

Laparoscopic Colorectal Surgery

By James Yoo, MD

Introduction

Laparoscopic colon resections are being performed with increasing frequency in the United States, though the use of minimally invasive techniques in colorectal surgery has lagged behind its application in other surgical fields. Since the first laparoscopic colectomy was described in 1991, a great deal of controversy has surrounded its use, particularly in the management of colorectal cancer. Several important new studies¹⁻³ have demonstrated the benefits and safety of laparoscopic colorectal surgery, making it now the preferred approach in the surgical management of many colorectal diseases.

History of Laparoscopic Colectomy

In the early 1990s, laparoscopic colectomy was an evolving technique whose oncologic safety had not been proved. Initial case reports describing port-site metastasis as a complication of laparoscopic surgery for cancer caused great alarm, with early reports in small case series noting metastasis rates as high as 21%.⁴ Many surgeons questioned whether there was a novel risk for tumor cell dissemination during laparoscopy compared to open, or conventional, surgery. Proposed mechanisms included cancer cell implantation during the release of pneumoperitoneum, direct tumor implantation from a contaminated instrument or during extraction of the specimen through a small incision, stimulation of tumor growth by the insufflating gas, and the laparoscopic technique itself.

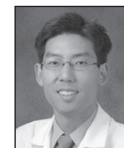
Döbrönte et al first described port-site metastasis in 1978 after an ovarian cancer operation.⁵ Though the underlying etiology is still unclear, the development of recurrent cancer at a previous surgical site is not unique to laparoscopic surgery but occurs after open surgery as well. Two retrospective reviews of open colectomy for colorectal cancer, each with more than 1500 patients, demonstrated an incidence of 0.6% to 0.68% of incisional tumors, with overall abdominal wall tumors having an incidence of 1%.^{6,7} Multiple studies have now demonstrated that the incidence of port-site metastasis

after laparoscopic surgery is low. A prospective evaluation by the Laparoscopic Bowel Surgery Registry, which was initiated in 1992 by the American Society of Colon and Rectal Surgeons, the American College of Surgeons, and the Society of American Gastrointestinal Endoscopic Surgeons, reported the rate of this complication to be at 1.1%,⁸ similar to the results for open surgery. Recent trials evaluating the outcomes of laparoscopic colectomy for cancer have also reported a similarly low incidence of port-site metastasis.^{1,9} Today these operations are performed with almost no thought of this now historical concern. However, it was only after the publication of a report on the Clinical Outcomes of Surgical Therapy (COST) Study Group¹ trial in 2004 that laparoscopic surgery became an accepted practice in the management of colorectal cancer. With the publication of several multi-institutional, prospective randomized trials,^{1,3} it became clear that laparoscopic colectomy is equivalent to open colectomy in terms of oncologic safety for all stages of colon cancer. Margins of resection, number of lymph nodes harvested, cancer-related survival rates, and rates of complications and mortality are the same whether the operation is performed open or laparoscopically.^{1,3,9-13}

Are There Immune Benefits to Laparoscopic Surgery?

A consequence of those early concerns was an increasing interest in understanding the physiologic consequences of surgery, both open and laparoscopic, and its effects on tumor biology and immune function. It is well known that surgery leads to transient immunosuppression, though the underlying etiology remains unclear. A well-known cascade of physiologic and immunologic responses occurs after surgery. Inflammation involves the recruitment of macrophages and neutrophils at sites of tissue injury, release of proinflammatory cytokines and growth factors to promote wound healing (and that may also stimulate tumor growth), and activation of T cell (cellular) and B cell (humoral) immunity. Surgery has been shown

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to dampen each of these responses, leading to varying degrees of immunosuppression. Laparoscopic surgery, which is associated with less patient trauma through smaller incisions and less postoperative pain, may be associated with less immunosuppression, compared with open surgery, though the data remain a subject of debate and the clinical significance of this effect remains unclear.¹⁴

Experimental models have demonstrated differences in the function of macrophage, neutrophil, lymphocyte, and T cell populations, differences in the level of secreted pro-inflammatory cytokines (interleukin 6, tumor necrosis factor), and alterations in delayed-type hypersensitivity (an indicator of cell-mediated immunity) comparing laparoscopic and open techniques.

In other models, stimulation of tumor growth or metastases after surgery has been shown to be reduced in laparoscopically treated patients compared with those who underwent open surgery. This could possibly be due to differences in the levels of angiogenic/growth factors secreted at the time of surgery. Vascular endothelial growth factor is a potent angiogenesis factor, and serum levels are elevated in patients with colon cancer. In a study by Belizon et al, patients who underwent surgery for colon cancer had further elevations in serum vascular endothelial growth factor levels during the early postoperative period.¹⁵ The increase occurred earlier, and was more profound, in patients having open surgery compared with laparoscopically treated patients. Levels also increased in proportion to incision length. Insulin and insulin-like growth factor are also associated with tumor growth; elevated levels may place patients at increased risk for the development of colon cancer. Studies have demonstrated lower levels of the tumor inhibitor insulin-like growth factor binding protein 3 in patients having open surgery, whereas no decrease was seen in laparoscopically treated patients.¹⁶

To date, no survival differences have been found comparing cancer patients treated by the open method and those treated laparoscopically; however, some intriguing trends have been seen in smaller studies. Systemic immune function and tumor growth may be differentially regulated by the degree of surgical trauma. Though the clinical impact of these findings is uncertain, the concept certainly warrants further study.

How Is Laparoscopic Colectomy Done?

The technique of laparoscopic colectomy has a long learning curve because of the advanced laparoscopic skills it entails. Unlike other laparoscopic procedures,

such as the Nissen fundoplication or cholecystectomy, colorectal procedures involve dissection and mobilization of intra-abdominal organs in multiple quadrants. Laparoscopic colorectal surgery involves the use of several small incisions through which a specialized camera and several laparoscopic instruments are inserted (Figures 1, 2). An insufflator blows carbon dioxide (CO₂) into the peritoneal cavity, creating a pneumoperitoneum that provides a working space to perform the operation. Tilting of the operating-room table in various positions during an operation uses gravity to allow intra-abdominal organs to fall away from the area of dissection, providing necessary exposure that would normally be achieved through the use of retractors. Intestinal resection requires laparoscopic ligation of large vessels, mobilization and removal of a long floppy segment of colon, and restoration of intestinal continuity. Once the colon segment has been completely mobilized and its blood supply divided, a small skin

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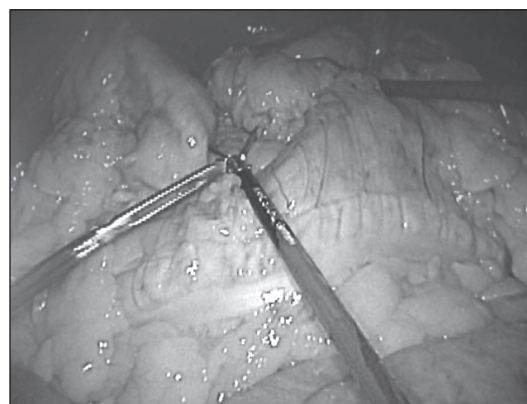


Figure 1. Typical view during a laparoscopic colectomy.



Figure 2. Typical scars after a laparoscopic right colectomy.

incision is made to exteriorize the colon, a resection and anastomosis are performed extracorporeally, and the rejoined colon is placed back into the abdomen.

Indications, Advantages, and Disadvantages of Laparoscopic Colectomy

Most patients are candidates for a laparoscopic approach. When the surgeon is experienced, even patients with a history of abdominal surgery are candidates. Though there are clear benefits, they have not been as compelling when compared to the clear advantages associated with other laparoscopic procedures. The main reason is that a colectomy, whether open or laparoscopic, results in a delayed return of bowel function. Though recovery of bowel function is quicker after laparoscopic surgery, the difference is on the order of one or two days, resulting in a similar reduction in length of hospital stay. Also, the laparoscopic approach is associated with longer operating-room times. Even if long-term benefits are equivalent between open and laparoscopic techniques, the short-term benefits are real advantages for patients. In practical terms, the laparoscopic approach is associated with less pain, a faster recovery, earlier return of bowel function, a shorter hospital stay, possible immune benefits, and smaller scars, making it the preferred method for intestinal resection.

Technical Pearls—Use of Carbon Dioxide Colonoscopy

The lack of tactile feedback during laparoscopic surgery can make tumor localization difficult, especially if the lesion location has not been tattooed on the colon wall before surgery. It is imperative that the exact location of the tumor is known prior to proceeding with colectomy. Even when the lesion location has been tattooed onto the colon, often the mark can be difficult to see, or there may be confusion regarding the location of the tattoo in relation to the tumor (proximal or distal), which can affect surgical margins. Intraoperative colonoscopy is a way of definitively localizing a lesion and should be available during all laparoscopic colectomies. Traditional colonoscopy uses room air as the insufflating gas, which leads to significant bowel distension and requires clamping of the proximal colon to minimize this effect. Clamping the bowel can lead to injury, and even when it is successfully performed, the degree of distension often makes simultaneous laparoscopic visualization difficult. These problems can be circumvented with the use of CO₂, rather than room air, as the insufflating gas (Figure 3). Because



Figure 3. Endoscopic carbon dioxide insufflator and colonoscope.

CO₂ is absorbed much more rapidly than room air, bowel distension is minimized and dissipates quickly, making proximal clamping unnecessary. Use of CO₂ allows for laparoscopic and endoscopic procedures to be performed simultaneously (Figure 4), and this technique has been shown to be safe and clinically useful.¹⁷ Besides tumor localization, CO₂ colonoscopy may have other potential applications.

How Is Laparoscopic Colectomy Evolving?

The laparoscopic approach continues to gain popularity and has evolved to include not just “pure” laparoscopic techniques but also hand-assist devices. Hand-assisted surgery can be used as a bridge for surgeons who are not completely familiar or facile with laparoscopic techniques, and even for the most experienced laparoscopic surgeons, it is often the preferred technique for surgery involving left-sided pathology (descending or sigmoid colon and rectum; Figure 5). Use of a hand-assist device decreases the learning curve associated with laparoscopy, provides tactile feedback for the surgeon, and shortens operating-room time while still preserving many of the advantages of laparoscopic surgery.¹⁸ By combining laparoscopic surgery with the tactile feedback of a hand-assist device, surgeons can reduce operating-room time and have a lower procedure conversion rate. The technique involves making an incision the width of a hand and placing a hand-assist device to facilitate laparoscopic dissection. New hand port devices make this technique possible without loss of pneumoperitoneum, which is essential for performing laparoscopic procedures. Because an incision (4–5 cm) is necessary to remove the colon specimen at the end of a laparoscopic operation, the difference between a pure laparoscopic procedure and a hand-assisted operation is generally a few additional

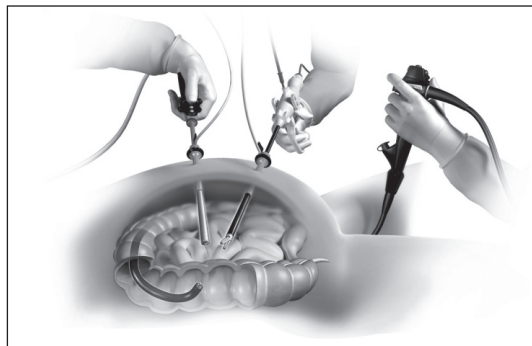


Figure 4. Combined laparoscopy and CO₂ colonoscopy.

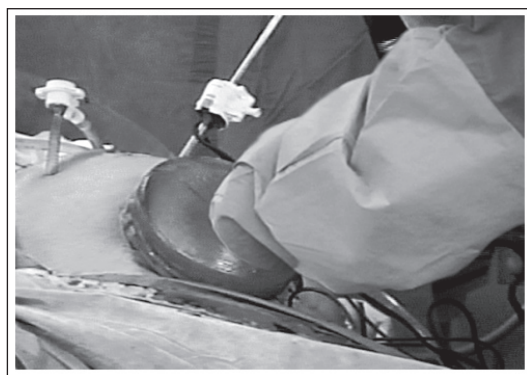


Figure 5. Commonly used hand-port device (GelPort).

centimeters (3–4 cm) of incision length. Several clinical trials have demonstrated that there is no difference in patient recovery or discharge for laparoscopic versus hand-assisted techniques.^{19,20} Because larger incisions are often needed and because of the increased risk of wound infections and pulmonary complications, this technique has particular advantages with overweight or obese patients.

What Is the Future of Laparoscopic Colectomy?

Laparoscopic techniques are currently used in the surgical management of diverticulitis, Crohn's disease and ulcerative colitis, familial polyposis, rectal prolapse, and benign and malignant colorectal neoplasms. As technology moves forward, minimally invasive surgery continues to evolve. Endoluminal approaches are being explored as an alternative or complimentary surgical technique.

Combined laparoscopic and colonoscopic procedures may bridge the gap to future developments in endoluminal surgery. In the past, simultaneous laparoscopy and colonoscopy was technically difficult because colonoscopy used room air as the insufflating gas, leading to significant bowel distension that obscured

the laparoscopic view and prohibited its simultaneous use. With CO₂ colonoscopy, combined laparoscopic and endoscopic procedures can be performed simultaneously and may have many potential applications, including the management of benign colonic polyps that are not removable by traditional endoscopic techniques. These polyps often require a colectomy because of the risk that they harbor cancer within them, as well as the future risk of developing cancer. However, an alternative approach in this setting may be a combined laparoscopic and CO₂ colonoscopic polypectomy. When these procedures are combined, a polyp can be removed without a formal bowel resection. This combined procedure allows for both intra- and extraluminal manipulation of the bowel wall to aid in endoscopic polyp removal (Figure 6). If the frozen section is found to be benign, the procedure is completed. However, if cancer is suspected, a formal laparoscopic colectomy can be performed. Any full-thickness injury to the bowel wall during endoscopic polyp removal is visualized at the time of surgery and can be managed laparoscopically.

Conclusion

The use of minimally invasive approaches in the surgical management of colorectal diseases continues to gain popularity. Laparoscopy has clear advantages and can be performed in a majority of patients at surgical centers with experienced surgeons. Use of hand-assist devices and CO₂ colonoscopy are essential tools in the operating room. As technology marches forward, newer techniques will continue to advance the quality of patient care. ❖

Disclosure Statement

Dr Yoo discloses that he is a consultant with Covidien.

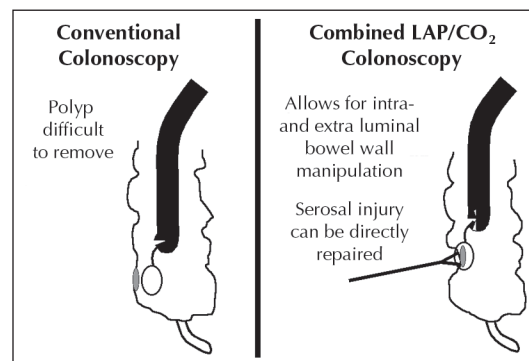


Figure 6. Combined laparoscopic and CO₂ colonoscopic polypectomy.

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Feel Kindly

We do not go to the operating table as we go to the theatre, to the picture gallery, to the concert room, to be entertained and delighted; we go to be tormented and maimed, lest a worse thing should befall us The experts on whose assurance we face this horror and suffer this mutilation should have no interests but our own to think of; should judge our cases scientifically; and should feel about them kindly.

— The Doctor's Dilemma, *preface (1913), George Bernard Shaw, 1856-1950, Irish poet and playwright, 1925 Nobel Laureate in Literature*