Pregledni članek

Review article

Laparoscopic technique for left hemicolectomy and sigmoidectomy

Laparoskopska leva hemikolektomija in sigmoidektomija

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Abstract

In the earliest report of laparoscopic colon resections in 1991, Jacobs, Florida, described his initial experience with "laparoscopic-assisted" colon resection in 20 patients. In the past 15 years, thousands of colorectal resections have been performed all over the world. Skillful surgeons have consistently introduced new surgical techniques with excellent outcomes and thus motivated their colleagues to use these techniques in their patients. As a result laparoscopic resection has been adopted to treat conditions of all parts of the large intestine. This paper deals with left hemicolectomy and sigmoidectomy. These procedures can be regarded as technically most challenging surgical laparoscopic operations. Several techniques have been described for mobilizing and resecting the splenic flexure, descending colon, sigmoid, and rectum.

We present our method with the aim to contribute to further development of laparoscopic colorectal surgery. Surgical strategies and techniques used in left hemicolectomy and sigmoidectomy are described and oncologically relevant aspects are considered.

Between April 1996 and December 2008, approx. 680 patients were treated by laparoscopic left hemicolectomy and sigmoidectomy using a standardised four-trocar laparoscopic surgical technique, described in this paper. The indications for surgery ranged from benign diseases to malignant conditions.

Key words. *Laparoscopic technique, colon resection, laparoscopic left hemicolectomy, sigmoidectomy.*

Izvleček

V prvem prispevku o laparoskopski resekciji debelega črevesa, objavljenem leta 1991, je Jacobs s Floride opisal svoje prve izkušnje z laparoskopsko asistirano resekcijo kolona pri 20 bolnikih. V zadnjih 15 letih so po vsem svetu opravili tisoče resekcij debelega črevesa in danke. Spretni kirurgi so uvajali vedno nove operativne metode z odličnimi izidi in so tako motivirali kolege, da so začeli te pristope uporabljati tudi pri svojih bolnikih. Tako so laparoskopsko resekcijo uvedli pri kirurškem zdravljenju vseh delov debelega črevesa. V tem prispevku opisujemo levo hemikolektomijo in sigmoidektomijo. Ti dve operaciji sodita med tehnično najzahtevnejše laparoskopske posege. Opisali so več metod mobiliziranja in resekcije vraničnega zavoja, navzgornjega kolona, sigmoidnega kolona in danke. Svojo metodo predstavljamo z namenom, da bi prispevali k nadaljnjemu razvoju laparoskopske kolorektalne kirurgije. Obravnavamo operativno strategijo in tehniko leve hemikolektomije ter onkološko pomembne vidike tega posega. Od aprila 1996 do decembra 2008 smo operirali okrog 680 bolnikov z laparoskopsko levo hemikolektomijo in sigmoidektomijo s standardiziranim laparoskopskim pristopom in uporabo štirih troakarjev, ki ga opisujemo v tem prispevku. Indikacije za operativni poseg so obsegale vrsto benignih in malignih bolezni.

Ključne besede. Laparoskopska tehnika, resekcija debelega črevesa, laparoskopska leva hemikolektomija, sigmoidektomija.

Introduction

The success and growing popularity of laparoscopic biliary tract surgery in late 1980s and early 1990s encouraged surgeons to apply this technology to the treatment of other organ systems, including the large intestine. The first report reports on laparoscopic and laparoscopic-assisted colon surgery for benign and malignant diseases date back to 1991 (1-3). Since then, laparoscopic colon resection has been successfully performed for the treatment of a wide spectrum of diseases of the large bowel. The indications include: large benign polyps not amenable to colonoscopic resection, invasive malignancies, inflammatory lesions, and even acute and recurrent volvulus (1-5). Early clinical studies have repeatedly echoed the advantages of the laparoscopic technique, stressing the safety and effectiveness of the procedure, improved postoperative pain management, diminished effects on pulmonary function, faster postoperative recovery, and shorter hospital stay (1,6,7). The use of laparoscopic surgery for patients with localized, and presumably curable, cancer of the colon, has been an area of continuing controversy. Several case reports have described trocar site and wound recurrences of malignancies following laparoscopic surgery (8-10).

As a result of controversial views on laparoscopic treatment in these cases, most surgeons adopted a very cautious approach when describing laparoscopy to their patients as a surgical option for a proven or even suspected colon cancer. A number of conducted or ongoing prospective trials have been designed to examine this issue (11-16). Although definitive answers are not yet available, these studies appear to support the view that the incidence of port site metastasis was overrated in some early reports; metastatic growth seems to be related to the stage of the disease or to the individual surgeon's technique rather than to laparotomy itself.

Indications

Laparoscopic resection of the left colon and sigmoid is indicated for both benign conditions (diverticulitis, segmental Crohn's disease, polyp not suitable for colonoscopy) and malignant etiologies (primary colon cancer). Laparoscopic sigmoid resection is one of the most common laparoscopic operations. In chronic diverticular disease, indications for laparoscopic sigmoid resection are the same as for open surgery.

The American Society of Colon and Rectal Surgeons (ACRS) (17) and the European Association of Endoscopic Surgeons (EAES), (18) consensus statements agree that laparoscopy is an acceptable alternative to open surgery for diverticulitis as long as the indications remain the same: two or more attacks of uncomplicated diverticulitis, diverticular stricture, or one attack of diverticulitis in an immunocompromised patient.

Evidence-based practice has confirmed the advantages of laparoscopic surgery over open surgery for colon carcinoma in selected patients. Laparoscopic management of colorectal cancer is associated with reduced post-operative pain, decreased use of analgesics, less blood loss, reduced need for blood products, lower incidence of short- and long-term complications, shorter hospital stay and faster return to normal activity.

Patients treated by laparoscopic surgery showed no decrease in overall survival or disease-free survival rates, and no increase in the recurrence rate. Lymph node harvest in laparoscopic resection is the same as in open surgery, and there was no increase in positive resection margins. The incidence of port site metastases is less than 1% and is not excessive compared to the rate of abdominal wall recurrences in open surgery (19-21).

Preoperative evaluation and selection of patients

Patient selection is of paramount importance for all surgeons contemplating a laparoscopic approach for any pathological condition of the colon. Relative contraindications to attempted laparoscopy include morbid obesity, cirrhosis (especially with associated portal hypertension), uncorrectable coagulopathies, severe acute inflammatory diseases, history of multiple prior abdominal surgeries, or previous radiation treatment to the pelvis.

The informed consent process should include discussion on the benefits and controversies of laparoscopic colon surgery, as well as information on the possible need for conversion to laparotomy and use of intraoperative colonoscopy. All patients undergoing colon surgery should have the same preoperative workup regardless of the surgical approach used. The only special consideration for the individual scheduled for laparoscopic surgery is ensuring that the surgeon can identify the site of pathology at the time of operative intervention. The loss of tactile sensation in laparoscopic surgery stresses the importance of other localizing techniques, especially in small lesions located in a very mobile portion of the bowel. These can be evaluated by barium enema or colonoscopy before surgery. In the present era of widespread colonoscopy, barium enemas are no longer invariably used for preoperative evaluation of colon cancer patients.

Unfortunately, colonoscopy causes some distortion of the appearance of the large bowel anatomy, which may pose some problems for the surgeon determining the exact location of a small neoplasm. In contrast, x-rays can provide the surgeon with a specific anatomic location of the lesion. Alternatively, the lesion can be marked with dye or India ink during colonoscopy to make the area transmurally visible during surgery. If the exact location of the lesion remains doubtful, the surgon should be prepared to perform intraoperative colonoscopy to confirm the location of the pathology. Intraoperative colonoscopy is best performed after the establishment of pneumoperitoneum and placement of all the trocars needed. One member of the surgical team can then straighten out loops of the bowel while at the same time carefully occluding the lumen of the more proximal colon. These maneuvres allow the endoscopist to rapidly advance the colonoscope to the site of the pathology without distending the proximal bowel. After the lesion has been identified, the surgical team can mark the location by placing an endo-loop or a vascular clip on the adjacent epiploic fat.

Individuals scheduled for elective laparoscopic colon surgery should be switched to intravenous fluid infusion 24 hours before the operation. Preoperative mechanical bowel preparation is done 18 h before the scheduled surgery. The patients are required to drink approximately 4-5 litres Golytely-solution, if needed given via a NGT or duodenal tube, or 90 ml sodium phosphate (22) or 4 litres polyethylene glycol (23). In addition, both oral and parenteral broad spectrum antibiotics are administered. We use non-absorbable antibiotics, such as neomycin (1gm) and erythromycin (1gm), administered at hours 13, 14 and 23, the day before operation, and intravenous antibiotics, typically 2gm ampicillin and 1gm Flagyl ½ hour before surgery.

All patients should be advised to refrain from taking aspirin or other platelet inhibiting products for at least ten days before surgery. Adequate thromboembolism prophylaxis, as preferred by the surgeon, should be administered, and intermittent leg compression stockings can be used.
Individuals at increased risk for thrombosis may be given subcutaneous low-dose heparin or low molecular weight heparin.
A nasogastric or orogastric tube and a urinary catheter are placed.

Patient positioning

A proper patient position is essential to facilitating operative maneuvres and preventing complications, such as nerve and vein compression, and traction injuries to the brachial plexus.
Some surgeons, including ourselves, prefer to operate on the patient supine, in the modified lithotomy position, with the legs abducted and knees slightly flexed. The patient's right arm is alongside the body and the left arm is usually placed at a 90°angle. Adequate padding is used to avoid compression on bone prominences.
Some surgeons prefer to avoid the lithotomy position because the flexed thighs interfere with the mobility of the laparoscopic instruments through the lower ports. The patient's upper body is tilted down by 15 degrees (Trendelenberg position) and the table is to the right side (Fig. 1a). The patient's position can be adjusted intraoperatively at the stage of left flexure mobilization; the body is kept in the anti-Trendelenberg position in order to move the small bowel toward the pelvis (Fig.1b).

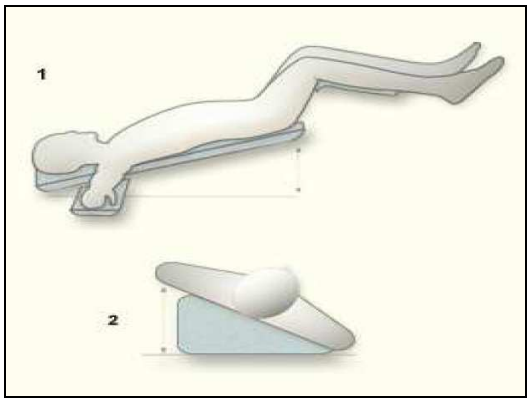

Figure 1a
Trendelenberg position with rt table tilt.

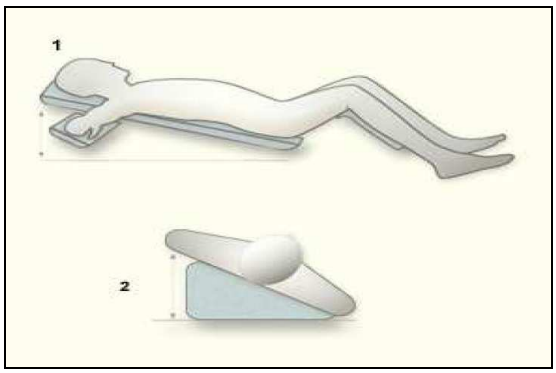

Figure 1b
Antitrendelenberg position for left flexure mobilization.

Surgical team

The procedure is usually performed with two assistants and a scrub nurse. The surgeon and the second assistant usually stand on the patient's right side, the first assistant on the patient's left, and the scrub nurse on the left foot side of the table (Fig. 2a). For dissection and mobilization of the left flexure the surgeon moves to stand between the patient's legs, the first assistant moves to the right side of the patient, the second assistant to the left side and the scrub nurse remains in the same position.
The procedure is preferably performed in a laparoscopic unit equipped with two to three monitors, adjustable intraoperatively (Fig. 2b).

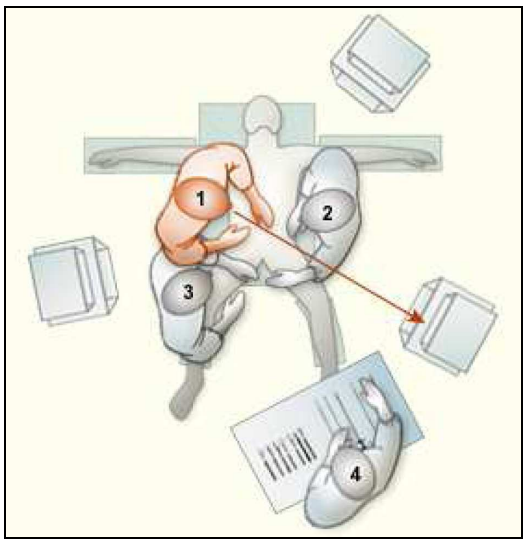

Figure 2a
Surgical team position and position of the monitors.

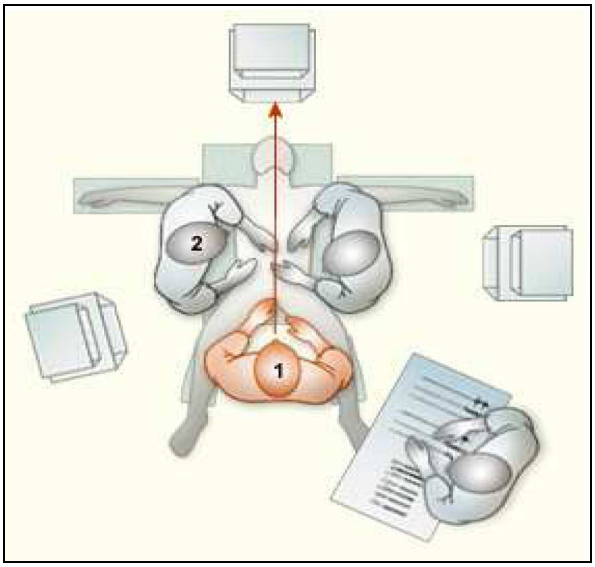

Figure 2b
Positions of the equipment and the surgical team for the laparoscopic left flexure mobilization .

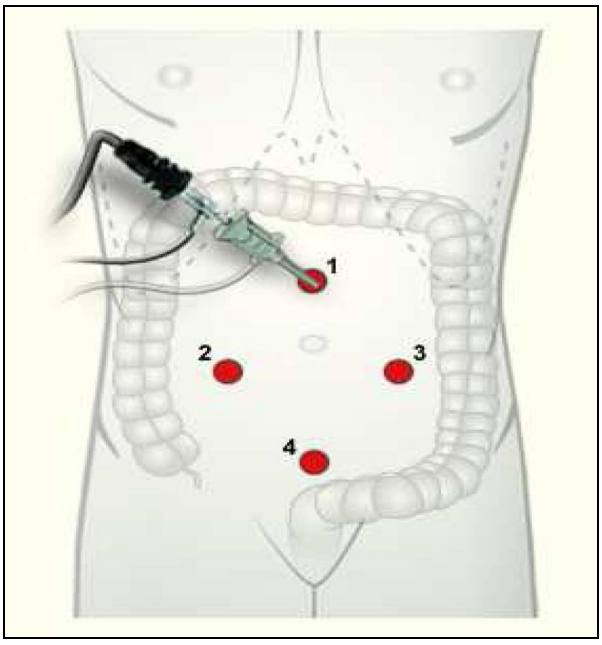

Figure 3
Trocars position for sigmoidectomy and left colectomy.

Recommended instruments

As is the case with most advanced laparoscopic procedures, the operation can only be safely performed with appropriate endoscopic and videoscopic instrumentation.

Cannula positioning

The number of cannulas, unlike their size and the length of the wound incision, has very little impact, if any, on postoperative outcomes. Although as few as three cannulas may be sufficient in uncomplicated cases, as preferred by some surgeons, we chose to standardize cannula placement and routine use of four cannulas for left-sided colectomies (Fig. 3). This allows us to achieve an excellent exposure, which may be particularly valuable at the beginning of a surgeon's learning curve. Using four to five cannulas allows the surgeon to use more instruments in the abdominal cavity for retracting the bowel and structures, especially in the presence of abundant intraabdominal fat or of dilated small bowel, as well as during mobilization of the splenic flexure.

It is important to fix the cannula to the abdominal wall in order to avoid CO_2 leakage, to minimize the passage of tumor cells and help reduce the incidence of port-site metastases in cases of malignancy (24). This is mainly achieved by fitting the size of the incision to the cannula size or by fixing the cannula to the abdomen with a suture placed around the stopcock of the cannula. We usually perform an "open" Hasson's technique for the insertion of the first cannula, which is placed at the midline above the umbilicus to reduce the risk of injury of abdominal organs. With some experience gained, the task can be performed easily and very rapidly. In patients with a history of previous abdominal operations, we usually inflate the abdominal cavity using the Veress needle which is placed in the left subcostal area to allow for the first cannula to be inserted as far lateral as possible into the right hypochondrium, thereby avoiding potential areas of postoperative adhesions.

As previously stated, the first cannula (10mm), which is used for the optical device, is positioned on the midline 3–4 cm approximately four fingerbreadths above the umbilicus.

Two operating cannulas are introduced: a10-12-mm cannula is inserted at the right midclavicular line at the level of the umbilicus to allow for the introduction of a linear stapler at the time of bowel resection. Another, 5-mm cannula is placed on the left midclavicular line 2 cm above the level of the umbilicus and accommodates an atraumatic grasper used for retraction and expo-

sure during the medial approach for the dissection of the left mesocolon. When performing mobilization of the splenic flexure, this cannula becomes an operating cannula.
A fourth, 10-12-mm cannula is placed on the midline 3–6 cm above the pubic bone and is used for retraction.
For most of the procedure, it accommodates a grasper used to expose the sigmoid and descending mesocolon. At the end of the procedure, the incision at this cannula's site is lengthened to allow extraction of the specimen.
We sometimes use an additional 5-mm cannula situated on the right midclavicular line in the subcostal area, which accommodates an atraumatic grasper used to retract laterally the terminal portion of the small intestine at the beginning of the dissection, and to retract the transverse colon during the mobilization of the splenic flexure.

Surgical technique

Exposure

For a complete exposure of the operative field, especially in the presence of obesity or bowel dilatation, active positioning of the bowel is usually necessary in addition to the passive action of gravity.
The greater omentum and the transverse colon are placed in the left subphrenic region and maintained in this position by the Trendelenburg tilt.
An atraumatic retractor may be introduced through the cannula on the left side. Next, the proximal small bowel loops are grasped gently and placed in the right upper quadrant. The distal small bowel loops are placed in the right lower quadrant with the cecum, and maintained there with gravity. If gravity is not sufficient, which is the case in patients with abundant intraabdominal fat or dilated bowel, an additional maneuver is used. Intraoperative success of laparoscopic surgery is based on many principles followed in conventional laparotomy, such as traction and countertraction, proper identification of the anatomy, including the avascular planes, and minimal manipulation of the region of pathology. However, several new techniques and operative maneuvres are unique to laparoscopy, e.g., the use of gravity for tilting the operative table allows ports and instruments to be available for other uses. Bimanual synchronous laparoscopic manipulation and adapting to viewing a three-dimensional field on a two-dimensional screen with the inherent loss of depth perception and alterations in color and lighting are important adjuncts to master.
Additional skills include familiarity with intracorporeal knot tying and the use of an angled laparoscope.
All laparoscopic-assisted colon procedures follow several common principles: (1) localization of the lesion, (2) mobilization of the colon, (3) devascularization of the specimen, (4) isolation of the specimen without spillage (dividing the bowel), (5) protection of the wound during specimen retrieval, and (6) completion of the anastomosis (intra- or extracorporeal).

Bowel mobilization and control of mesenteric vessels

After determining the location of the lesion, as previously described, mobilization of the colon begins by dividing natural attachments to the lateral abdominal wall, retroperitoneum, and other adjacent organs. These attachments can be divided using either monopolar or bipolar electrocautery or the ultrasonic scalpel.
Dissection usually begins at the sigmoid colon. The bowel is gently grasped with the atraumatic forceps and retracted toward the midline. Special attention should be paid to minimizing the risk of injury while holding the bowel. This admonition is especially pertinent to laparoscopic procedures because the semirigid abdominal wall can act as a fulcrum and magnify the traction force applied to the internal structures. We usually prefer to use an atraumatic Babcock-like clamp or atraumatic intestinal clamp and place it all the way around the intestine so that the jaws of the instrument are actually applying more pressure against the adjacent mesentery.
Dissection begins along the peritoneal reflection and proceeds cephalad and caudad. Curved scissors are preferably utilized for this maneuvre (Fig. 4).
If the dissection proceeds in the right plane, there should be minimal or no bleeding. The operating table should be placed in the steep Trendelenburg position with rotation to the right to help "drop" the small bowel away from the operative field.

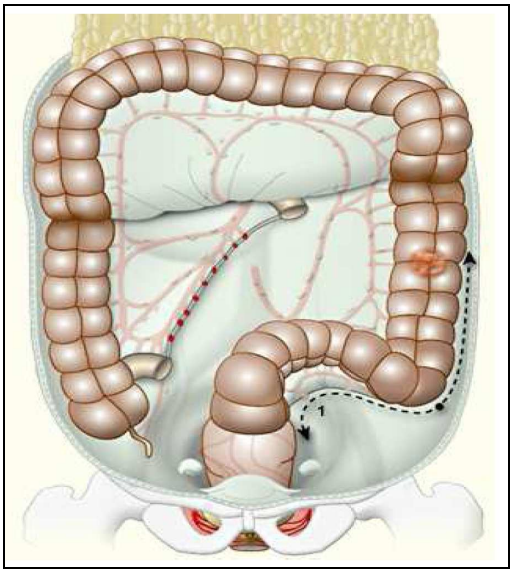

Figure 4
Lateral mobilization of colon

After dividing the lateral peritoneal attachments, the Endo-Sponge can be used to gently mobilize the colonic mesentery away from its retroperitoneal attachments. This sponge is supplied in a pretied, tubular shape that is easily introduced through a 10- or 11-mm cannula.
Ideally, the descending colon, sigmoid, and attached mesentery should be dissected to the extent to allow retraction well over to the right side of the abdominal cavity.
As the distal descending colon and sigmoid are mobilized medially, both ureters should be identified before any bleeding and staining of the tissues occurs. The landmarks used for laparoscopic identification are the same as those used during laparotomy (Figs. 5a and b).
If necessary, the ureter is mobilized laterally to avoid inclusion within the transected specimen.
Adequate mobilization of the specimen may require mobilizing the splenic flexure and portions of the transverse colon if these encompass the lesion or if additional length is necessary for a tension-free reconstruction.
This mobilization must proceed with caution in order to prevent trauma to the spleen. Usually this maneuver requires at least four laparoscopic cannulas. If extensive mobilizationof the splenic flexure is required, it is advisable to place the patient into the steep reverse Trendelenburg position with the right side tilted down so that the small bowel drops away from the operative field. The surgeon may choose to stand between the patient's legs to face directly the upper abdomen and the video monitor.

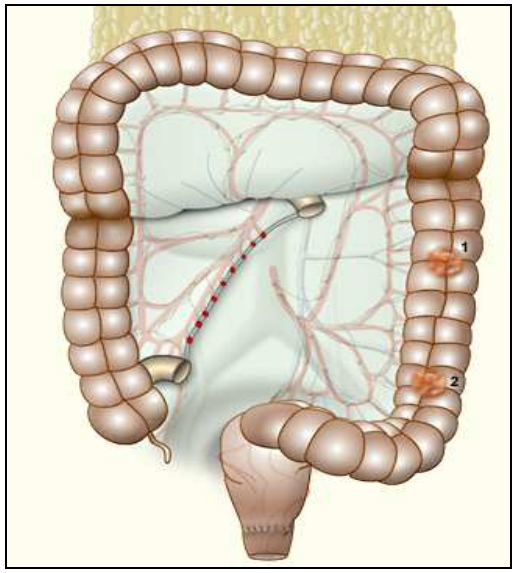

Figure 5a

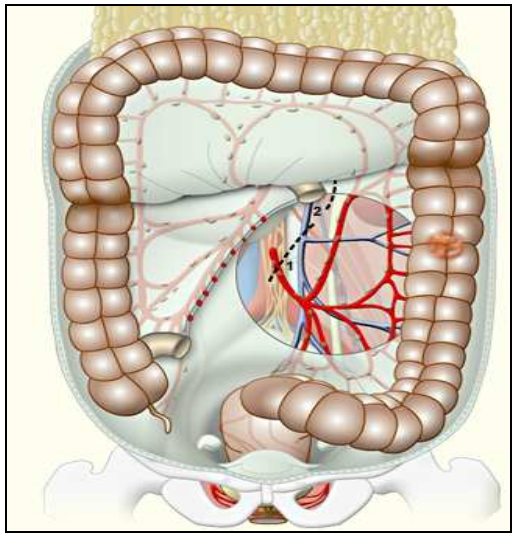

Figure 5b

Figure 5
Medial mobilization of colon.

The omentum should be retracted away from the operative field so that the surgeon has a good view of the splenic flexure. Gentle, caudad traction on the colon helps expose its attachments to the lower pole of the spleen and to any of the

perisplenic tissues. Most of these attachments can be safely divided with either a bipolar instrument or an ultrasonic scalpel. Vessels larger than 4 to 5 mm are best clipped before the division. Care must be taken to avoid injury to the spleen and to the inferior border or tail of the pancreas. Because of this fulcrum effect of the abdominal wall, traction on the tissues attached to the lower pole of the spleen is greater than appreciated by the surgeon. Some surgeons use the colonoscope to retract the splenic flexure (25). This technique has some appeal as the endoscope may already be in the operating room for localization purposes, but once again the endoscopist must try to minimize the air used to distend the bowel.

Complete mobilization of the splenic flexure may also require separation of the gastrocolic ligament. The distal transverse colon is retracted medially and caudad and, if necessary, the greater curvature of the stomach is grasped and elevated. Retraction of the stomach helps the surgeon avoid inadvertent dissection of the transverse mesocolon (Figs. 6a and b). These maneuvres should expose the gastrocolic ligament and allow the surgeon to divide the vessels with bipolar cautery, clips, or ultrasonic scalpel.

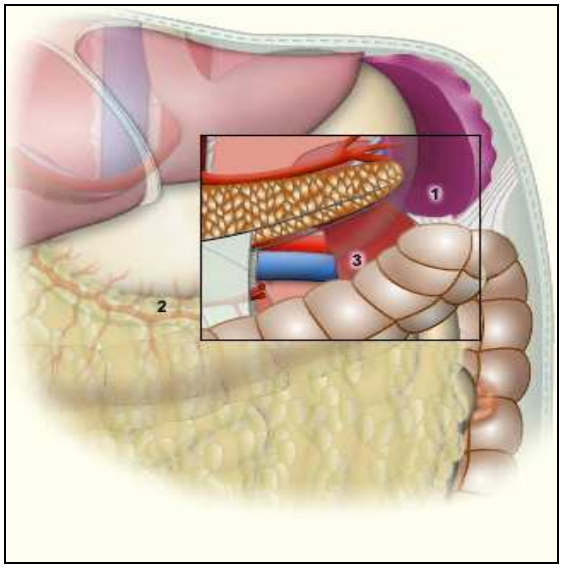

Figure 6a

For distal sigmoid or rectal lesions it may be necessary to mobilize both the bowel and the mesentery caudal to the peritoneal reflection. Dissection of the rectum to a point distal to the lesion is accomplished by retracting the rectum laterally, anteriorly, and cephalad. The ureters should once again be visualized and their course followed to the trigone of the bladder.

The plane between the mesorectum and Waldeyer's fascia is opened using bipolar cautery or the ultrasonic scalpel. The mesocolon is usually quite short and relatively avascular compared to the mesentenic attachments of the descending and sigmoid colon.

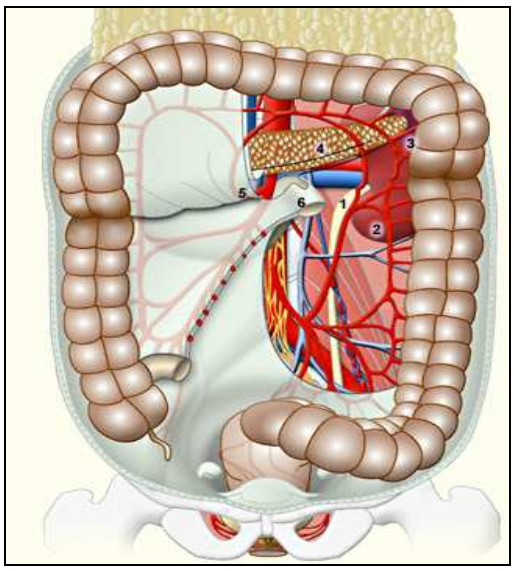

Figure 6b.

Figure 6
Mobilization of left flexure.

The surgeon performing proctectomy for benign disease should try to preserve the sympathetic nerves. The dissection plane should be kept medial to the fascia and anterior to the sacral promontory. With these maneuvres the seminal vessels should be easily visible and can be used as an additional guide to avoid injury to these nerves (Fig. 7).

Complete mobilization of appropriate segments of the colon is followed by devascularization of the specimen.

The mesentery of the colon is then placed under tension to create a "bow-stringing" effect that helps identify the aforementioned vasculature to the specimen. These large vessels are then dissected so that a window is created around the pedicle, and divided close to their origin with either clips, staples, or sutures. Before dividing

these vessels, the surgical team should re-confirm the location of the ureter(s). The remaining mesentery is then divided with cautery or the ultrasonic scalpel. Depending on the indication for surgery, this mesenteric dissection may take place near the bowel wall or lower, near the root of the mesentery, which allows for a more extensive en bloc resection (Figure 8).

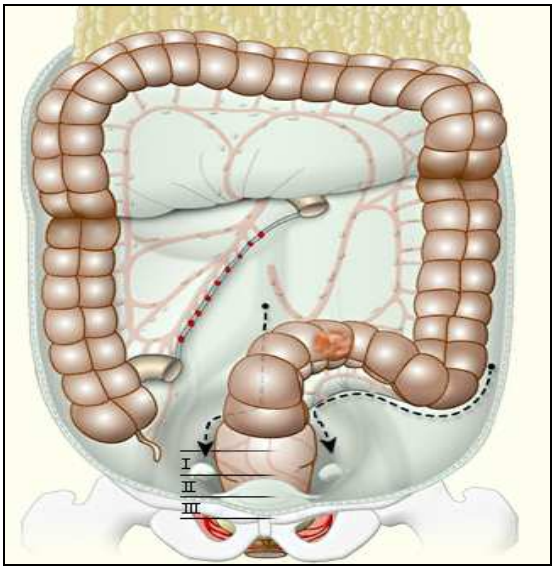

Figure 7
Moblization of the upper rectum.

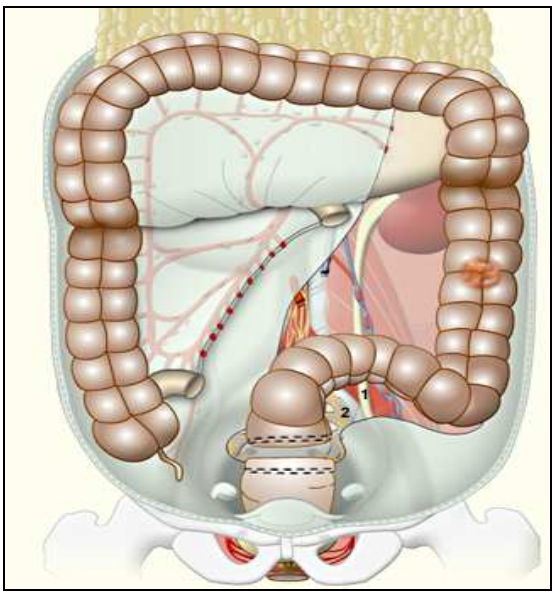

Figure 8
Complete left colon mobilization.

Specimen retrieval and colonic resection

The next step is to divide the bowel so that the specimen can be removed; this can be accomplished intracorporeally or after completely eviscerating the mobilized segment of bowel. The technique used depends on the location and the disease process requiring surgical intervention. For benign lesions in the sigmoid or distal descending colon, the surgeon can, in most cases, mobilize the bowel so that it can be brought through a 3- to 6-cm fascial opening. An opening can be made just above the pubic symphysis, or a left midabdominal or lower quadrant muscle splitting incision may be used.
Once outside the abdomen, the surgeon can confirm the localization of the pathology and then divide the bowel with either conventional instruments or staplers.

Colorectal anastomosis

The anastomosis is completed outside the abdomen and may be handsewn or stapled depending on the surgeon's preference. If necessary, any significant mesenteric defect is closed. The bowel is then placed back into the peritoneal cavity and the fascial defect is closed. The abdomen is once again distended so that the surgical team can examine the anastomosis and check for any bleeding or remaining mesenteric defects.
The extracorporeal method of resection and anastomosis may not be possible if the distal margin of resection involves the rectum that cannot be mobilized above the skin. Therefore, for most left-sided lesions, the mesenteric dissection, division of bowel, and anastomosis must be completed within the peritoneal cavity.
The mesentery is divided as described earlier. Bowel segments are usually divided using a 30- to 60-mm laparoscopic linear stapler; the stapler cartridges are selected depending on the thickness of the tissue being divided and stapled.
After isolating the specimen, an enlarged fascial opening is used to remove the specimen. If operating on a patient with a suspected localized malignancy, an impenetrable barrier is placed within the extraction site of the specimen to protect the wound against tumor implantation.

The most popular method of completing the anastomosis in sigmoid colectomy or anterior resection of the rectum is a laparoscopic-assisted procedure employing a circular stapler guided through the anus and rectum. The bowel and mesentery are divided intracorporeally and extracted via a suprapubic fascial opening.
The proximal bowel segment is eviscerated through the same opening and prepared for a stapled anastomosis. This step usually entails dissecting the attached distal mesentery so that, when fired, the staples penetrate the bowel wall, not the surrounding fat. The anvil of the circular stapler is positioned within the proximal bowel segment and a pursestring suture is placed to secure it within the lumen.
The colon is returned to the peritoneal cavity, the fascial opening closed, and the pneumoperitoneum reestablished. After gradual dilatation of the anus, the shaft of the circular stapler is introduced transanally up to the end of the distal bowel.

Figure 9
Closure of the inscion.

Exerting light pressure against the intestinal wall, the trocar within the shaft is slowly extruded until it pierces the bowel wall. Under laparoscopic guidance, the anvil of the stapler is connected to the trocar of the circular stapler. A special anvil-grasping instrument is available to help perform this maneuvre (Endo-Alis Clamp; Ethicon Endosurgery, Cincinnati, OH, USA). The circular stapler is then fired and the integrity of the anastomosis is verified by inspection of both tissue doughnuts.
Integrity of the anastomosis is tested by transanal water irrigation. If a leak is found a revision of the anastomosis is performed.
The anastomosis and the operative field are then inspected laparoscopically to assess the anastomosis and verify hemostasis. All fascial openings greater than 5 mm in diameter are closed (Figure 9).

Tips and comments

- Trendelenburg position must be sufficient for adequate exposure. The degree has to be measured, not guessed, by the anaesthesiologist.
- The left ureter is more easily found in the left parietal colic position at the learning stage and occasionally, in patients with difficult anatomy.
- With experience, however, it is easy to perform a primary control of the inferior mesenteric vessels with visualization of the left ureter from the right side.
- Complex inflammatory conditions (abscess, fistula) occasionally make the latter solution mandatory.
- The promontorium is the first landmark for the dissection of the inferior mesenteric vessels. The opening of the peritoneum at this level enables the surgeon to see the vascular elements correctly.
- Dissection of the mesorectum must be performed in close contact in order to leave the pelvic innervations and the posterior presacral fascia intact.
- To free the splenic flexure, one can choose to start at the level of the gastrocolic ligament. The retroperitoneal detachment of the mesocolic space may be hindered by the presence of excess tissue.
- One must know how to continue laterally at the parietal colic attachments or at the upper part of the splenic flexure to complete the dissection and lowering of the left angle.

- Resection of the inferior mesenteric artery at its origin may require sacrificing the left colic artery. The level of the colonic resection must be adapted to this anatomical circumstance and to the quality of the colon vascularization.
- The inferior mesenteric vein can be resected at its termination near the pancreas in a true left colectomy (transverse colon – rectal anastomosis); or, preferably lower to the left colic venous branches in the case of the resection of the descending colon.

Results and postoperative care

Patients treated by laparoscopic colon surgery experience an earlier return of gastriointestinal function than those undergoing open surgery (26).

Whether a laparotomy or a laparoscopic resection has been performed, most surgeons remove the naso- or orogastric tube at the end of the operation. Most patients can tolerate an oral diet by the first or second day after surgery and are offered liquids almost routinely the day following surgery. If liquids are tolerated, the diet is rapidly advanced to solids. Hospital stay following laparoscopic colectomy is three to five days shorter than after laparotomy (11,13,15,26).

Patients undergoing laparoscopic resections have less perceived pain and lower narcotic requirements than laparotomy patients.

Laparoscopic surgery and laparotomy yield equivalent results as regards perioperative mortality, length of specimen resected, adequacy of margins, and number of lymph nodes collected. Improved postoperative T-cell-mediated immunity, lymphocyte function, and neutrophil chemotaxis have been reported after laparoscopic surgery (7).

Return to normal activity depends on each individual's age, occupation and motivation.

Complications

A number of complications that may occur with laparoscopic colectomy have been described in several series reported in the literature. These complications, which are for the most part the same as those associated with laparotomy, include: ureteral injuries, inadvertent enterotomies, anastomotic leaks, postoperative strictures or even obstruction at the anastomosis, herniation through the mesenteric defect, and intraabdominal abscess (26-31).

In some of the earlier clinical series, very high rates of laparoscopic-associated complications (greater than 30%) and conversions (greater than 40%) were reported (32-34). These preliminary studies confirmed the fact that minimally invasive colon surgery has a steep learning curve.

Later publications have shown that, in the hands of experienced surgeons, laparoscopic colectomy is associated with a significant decrease in both major and minor postoperative complications, and has the advantage of shorter hospital stay (35,36). In addition, most clinical investigators have reported that laparoscopic surgery is associated with a considerably reduced intraoperative blood loss and that pulmonary function after the operation is significantly less compromised than in comparable open procedures (37,38).

Operative times for laparoscopic colon procedures are undoubtedly longer than those for comparable open operations. Initially, the length of operation was attributed to the steep learning curve, with some early authors reporting times in excess of eight hours (32). However, the growing experience of the surgeons has resulted in significantly reduced operative times of laparoscopy. Operative times ranging from 45 to 120 min are now not uncommon in uncomplicated cases. Initially, laparoscopic surgery may not bring overall hospital cost savings because the decreased length of hospital stay is offset by high intraoperative costs due to the added expense of laparoscopic disposable devices and longer operative times discussed earlier.

However, greater cost savings may be realized as operative times and cost of laparoscopic instrumentation start to decrease as a result of production and economic market forces driven by competition. It needs to be stressed that the patient's return to usual activities and work is much faster with the laparoscopic approach (35,39). This advantage has been underreported as a cost benefit to both society and the business community, and has thus been poorly recognized. In view of the growing concerns of employers about sick leaves taken by their employees, the advantages of the operative method described will certainly play a greater role in the managed care market.

Conclusion

Laparoscopic colon surgery has been performed in the United States since 1990. The surgeon using the laparoscopic approach can follow nearly all the principles governing colonic resection. In experienced hands, laparoscopic surgery offers the the advantages of decreased postoperative pain, shorter hospital stay, better cosmesis, and faster return to normal activity.

As a result, this procedure has been enthusiastically embraced by many clinicians as a reasonable treatment option for benign colonic disorders or as a palliative procedure in unfortunate individuals with distant metastatic cancer.

In the past, great caution was used in selecting patients with localized cancer as possible candidates for laparoscopic surgery. A review of the current available literature revealed a number of short-term benefits of laparoscopic resection for colon cancer, including decreased postoperative pain and reduced analgesia requirements, quicker recovery of bowel function, shorter hospital stay, and potentially decreased rate of wound infection. Moreover, patients undergoing laparoscopic colectomy report improved quality of life, particularly in terms of social function. Cost analyses have demonstrated comparable overall net costs of laparoscopic and open colectomy for cancer, despite higher operative costs associated with laparoscopy. Randomized studies have also demonstrated that laparoscopic and open colectomy for cancer, when performed by experienced surgeons, yield equivalent and satisfactory oncologic resections, in terms of the number of lymph nodes retrieved and resection margins. Also, long-term outcomes have been shown to be equivalent in terms of 3- and 5-year survival rates, and disease-free survivals. The two techniques are associated with similar rates of wound/port site tumor recurrences (19-21).

As a result, increased numbers of patients have been enrolled in prospective randomized trials to determine the appropriateness of laparoscopic intervention, one of these trials being a large, multicentre trial, funded by the National Cancer Institute. Smaller prospective clinical series focusing on this issue have been reported (39-42). The laparoscopic approach for resection of colon carcinomas is a viable, effective procedure, with definite advantages for the patient and with potential future cost benefits. Today, laparoscopic surgery is considered a safe and feasible treatment option with favourable short- and mid-term outcomes in selected patients with rectal cancer (43).

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