety as measured by operative and perioperative morbidity and mortality; it has advantages over open colectomy in terms of patient-related benefits, such as amount of pain medication used and length of hospital stay; and based on the equivalent cancer outcomes, it is safe to proceed with laparoscopic colectomy in patients with colon cancer.

The COLOR trial is a multicenter European trial with surgeons contributing patients from many countries including Sweden, Italy, France, Spain, The Netherlands, Germany, and the United Kingdom.¹⁵ The trial began in 1997 and will analyze the 3-year cancer-free survival of some 1200 patients. Some preliminary results were published in 2002, at which time more than 850 patients were randomly assigned. As in the COST trial, patients with transverse colon and rectal lesions as well as T4 or metastatic lesions were excluded from participation. To ensure quality control, the surgeon must have completed at least 20 procedures and have demonstrated facility with standardized technique. Gasless laparoscopy and hand-assisted laparoscopy were allowed in the trial. At 46 months after the start of the trial, preliminary data show that the overall recurrence is 6.8%. The distribution of stage of disease is similar to that in the major randomized trials.

Another important randomized trial headed by P.J. Guillou is the Conventional versus Laparoscopic-assisted Surgery in Colorectal Cancer (MRC CLASICC) trial.⁵⁰ This trial has a target accrual of some 1000 patients from Great Britain and will examine recurrence, morbidity and mortality, and disease-free survival specifically in laparoscopy-assisted surgery versus conventional surgery.⁵⁰

SUMMARY

Laparoscopy is now an integral part of the practice of general and colorectal surgery. Although the move toward laparoscopic approaches to many routine intra-abdominal procedures has proceeded rapidly, this has not been the case for laparoscopic colectomy, especially when it is being performed for the curative treatment of colon cancer. As a result of concerns regarding adequacy of resection for cancer and the issue of port and wound site recurrences, there has been much caution. Based on the results of nonrandomized and randomized trials, it can now be fairly said that, in experienced hands, laparoscopic colectomy is equivalent to open colectomy as a treatment for colon cancer. We expect that as good results from large, well-designed, prospective randomized trials continue to emerge and as more experience is gained, the safety, efficacy, and adequacy of these procedures for the treatment of colon cancer will become even clearer. The challenge then will be to train the current generation of surgeons to perform these procedures so that the benefits can be made available to patients on a more widespread basis.

REFERENCES

- Greenlee RT, Murray T, Bolden S, et al. Cancer statistics, 2000. *CA Cancer J Clin* 2000;50:7-33
- Schlinkert RT. Laparoscopic assisted right hemicolectomy. *Dis Colon Rectum* 1991;34:1030-1031
- Guillou PJ, Darzi A, Monson JR. Experience with laparoscopic colorectal surgery for malignant disease. *Surg Oncol* 1993;2:43-49
- Falk PM, Beart RW, Wexner SD. Laparoscopic colectomy: a critical appraisal. *Dis Colon Rectum* 1993;36:28-34
- Peters WR, Bartels TL. Minimally invasive colectomy—are the potential benefits realized? *Dis Colon Rectum* 1993;36:751-756
- Nduka CC, Monson JR, Menzies-Gow N, Darzi A. Abdominal wall metastases following laparoscopic surgery. *Br J Surg* 1994;81:648-652
- Cava A, Roman J, Gonzalez Quintela A, Martin F. Subcutaneous metastasis following laparoscopy in gastric adenocarcinoma. *Eur J Surg Oncol* 1990;16:63-67
- Lacy AM, Delgado S, Garcia-Valdecasas JC. Port site metastases and recurrence after laparoscopic colectomy. A randomized trial. *Surg Endosc* 1998;12:1039-1042
- Wexner SD, Cohen SM. Port site metastases after laparoscopic colorectal surgery for cure of malignancy. *Br J Surg* 1995;82:295-298
- Larach SW, Salomon MC, Williamson PR, et al. Laparoscopic-assisted colectomy: experience during the learning curve. *Coloproctology* 1993;1:38-41
- Buchman P, Christen D. Pro laparoscopic surgery for colorectal cancer. *Dig Dis* 1995;12:296-301
- Fowler DL, White SA. Laparoscopy-assisted sigmoid resection. *Surg Laparosc Endosc* 1991;1:183-188
- Nakajima K, Lee SW, Cocilovo C. Hand assisted laparoscopic colorectal surgery using Gelport. *Surg Endosc* 2003;18:102-105
- Clinical Outcomes of Surgical Therapy Study Group. Clinical outcomes of surgical therapy study group of the laparoscopic colectomy trial. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050-2059
- Wittich PH, Kazemier G, Schouten WR, et al. The colon cancer laparoscopic or open resection (COLOR trial). *Ned Tijdsch Geneesk* 1997;141:1870-1871
- Milsom JW, Fazio VW. Concerns about laparoscopic colon cancer surgery. *Dis Colon Rectum* 1994;37:625-626
- Cawthorn SJ, Gibbs NM, Marks CG. Clearance technique for the detection of lymph nodes in colorectal cancer. *Br J Surg* 1986;73:58-60
- Gray D, Lee H, Schlinkert R, et al. Adequacy of lymphadenectomy in laparoscopic-assisted colectomy for colorectal cancer: a preliminary report. *J Surg Oncol* 1994;57:8-10
- Lacy AM, Garcia-Valdecasas JC, Pique JM, et al. Short term outcome analysis of a randomised study comparing laparoscopic versus open colectomy for colon cancer. *Surg Endosc* 1995;9:1101-1105
- Papagrigoriadis S. Prospective randomized study of laparoscopic versus open colonic resection for adenocarcinoma. *Br J Surg* 1997;84:1173-1174
- Moore JW, Bokey EL, Newland RC. Lymphovascular clearance in laparoscopically assisted right hemicolectomy is similar to open surgery. *Aust N Z J Surg* 1996;66:605-607
- Falk PM, Beart RW Jr, Wexner SD, et al. Laparoscopic colectomy: a critical appraisal. *Dis Colon Rectum* 1993;36:28-34
- Bokey EL, Moore JW, Chapuis PH. Morbidity and mortality following laparoscopic assisted right hemicolectomy for cancer. *Dis Colon Rectum* 1996;39:S24-S28
- Lord SA, Larach SW, Ferrera A. Laparoscopic resections for colorectal carcinoma: a 3 year experience. *Dis Colon Rectum* 1996;39:148-154
- Stone MD, Kane R, Bothe A, et al. Intraoperative ultrasound imaging of the liver at the time of colorectal cancer resection. *Arch Surg* 1994;129:431-435
- Foroutani A, Garland A, Berber E, et al. Laparoscopic ultrasound vs. triphasic computed tomography for detecting liver tumors. *Arch Surg* 2000;135:933-938
- Stewart PJ, Chu JM, Kos SC, et al. Intraoperative ultrasound for the detection of hepatic metastases from colorectal cancer. *Aust N Z J Surg* 1993;63:530-534
- Nduka CC, Monson JR, Menzies-Gow N, Darzi A. Abdominal wall metastases following laparoscopic surgery. *Br J Surg* 1994;81:648-652
- Vukasin P, Ortega AE, Greene FL, et al. Wound recurrence following laparoscopic colon cancer resection: results of the

- American Society of Colon and Rectal Surgeons Laparoscopic Registry. *Dis Colon Rectum* 1996;39(suppl):S20-S23
30. Reilly WT, Nelson H, Schroeder G, et al. Wound recurrence following conventional treatment of colorectal cancer: a rare but perhaps underestimated problem. *Dis Colon Rectum* 1996;39:200-207
31. Gertsch P, Baer HU, Kraft R, et al. Malignant cells are collected on circular staplers. *Dis Colon Rectum* 1992;35:238-241
32. Hartley JE, Mehigan BJ, Monson JR. Alterations in the immune system and tumor growth in laparoscopy. *Surg Endosc* 2001;15:305-313
33. Wang PH, Yuan CC, Lin G. Risk factors contributing to early occurrence of port site metastases of laparoscopic surgery for malignancy. *Gynecol Oncol* 1999;72:38-44
34. Berends FJ, Kazemier G, Bonjer HJ, et al. Subcutaneous metastases after laparoscopic colectomy [letter]. *Lancet* 1994;344:58
35. Jessup JM, McGinnis LS, Steele GD Jr, et al. The national cancer database. Report on colon cancer. *Cancer* 1996;78:918-926
36. Fleshman JW, Nelson H, Peters WR, et al. Early results of laparoscopic surgery for colorectal cancer. Retrospective analysis of 372 patients treated by Clinical Outcomes of Surgical Therapy (COST) Study Group. *Dis Colon Rectum* 1996;39:S53-S58
37. Gellman L, Salky B, Edye M. Laparoscopic assisted colectomy. *Surg Endosc* 1996;10:1041-1044
38. Franklin ME, Rosenthal D, Abrego-Medina D. Prospective comparison of open versus laparoscopic resection of the colon and rectum for cancer. *Dis Colon Rectum* 1996;39:35-46
39. Lacy AM, Garcia-Valdecasas JC, Delgado S, et al. Post-operative complications of laparoscopic-assisted colectomy. *Surg Endosc* 1997;11:119-122
40. Leung KL, Yiu RY, Lai PB, et al. Laparoscopic-assisted resection of colorectal carcinoma: five year audit. *Dis Colon Rectum* 1999;42:327-332
41. Bohm B, Schwenk W, Muller JM. Long-term results after laparoscopic resection of colorectal carcinoma. *Chirurg* 1999;70:453-455
42. Poulin EC, Mamazza J, Schlachta CM, et al. Laparoscopic resection does not adversely affect early survival curves in patients undergoing surgery for colorectal adenocarcinoma. *Ann Surg* 1999;229:487-492
- 42a. Lechaux D, Trebuchet G, Le Calve JL. Five-year results of 206 laparoscopic left colectomies for cancer. *Surg Endosc* 2002;16:1409-1412
- 42b. Lumley J, Stitz R, Stevenson A, Fielding G, Luck A. Laparoscopic colorectal surgery for cancer: intermediate to long-term outcomes. *Dis Colon Rectum* 2002;45:867-872
43. Lujan HJ, Plasencia G, Jacobs M, et al. Long-term survival after laparoscopic colon resection for cancer. *Dis Colon Rectum* 2002;45:491-501
44. Lacy AM, Garcia-Valdecasas JC, Delgado S, et al. Laparoscopic assisted colectomy vs. open colectomy for treatment of non-metastatic colon cancer: a randomized trial. *Lancet* 2002;359:2224-2229
45. Patankar S, Larach S, Ferrara A, et al. Prospective comparison of laparoscopic vs. open resections for colorectal adenocarcinoma over a ten-year period. *Dis Colon Rectum* 2003;46:601-611
- 45a. Schwenk W, Bohm B, Muller JM. Post operative pain and fatigue after laparoscopic or conventional colorectal resections. A prospective randomised trial. *Surg Endosc* 1998;12:1131-1136
- 45b. Milsom JW, Bohm B, Hammerhoer KA, et al. A prospective randomised trial comparing laparoscopic versus conventional techniques in colorectal cancer surgery: a preliminary report. *J Am Coll Surg* 1998;187:46-47
- 45c. Curet MJ, Putrakul K, Pitcher DE, et al. Laparoscopically assisted colon resection for colon carcinoma: perioperative results and long term outcome. *Surg Endosc* 2000;14:1062-1066
- 45d. Hasegawa H, Kabeshima Y, Watanabe M, et al. Randomised controlled trial of laparoscopic versus open colectomy for advanced colorectal cancer. *Surg Endosc* 2003;17:631-640
46. Ries LA, Eisner MP, Kosary CL, et al, eds. SEER Cancer Statistic Review, 1973-1997. Bethesda, MD: Kosary National Cancer Institute; 2000
47. Anderson CA, Kennedy FR, Potter M. Results of laparoscopically assisted colon resection for carcinoma. The first 100 patients. *Surg Endosc* 2002;16:607-610
48. Stage J, Schulze S, Moller P, et al. Prospective randomised study of laparoscopic vs open colonic resection for adenocarcinoma. *Br J Surg* 1997;84:391-396
49. Lacy AM, Garcia-Valdecasas J, Delgado S. Laparoscopy assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002; 359:2224-2229
50. Guillou PJ. Phase III randomized study of conventional versus laparoscopic assisted surgery for colorectal cancer. *Cancernet*. Available at: <http://cancernet.nci.nih.gov/>. Accessed December 2004