Laparoscopic right hemicolectomy for cancer: 11-year experience

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Recibido para publicación: 01 de mayo de 2003.
Aceptado para publicación: 31 de julio de 2004.

RESUMEN Introducción: *la cirugía laparoscópica ha tomado su lugar como el estándar de oro para muchos procedimientos. La práctica laparoscópica de cirugía colorrectal está iniciando su segunda década, y a pesar de que hay muchas publicaciones dirigidas a la cirugía del colon distal, existen sólo algunas de colon derecho tratado completamente por laparoscopia.* ***Objetivos:*** *presentar los datos recolectados de manera prospectiva de una sola institución en un periodo de once años, enfocados en la hemicolectomía derecha para malignidad.* ***Material y métodos:*** *se analizaron prospectivamente los pacientes elegidos para hemicolectomía derecha por cáncer de colon en un periodo de 11 años. De mayo de 1991 a mayo de 2002, en 98 pacientes se intentó realizar hemicolectomía derecha por laparoscopia para tratamiento de cáncer, 44 hombres y 54 mujeres, con edad promedio de 70.6 años, se incluyeron tanto casos electivos como casos de emergencia, los pacientes sometidos a laparoscopia diagnóstica y aquellos convertidos inmediatamente después de iniciar el procedimiento fueron excluidos del estudio.* ***Resultados:*** *noventa y dos pacientes fueron incluidos en el estudio, a 82 se les realizó el procedimiento completamente laparoscópico y 10 tuvieron una anastomosis extracorpórea. El tiempo quirúrgico promedio fue de 136 minutos para el grupo intracorpóreo y de 159 minutos para el extracorpóreo. El promedio de ganglios resecados fue de 20.8 y el resultado final de patología mostró 26 tumores estadio I, 24 estadio II, 31 estadio III y 17 estadio IV.* ***Conclusiones:*** *en manos experimentadas la colectomía laparoscópica puede ser realizada de manera segura y efectiva. Este estudio reafirma que el abordaje laparoscópico del cáncer de colon ofrece seguridad oncológica equivalente o incluso mejor que la cirugía abierta.*

Palabras clave: *laparoscopia, hemicolectomía derecha, cáncer de colon.*

SUMMARY Introduction: *Laparoscopic surgery has emerged as the gold standard for many intra-abdominal procedures. Laparoscopic colon surgery is now entering its second decade of practice, and although there are many papers focusing on surgery of the distal colon, only a few have been published regarding right sided lesion approached totally laparoscopically.* ***Objective:*** *Present data collected in a prospective manner from a single institute over an eleven year period, focusing on laparoscopic right hemicolectomy for malignancy.* ***Methods:*** *Patients elected for laparoscopic right hemicolectomy for colon cancer were analyzed prospectively. From May 1991 to May 2002, 98 patients underwent attempted laparoscopic right hemicolectomy for cancer, 44 male and 54 female, with a mean age of 70.6 years, emergent and non emergent cases were included. Patients who underwent a diagnostic laparoscopy and those converted immediately to open procedure were excluded from this study.* ***Results:*** *Ninety-two patients were included in the study, eighty-two of these had a totally intracorporeal anastomosis created, and ten had an extracorporeal anastomosis performed. The mean operative time for the intracorporeal group was 136 minutes, and for the extracorporeal group was 159 minutes. The average number of lymph nodes harvested was 10.8 and the final pathologic analysis showed 26 tumors stage I, 24 stage II, 31 stage III and 17 stage IV.* ***Conclusions:*** *In experienced hands, laparoscopic colectomy can be performed safely and effectively for the treatment of both benign and malignant diseases of the right colon. This study reaffirms the contention that laparoscopic approach to colon cancer offers equivalent, or in some instances, greater oncologic safety when compared to the open technique.*

Key words: *Laparoscopy, right hemicolectomy, colon cancer.*

INTRODUCTION

Laparoscopic surgery has emerged as the procedure of choice for many intra-abdominal disease processes. One area that is of particular interest to colorectal surgeons is the role of laparoscopic colon surgery which is now entering its second decade of practice. While there is a staggering amount of literature focusing on laparoscopic surgery of the distal colon, there is a paucity of such regarding right-sided lesions approached totally laparoscopically. The reason for this relative under-representation is unclear. One possible explanation is the conviction that conventional right hemicolectomy is a fairly simple and straightforward procedure to perform, and that any added costs or increases in operative time are therefore not justified. In this regard, the debate is very similar to the arguments that are made for and against the use of laparoscopic inguinal herniorrhaphy. Many question whether the benefits seen for laparoscopic cholecystectomy over conventional open surgery will be realized for laparoscopic colon surgery. In addition, controversy persists regarding the safety and efficacy of these minimally invasive procedures for the treatment of malignant disease, as well as whether they are appropriate in acute inflammatory or infectious processes.

The aim of this review is to present data collected in a prospective manner from a single institution over an eleven-year period, focusing on laparoscopic right hemicolectomy for malignancy. The surgical procedure is described in detail, with special emphasis on the totally intracorporeal technique for fashioning the intestinal anastomosis.

PATIENTS AND METHODS

Patients

From May 1991 to May 2002 a total of 98 patients underwent attempted laparoscopic right hemicolectomy for cancer under the care of surgeons from a single institution. The subjects included 44 males and 54 females, with a mean age of 70.6 years (24 to 94 years). Both emergent and non-emergent cases were included. All patients who had laparoscopic right colon surgery for malignancy during the study period were included.

Patients who underwent a diagnostic laparoscopy as their primary procedure and who were immediately converted to an open procedure were not included as subjects in this study, unless attempts to perform the procedure laparoscopically were made. A conversion was defined as any unplanned incision in the abdominal wall for the purpose of completing any portion of the procedure that could not, after appropriate attempts, be performed safely via the laparoscopic approach. The totally intracorporeal approach describes patients who underwent laparoscopic mobilization of the colon, laparoscopic ligation and division of the major blood vessels, laparoscopic division of both ends of the specimen, and laparoscopic intestinal anastomosis without hand assistance or externalization of bowel until the end of the procedure when the specimen was removed. Patients were considered to have had an extracorporeal anastomosis when the majority of the above steps were carried out laparoscopically, but the specimen was brought outside the abdomen for either a portion of the resection or creation of the anastomosis. Use of the term "laparoscopically assisted" has been purposely omitted because its exact meaning tends to be interpreted differently by various authors, and could therefore be misleading.

Surgical procedure

Once informed consent is obtained, patients are transferred to the operating room and placed under general anesthesia. Following this, patient monitoring lines (central venous pressure, arterial pressure, pulse-oximetry, EKG, blood pressure cuff, esophageal thermometer) are placed and secured as needed, and a warm-air upper body warming device is laid across the patient's chest and arms to help prevent hypothermia. An orogastric suction tube, a urinary bladder catheter, and lower extremity pneumatic compression stockings are used in all cases.

The patient is placed in the modified lithotomy position, with the hips and knees slightly flexed to facilitate use of the flexible colonoscope intra-operatively. The patient's arms are tucked at the side, and the shoulders are securely taped to the operating table to allow for the placement of the patient in steep Trendelenburg or airplaning as needed to aid in visualization. After prepping and draping the patient in sterile fashion, the surgeon and the camera operator stand to the patient's left side, and the first assistant stands opposite them. A mobile video monitor is placed close to the patient's right shoulder, and another to the left, to ensure that the entire surgical team has good visibility.

Pneumoperitoneum is established by use of the Veress needle, and the abdomen is insufflated with carbon dioxide gas to a pressure of 14mmHg. In most cases the Veress needle is placed in the left lower quadrant: however, an alternate site (upper midline, left upper quadrant)

is often selected in patients who have had prior abdominal surgery in this region. Following adequate insufflation, a 12-mm port is placed and the 10-mm zero-degree video laparoscope is inserted. The abdomen is thoroughly inspected for any signs of metastatic disease, the presence of which may alter the anticipated procedure. Any adhesions to the anterior abdominal wall are taken down carefully in a step-wise fashion, and the rest of the working ports are placed under direct visualization. Once placed, the trocars are secured to the abdominal wall to prevent dislodgement and the so-called "chimney effect" whereby possibly aerosolized viable tumor cells could pass through the naked skin edges and become adherent to the soft tissues, thus theoretically increasing the risk for port-site metastases. The final configuration shows a 5-mm port in the upper midline, a 10-mm port in the right lower quadrant, another 10-mm port in the left lower quadrant, and a 10-mm port at the umbilicus. Additional trocars are occasionally added as needed *(Figure 1).*

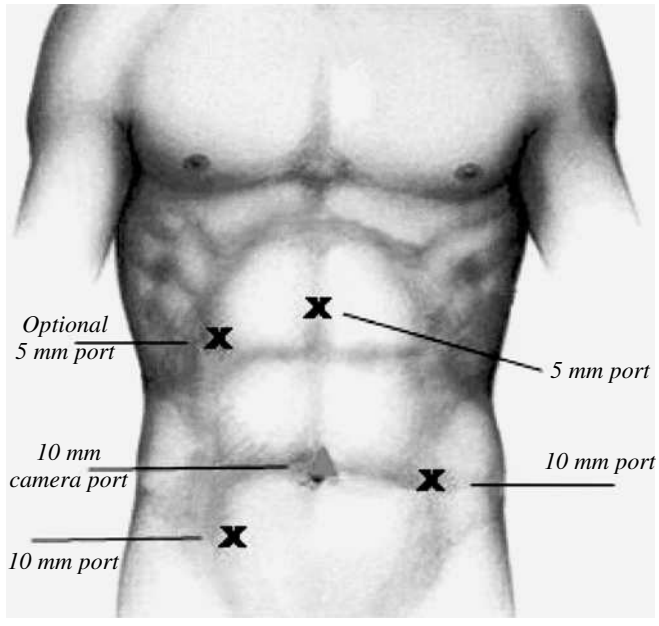

Figure 1. *Trocar positioning for laparoscopic right hemicolectomy.*

Once all trocars are placed, the pathologic segment and cecum are identified and a careful "no-touch" technique is rigidly enforced. The terminal ileum and cecum are mobilized first, followed by the ascending colon along the white line of Toldt. The hepatic flexure and proximal transverse colon are also freed to ensure adequate distal margins and a tension-free anastomosis. Following this the duodenum is identified behind the colon, and a window is created in the mesentery in this region. In a step-wise fashion, the named vessels (right colic artery and vein, ileocolic artery and vein) are sequentially identified, clipped twice proximally and once distally, and divided near their respective origins from the superior mesenteric artery. This dissection progresses until the terminal ileum is reached. The terminal ileum is then divided with an endoscopic stapling device.

At this point, patients who are to undergo totally intracorporeal anastomosis also have laparoscopic division of the colon at the distal end of the mesenteric window. This is again performed using the endoscopic stapling device after inspection of the region to ensure that an adequate blood supply is present. The specimen is then placed in a large specimen bag, which is sealed and stored above the liver for extraction after intestinal continuity is restored. An ileo-transverse colostomy is then created with the endoscopic stapling device in the following manner. First, a small enterotomy is made on the anti-mesenteric border of the colon at the edge of the previous staple line. This is then drawn over the lower jaw of the stapling device, and held in place while this maneuver is repeated on the ileum side. With the colon drawn over the lower jaw of the stapler and the terminal ileum in a similar position on the upper jaw, the stapler is closed, fired, and removed, creating a 6-cm anastomosis. An additional firing of the stapler seals the remaining enterotomy, and a laparoscopic hernia stapler is used to repair the rent in the mesentery when needed. Next, an intra-operative colonoscopy is performed to ensure that the target lesion has been removed, to inspect for synchronous lesions, and to check the anastomosis for air leakage. Colonoscopy is carried out prior to specimen transection in patients who present emergently and have therefore not undergone routine preoperative evaluation, or in any instance where the location of the target lesion is in question. Then the right lower quadrant trocar site (or alternate site selected for specimen extraction) is enlarged to 3-5 cm, and after placing a wound protector, the specimen is removed and the wound closed. The abdomen is then inspected a final time. Thorough irrigation with dilute (5%) povodine-iodine solution is then performed to cleanse the anastomosis and all port sites and trocars. Once all irrigation is aspirated from the peritoneal cavity, trans-fascial sutures are placed under direct visualization using the Carter-Thomason® (Louisville Laboratories, Inc., Louisville, KY) suture passer at all sites greater than 5 mm. The insufflator is turned off and the pneumoperitoneum is released through the trocars while still in place, to further help prevent the "chimney effect." The trocars are then removed, and the fascial sutures are tied down

securely. Skin closure is accomplished with sutures or staples as appropriate.

For patients who are to undergo extracorporeal anastomosis, after division of the terminal ileum the right lower quadrant trocar incision is extended to a length of 3-5 cm. A wound protector fashioned from a plastic camera bag is then placed, and the loop or divided end of the specimen is delivered up through the wound. The resection is completed either sharply or with a stapling device, and a hand-sewn or stapled ileo-transverse colostomy is created. The anastomosis is then returned to the abdominal cavity, and after intra-operative colonoscopy, the final steps of the procedure are carried out as outlined above.

Post-operatively, all patients completed laparoscopically have the orogastric tube removed when bowel sounds are present, usually post-operative day #1 and are allowed to have ice chips. On the second post-operative day patients are started on a clear liquid diet, and bladder catheters are routinely discontinued at this time. Diet is advanced as tolerated. Patients are discharged from the hospital when they have return of bowel function, can tolerate a regular diet, and have adequate pain control with oral analgesics.

Information regarding pre-operative work-up, operative time, blood loss, pathologic details of the surgical specimen, and post-operative course was recorded in a prospective manner for all patients, and thus included in the current analysis. Special attention was placed on the size and location of abdominal incisions, as well as on the steps taken to prevent oncologic or infectious complications.

RESULTS

Of the 98 patients who met the inclusion criteria, 92 (93.9%) were completed laparoscopically *(Table 1).* Eighty-two of these (89.1%) had a totally intracorporeal anastomosis created, while the remaining 10 (10.9%) had an extracorporeal anastomosis performed. Of the 6 patients (6.1%) that were converted to an open procedure, the reason was extensive adhesions for 3 patients, massive dilatation of the small bowel in 2 patients, and extensive tumor fixation to other intra-abdominal organs in 1 patient.

The following intra-operative and specimen data applies to the 92 patients who were completed laparoscopically *(Tables 2, 3).* The mean operating time for the intracorporeal group was 136 minutes, and for the extracorporeal group it was 159 minutes (overall range 105-300 minutes). Operative blood loss for the intracorporeal group was 114 cc, and for the extracorporeal group it was 142 cc (overall range 25-650 cc). Since lymph node harvest and extent of intestinal resection were performed the same way for both groups, these were not considered individually. The average specimen measured 29.31 cm in length, with average proximal and distal resection margins of 10.45 cm and 14.95 cm, respectively. The average number of lymph nodes harvested was 20.8. The final pathological staging showed 26 tumors were Stage I, 24 were Stage II, 31 were Stage III, and 17 were Stage IV *(Table 4).*

Abdominal incisions for removal of the specimen in the intracorporeal group, and for externalization and creation of the anastomosis in the extracorporeal group, averaged 3.96 cm and 6.00 cm, respectively. Of these, 27 incisions could be placed in pre-existing scars from prior appendectomy (19 patients) and hysterectomy (8 patients).

TABLE 1

Patient data	
Total patients	98
Gender	
Male	44
Female	54
Mean age (years)	70.6
Completed laparoscopically	92
Intracorporeal	82 (89.1%)
Extracorporeal	10 (10.9%)
Conversions	6 (6.1%)

TABLE 2

Operative Data	Intracorporeal anastamosis N = 82	Extracorporeal anastamosis N = 10
Mean operating time	136 min	159 min
Mean operative blood loss	114 cc	142 cc
Mean size of largest incision	3.96 cc	6.00 cm

TABLE 3

Specimen data	Mean	Range
Specimen length	29.31 cm	13-55.5 cm
Proximal margin	10.45 cm	2.5-21.0 cm
Distal margin	14.95 cm	4.0-22.0 cm
Lymph node harvest	20.8 nodes	5-48 nodes

TABLE 4
STAGING DATA

Stage I	26
Stage II	24
Stage III	31
Stage IV	17
Total	98

TABLE 5
EARLY COMPLICATIONS (< 30 DAYS)

Urinary tract infection	5 (4.8%)
Diarrhea	5 (4.8%)
Ileus ≥ 7 days	4 (3.8%)
Post-op bleed	2 (1.9%)
Wound infection	2 (1.9%)
Anastomotic leak	0
Total	18 (18.4%)

TABLE 6
LATE COMPLICATIONS (> 30 DAYS)

Bowel obstruction	3 (2.9%)
Constipation	2 (1.9%)
Diarrhea	1 (1.0%)
Failure to thrive	1 (1.0%)
Trocar site implants	0
Total	7 (7.1%)

One hundred percent of patients completed laparoscopically had their wound protected from the surgical specimen at the time of extraction. Similarly, all patients had their anastomotic site, trocars, and port sites thoroughly cleansed with dilute 5% povodine-iodine solution.

Early complications (occurring less than or equal to 30 days post-operatively, Table 5) included 5 urinary tract infections, 5 patients who complained of diarrhea, 4 cases of prolonged ileus (lasting more than 7 days), 2 wound infections, and 2 postoperative bleeds requiring blood transfusion for a complication rate of 18.4%. There were no anastomotic leaks and no peri-operative deaths in this series.

Late complications (those occurring greater than 30 days post-operatively, Table 6) included 2 intestinal obstructions from benign strictures at the anastomosis and 1 intestinal obstruction from tumor recurrence at the anastomotic site. In addition, 2 patients developed chronic constipation, 1 developed chronic diarrhea, and 1 had failure to thrive for a long-term complication rate of 7.1%. Of note, there have been zero trocar or wound implants to date, despite close post-operative surveillance for an average of 53 months (range 3-111 months). Persistent disease in the face of stage IV malignancy at the time of surgery was not considered a complication.

DISCUSSION

The field of laparoscopic colon surgery has been the focus of much criticism and debate since it was first performed in 1990.[1-3] The earliest criticism centered on the technical safety and feasibility of the procedure. Now, as the surgical procedure *per se* has gained acceptance,[4-8] it is the indication for surgery that is causing more controversy. It is safe to say most surgeons agree that the laparoscopic approach is acceptable for benign conditions such as diverticular disease, arterio-venous malformations, inflammatory bowel disease, etc.[9-12] However, controversy still exists regarding resection for malignant disease.[13-15]

The potential benefits of performing a laparoscopic procedure rather than an open procedure include improved cosmesis, less post-operative pain and ileus, reduced perioperative immunosuppression, decreased hospital stay, and earlier return to normal activity.[16, 17] These are opposed by the proposed risks attributed to the laparoscopic approach, including increased incidence of wound metastases, performing an inadequate resection, improper tumor staging, difficulty creating a good anastomosis, and intra-operative complications due to the increased difficulty of the procedure.[18]

The first reported case of wound metastasis following laparoscopic colon surgery was by Alexander et al. in 1993, following a laparoscopically assisted right hemicolectomy.[19] Since that time, the risk of wound metastases after laparoscopic colectomy has been well documented.[13-15, 20-26] Many attribute this to factors such as prolonged operative time, poor operative technique, high intra-abdominal pressures caused by pneumoperitoneum,

and increased manipulation of the cancer during the procedure.[14,20,23,26] In our study, there were zero cases of wound metastasis out of 92 patients operated on laparoscopically, even after an average follow-up of 57 months. At our institution we routinely follow measures to prevent spread of disease, such as purposely avoiding any unnecessary specimen manipulation, routinely placing the specimen in a bag as soon as it is excised, and the aforementioned steps to help prevent the "chimney effect".[27] All wounds are then protected from having direct contact with the specimen during its removal, as has been suggested by others.[20, 26, 28] These maneuvers combine to decrease the likelihood of malignant cell spillage and abdominal wound infection. In addition, as povodine-iodine solution has been shown to have a tumoricidal effect on cancer cells,[29] we use copious amounts of a dilute 5% solution to help cleanse all exposed surfaces at the conclusion of the procedure. Although some have recommended intraperitoneal chemotherapy,[30] this is less widely accepted and therefore not performed at our institution.

Perhaps the largest stumbling block for complete acceptance of laparoscopic colon surgery for cancer is the question of oncologic safety. These concerns have been addressed in a number of studies and seem to show comparable results between the laparoscopic and open approach.[18, 31-34] Our study re-affirms the contention that the laparoscopic technique can produce equivalent if not better oncologic standards, when compared to the open approach, with respect to lymph node harvest, specimen length, and margins of resection.

Along with being able to minimize the known risks of laparoscopic colon surgery, we have been able to realize some of the other reported benefits without compromising patient safety or outcome. A concerted effort was made in many cases to use already existing abdominal scars as trocar placement sites, and to use these sites for extraction of the surgical specimen. By using the totally intracorporeal technique, the ability to extract the specimen from anywhere in the abdomen allowed use of scars located outside of the right lower quadrant. Examples of these would include low midline and Pfannenstiel incisions from prior gynecologic surgery. In one case the specimen was removed through the site of an incisional hernia, which was then subsequently repaired. Furthermore, the intracorporeal technique eliminates the need to modify incision sites for patients with short mesentery from inflammation, and allows us to adhere to a standardized technique for all patients regardless of body habitus. It should be noted, however, that while cosmesis is somewhat of a factor in laparoscopic surgery, it is certainly not the major concern when dealing with malignancy. Smaller incisions usually result in less post-operative pain. This in turn results in decreased pulmonary dysfunction after surgery.[35] Since upper abdominal incisions carry the highest risk of pulmonary complications from diaphragmatic dysfunction[36] and respiratory splinting,[37] limiting incision size and location to below the umbilicus should result in less pulmonary-related complications. This should carry with it a decrease in post-operative morbidity and mortality, since pulmonary complications have been reported as second only to cardiac complications as leading to significant problems post-operatively.[8] In the current study, no patient's hospitalization was extended due to significant pulmonary complications.

Immune function is of particular concern in the operative care of surgical patients, especially those with malignancy. Both animal and human studies have documented immunosuppression related to surgical stress, including decreased natural killer cell cytotoxicity,[38] leukocyte hypofunction,[39] and a host of biochemical, hormonal, and immunologic effects.[17,40,41] Several studies have shown that preservation of immune function is greater following laparoscopic surgery, for both cholecystectomy[42,43] and colectomy.[40,41] In fact, an article by Whelan et al. points to a possible survival benefit for certain colon cancer patients operated on laparoscopically compared with open surgery, citing these immunologic factors as perhaps playing a significant role.[44]

While post-operative pain and true return to normal levels of function were not focused on in the current study, we did see a very low incidence of prolonged ileus (only four patients). In addition, we have encountered very few late complications in the form of chronic diarrhea (1 patient), chronic constipation (2 patients), and bowel obstruction (3 patients). These complication rates are comparable to other published series.[11,16,45] The issue of post-operative pain has also been addressed elsewhere,[5] where less analgesia was used in the post-operative period by patients operated on laparoscopically compared to conventional surgery. Median post-operative hospital stay for the group completed laparoscopically in our series was 5 days (range 3-22 days), and is comparable to other published studies.[8,46] There was no noticeable difference between the intracorporeal and extracorporeal groups in hospital stay. It is felt, however, that by not filtering any patients out of our study, we were obliged to include many acutely ill patients as well

as patients with other co-morbidities which prolonged their hospital stays, thus skewing our results toward a longer hospitalization period.

CONCLUSION

In experienced hands, laparoscopic colectomy can be performed safely and effectively for the treatment of both benign and malignant diseases of the right colon. This study re-affirms the contention that the laparoscopic approach to colon cancer offers equivalent, or in some instances, greater oncologic safety when compared to the open technique. With further experience and longer follow-up, we feel that the laparoscopic approach will emerge as the procedure of choice for treating patients with right colon pathology[47].

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