Colon cancer continues to be a disease of significant burden worldwide. In the United States, it is the third most commonly diagnosed cancer and cause of cancer death. In 2013, 102,480 new diagnoses of colon cancer are expected in the United States, with an additional 40,340 new cases of rectal cancer. This is despite the overall declining incidence of 2 to 3% per year seen since 1998, thought to be due to the growing prevalence of colorectal cancer screening.

The majority of patients diagnosed with colon cancer will benefit from a properly performed oncologic surgery, which typically involves a partial colectomy to achieve locoregional control and establish the true stage of the cancer. Partial colectomy is one of the most commonly performed operations in the United States. With well over 250,000 colectomies performed annually, colon cancer is the most common indication. Patient outcomes from these operations are increasingly scrutinized because of the considerable morbidity and mortality associated with these procedures. Overall, morbidity after colectomy stands at 24%, with major morbidity occurring in 11% and mortality in 3%. Therefore, it is critical that general surgeons are adept in managing this disease and performing the appropriate operation. In this review, we address the technical issues of safe and oncologically proper methods of colon cancer resection with appropriate preoperative planning and postoperative care involved in these important and commonly performed operations.

**Indications for Surgery**

In general, resection is the mainstay of therapy for all patients with nonmetastatic disease. A small minority of patients may not be candidates for surgical resection due to medical comorbidity. For patients with metastatic disease, thorough consideration of the risks and benefits of resecting the primary tumor will determine the proper approach. Patients who are candidates for resection of metastatic disease can usually undergo resection of the primary tumor simultaneously. However, the majority of patients with unresectable metastatic disease, which determines the prognosis, can have their primary colon tumor managed without surgery. Patients with endoscopically unresectable polyps that are histologically benign should be treated according to the same oncologic principles as patients with colon cancer. There is a dual rationale for this seemingly aggressive approach. First, there is a distinct likelihood that the polyp may harbor an undiagnosed carcinoma. This risk of carcinoma is approximately 17%, and polyps with dysplasia on histology from endoscopic biopsy or those that are left sided are at greater risk for containing cancer. The risk is not necessarily proportional to polyp size, as previously reported. Second, there is a distinct but unquantifiable risk that the polyp will degenerate into a malignant lesion over time.

When a malignant polyp is identified after endoscopic polypectomy, it should be considered an indication for colectomy unless specific criteria are met: (1) pathologic evaluation confirms at least a 2 mm margin and (2) absence of any unfavorable histologic features, such as poor differentiation, lymphovascular invasion, or extensive budding. The cancer should also be limited to the superficial submucosal layer (SM1 or SM2). When unfavorable histologic features are present, even when the malignant polyp is adequately excised, the risk of nodal metastasis rises, requiring an oncologic resection even in the absence of residual disease in the bowel wall.

**Preoperative Planning**

Preoperative planning of an operation for a patient with colon cancer includes the need for the surgeon to understand as best as possible the location of the tumor in the colon, the clinical stage of the cancer, and the patient’s physiologic status and risk factors. The informed consent process should always include a discussion of the minor and major complications of a major abdominal operation, including the infrequent but dreaded complication of anastomotic leak and possible need for temporary ostomy, either at the time of surgery or as a result of postoperative complication.

**Colonoscopy**

It is imperative that a patient with a colon cancer diagnosis have a preoperative complete endoscopic evaluation of the colon whenever technically feasible. A patient who has a neoplastic process in one segment of the colon has greater risk in other segments. A study of patients with obstructing colon cancers demonstrated a 58% synchronous adenoma rate and a 6% synchronous cancer rate.

Endoscopic tattooing of the tumor site should be performed routinely with submucosal injection except in situations where localization is straightforward due to the tumor being within constant anatomic landmarks, such as the ileocecal valve, or the tumor is large and can be localized on a computed tomographic (CT) scan. Preoperative endoscopic tattooing is especially critical when dealing with the site of a malignant polyp that was removed endoscopically with positive margins. In these cases, the patient should undergo a second endoscopy to ink the polypectomy site as soon as the endoscopist learns of the malignant diagnosis, before the polypectomy site heals and becomes impossible to localize. This tattoo is important regardless of whether or not a colon resection is planned.

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Even if a colectomy is not performed, the tattoo will facilitate future surveillance endoscopy.

**Endoscopic Stenting**

When a patient presents with a distal colonic obstruction due to a colon cancer, endoscopic stents can often be a valuable tool to convert an emergency operation to a controlled semielective one. Although there are pitfalls such as perforation, stenting can be an excellent bridge to resection or as palliation to relieve obstruction in patients with advanced metastatic disease who are not fit for surgery or have a very limited prognosis. Patients who are candidates for curative surgery can benefit from preoperative stent placement. In select cases, stents can facilitate primary anastomosis and avoid the need for ostomy formation by allowing normalization of bowel integrity. In addition, this allows time for preoperative physiologic optimization of the patient. Successful stent deployment and subsequent definitive resection after about 7 days of decompression can be achieved in approximately 70% of patients.

Stenting as a bridge to resection is generally not useful in patients with colonic obstructions proximal to the splenic flexure as these lesions are best treated with a right hemicolectomy or extended right hemicolecetomy. These types of resection involve an anastomosis between ileum and colon distal to the site of obstruction and therefore are not facilitated by decompression.

**Computed Tomography**

Contrast-enhanced CT scanning of the chest/abdomen/pelvis is the recommended initial staging study for colon cancer. Patients found to have unresectable hepatic metastases or those replacing more than 50% of the hepatic parenchyma should be referred for systemic therapy as the risks of hepatic failure and mortality are high in these patients. When resectable or borderline resectable liver metastases are identified, a multidisciplinary decision should be made on the sequence of treatment. The options include simultaneous liver and colon resection followed by systemic chemotherapy or upfront chemotherapy followed by simultaneous versus staged liver and colon resection. CT imaging that identifies invasion of the tumor into adjacent structures such as the duodenum or bladder may alter the surgical plan, possibly necessitating the involvement of multiple surgical disciplines. CT combined with positron emission tomography (PET) is not recommended for initial staging in lieu of a contrast-enhanced CT scan but may be useful in the evaluation of indeterminate findings or in the setting where recurrence is suspected.

**Genetic Testing**

Although a review of the ever-expanding role of genetic analysis in surveillance and personalized treatment planning for colon cancer patients is beyond the scope of this review, its role in preoperative planning is worth noting. Hereditary colorectal cancer syndromes are thought to account for up to 10% of all colorectal cancers, with another 20% having a familial predilection for colorectal cancer without a clear genetic footprint being identified.

Hereditary colorectal cancer syndromes can be divided into those associated with colonic polyposis (e.g., familial adenomatous polyposis [FAP]) and those not associated with colonic polyposis (e.g., hereditary nonpolyposis colon cancer [HNPPC]). The decision to initiate genetic testing and counseling for a patient with colon cancer diagnosed in the setting of polyposis is intuitive. Such a decision is more difficult when polyposis is not present; therefore, selecting which patients should be tested for HNPCC requires consideration of a number of clinical features, including personal and family history as well as morphologic features of the tumor(s). Germline mutations in the mismatch repair (MMR) genes MLH1 and MSH2 are responsible for the majority of cases of HNPCC, followed by MMR mutations in MSH6, PMS2, and EPCAM. Individuals with HNPCC have an 80% lifetime risk of colon cancer, with a predominance of cancers proximal to the splenic flexure (68% HNPCC versus 49% sporadic cases) and a higher incidence of synchronous cancer (7% HNPCC versus 1% sporadic cases) and metachronous cancer (29% HNPCC versus 5% sporadic cases).

The propensity for development of a metachronous cancer after resection of the index cancer is the basis for the patient with HNPCC to consider a total abdominal colectomy with ileorectal anastomosis with subsequent annual proctoscopy over a partial colectomy. If this is not undertaken, the patient with HNPCC should be advised to undergo surveillance with annual colonoscopy.

Mounting evidence suggests that there will likely come a time when all patients with colon cancer are offered some form of genetic testing, but a “test all” approach is not yet practical or cost-effective. Therefore, a selective approach is generally recommended. For a patient with colon cancer diagnosed at under 50 years of age or a patient with colon cancer over 50 years of age with a first-degree relative with HNPCC to consider a total abdominal colectomy with ileorectal anastomosis followed by subsequent annual proctoscopy.

The role of preoperative mechanical bowel preparation in patients undergoing colectomy has been a topic of debate over the past decade. Patients have traditionally been required to undergo preoperative mechanical bowel preparation with the belief that it would reduce the risks of surgical site infection and anastomotic leak. We now know that the risk of overall complications is similar regardless of whether mechanical bowel preparation was performed and the practice of mandatory bowel preparation of the past was largely unnecessary. However, there are some differences in individual complications, with a lower risk of intra-abdominal abscess and higher surgical site infection rates in patients who undergo preparation. These findings have supported the omission of bowel preparation in enhanced recovery after surgery pathways to minimize the fluid shifts...
of bowel preparation that may result in delayed return of bowel function.\textsuperscript{29,30}

Currently, bowel preparation is best considered discretionary. Apart from the mixed effect of bowel preparation on patient outcomes, there are a number of situations in which bowel preparation has practical utility. A prepared colon will allow for intraoperative colonoscopy if the location of a tumor is ever in question. Also, when performing laparoscopic colon surgery, a colon that is distended with solid stool can be very difficult to manipulate and exteriorize, thereby compromising the surgeon's ability to offer patients a minimally invasive operation. This is especially true when a left-sided colon resection is required.

**STOMA MARKING**

Very few patients with colon cancer require a stoma. However, in situations when a stoma is contemplated or possible (e.g., obstruction, perforation, or immunocompromised state), preoperative marking of the stoma site is strongly advised. There are significantly fewer stoma-related complications in patients who have been marked for a stoma site preoperatively.\textsuperscript{31} Stoma marking and education are typically done by a certified enterostomal therapy nurse, but if one is not available, the surgeon should mark the site preoperatively according to a few basic principles. This includes choosing a site over the rectus muscle that is flat and visible to the patient in the sitting and standing positions and avoiding the creases of abdominal folds as these will lead to difficulty with pouching of the stoma with an appliance. In morbidly obese patients, placing the stoma through the rectus on the upper abdomen (where the abdominal wall is thinner) is a safe strategy.\textsuperscript{32}

**DEEP VEIN THROMBOSIS PROPHYLAXIS**

Patients with cancer have an increased risk of deep vein thrombosis (DVT) and pulmonary embolism (PE). This risk is intensified with the addition of major abdominal surgery and is a major contributor to mortality after surgery for colon cancer. Without prophylaxis, the risk of DVT is as high as 30%.\textsuperscript{33} Patients undergoing surgery for colon cancer should receive a preoperative dose of subcutaneous heparin followed by postoperative heparin three times daily, as well as sequential compression devices and early mobilization.\textsuperscript{33} Pharmacologic prophylaxis regimens have not been associated with any significantly increased risk of bleeding.\textsuperscript{34}

**PREOPERATIVE ANTIBIOTICS**

Current guidelines under the Surgical Care Improvement Project include perioperative antibiotic (e.g., ertapenem) started within 1 hour of incision, usually as a single dose but not to exceed 24 hours of therapy if redosed. Surgical site hair should be clipped rather than shaved. Urinary catheters should be removed by postoperative day 2 unless there is a specific indication such as urinary retention, and normothermia should be maintained perioperatively.\textsuperscript{35}

**PREOPERATIVE URETERAL STENTING**

The intimate association of both ureters with the colon makes them vulnerable structures to injury that may lead to significant morbidity. A thorough understanding of anatomy and meticulous dissection and identification of the ureters should keep them safe in routine cases. However, in the setting of bulky tumors, recurrent cancer cases, or expected inflammatory disease in the rectosigmoid or cecum that may distort anatomy, ureteral stents can be very useful.\textsuperscript{36} Ureteral stents offer a means for both visualization and palpation of the ureters. A selective approach to ureteral stenting in complex cases should not require a significant amount of additional time at the start of surgery, can save a significant amount of time, and provides reassurance during surgery in the setting of troublesome anatomy while being at least cost neutral.\textsuperscript{37,38}

**Technical Considerations**

**LAPAROSCOPIC VERSUS OPEN SURGERY**

The safety of laparoscopic surgery for colon cancer is now widely accepted and is gradually becoming the standard of care for the majority of cases.\textsuperscript{39,40} Laparoscopic colectomy has been shown to have short-term advantages over open colectomy in terms of earlier return of bowel function leading to shorter hospital stay (1 or 2 days); reduced postoperative pain, narcotic use, and complication rates; and improved quality of life in the initial postoperative period.\textsuperscript{41-47} Analyses of cost also favor laparoscopic colectomy because the greater expense of the surgical instruments and longer operating times are outweighed by the savings incurred by a shorter hospital stay.\textsuperscript{46-48} Laparoscopic colectomy also provides the advantage of cosmetic results and body image perception, although long-term quality of life is similar. The value of the reduced surgical site complications in colon cancer patients is probably understated, especially for patients who receive adjuvant chemotherapy as wound complications can delay initiation of systemic therapy. The multicenter prospective randomized trials carried out by the COST, CLASICC, and COLOR study groups showed that survival, recurrence, and complications were not significantly different between laparoscopic and open approaches over long-term follow-up.\textsuperscript{41,49,50}

The decision of whether to pursue a laparoscopic or open operation for a patient with colon cancer should be determined by both patient factors and surgeon factors. Some patients are not good candidates for laparoscopic surgery. It is also expected that some tumors are not appropriate for a laparoscopic approach. In fact, the most common indication for conversion from laparoscopic to open surgery in the COST trial was tumor-related factors. It is critical that the quality of the surgery is not compromised for the sake of performing the operation laparoscopically. When all else is equal, a laparoscopic approach is probably preferable, but it is important that surgeons are aware of their skill and experience and remember that a well-performed open surgery is superior to a poorly performed laparoscopic one.

**ONCOLOGIC CONSIDERATIONS**

The key to a proper oncologic resection for a colon cancer requires clear margins, resection of the locoregional lymph node–bearing mesentery for both cure and accurate staging, and fashioning of an air-tight, tension-free, and well-vascularized anastomosis. In general, a proximal and distal margin of at least 5 cm from the tumor is considered...
appropriate, although additional length of resection is often required as determined by the vascular supply to the colon segment. The proximal and distal margins are usually easily obtained when an adequate mesenteric resection is performed. When a colon cancer has invaded locally into surrounding structures such as small bowel, duodenum, or bladder, an en bloc resection should be planned.

Once the tumor and its associated mesentery are resected, a large portion of the pathologic evaluation of the specimen is focused on evaluation for nodal metastases. The correlation between the number of lymph nodes analyzed and the patient’s oncologic outcomes has been an area of extensive study. Numerous studies have shown an improvement in disease-specific and overall survival when increasing numbers of lymph nodes are examined for stage II and stage III colon cancer. In fact, consensus guidelines have suggested that examination of 12 regional lymph nodes is a minimum for adequate nodal evaluation for colon cancer. These have led to a belief that an adequate lymph node analysis is a measure of quality of care. The improvement in outcomes is probably due in part to stage migration or more accurate staging that allows for increased use of adjuvant chemotherapy. The adequacy of lymph node examination for colon cancer may alternatively be a proxy for other factors that account for the improvement in outcomes, such as overall surgical technique, multimodality therapy, and cancer surveillance activities. The suggestion that there is a direct therapeutic benefit from a more complete surgical lymphadenectomy and pathologic examination is speculative at this point. Therefore, the focus should be on adhering to meticulous oncologic principles and techniques to produce high-quality patient outcomes rather than achieving a specific lymph node “count” as the target outcome.

As a general rule, the extent of resection in a colectomy should encompass one blood vessel proximal and one vessel distal to the tumor location in the colon [see Figure 1 and Figure 2]. Therefore, for tumors anywhere along the ascending colon, a right hemicolectomy is required. This involves proximal resection of 5 to 10 cm of terminal ileum with ligation of the ileocolic pedicle origin and right branch of the middle colic vessels, with distal margin transection at the level of the proximal to midtransverse colon. A tumor at the hepatic flexure or transverse colon requires an extended right hemicolectomy, which involves ligation of the middle colic vessels at their origin rather than only the right branch of the middle colic vessel as in a standard right hemicolectomy. The distal margin of resection is at the distal transverse colon. A transverse colectomy is not appropriate oncologically for a transverse colon cancer unless limited surgery is being performed for palliation or the patient cannot tolerate more extensive surgery. Tumors in the distal

![Vascular anatomy of the colon.](image-url)
Figure 2  
(a) Oncologic resection of cecal and ascending colon carcinoma.  
(b) Oncologic resection of hepatic flexure carcinoma, in which the distance between the tumor and the left branch of the middle colic vessels is greater than 10 cm.  
(c) Oncologic resection of proximal transverse colon carcinoma, in which the distance between the tumor and the left branch of the middle colic vessels is less than 10 cm.  
(d) Two options for resection of transverse colon carcinoma: transverse colectomy (A) and extended right hemicolectomy (A plus B).  
(e) Two options for resection of splenic flexure carcinoma: splenic flexure resection (A) and left hemicolectomy (A plus B).  
(f) Oncologic resection of descending colon carcinoma.  
(g) Oncologic resection of sigmoid colon carcinoma.
transverse or splenic flexure require a left hemicolectomy with ligation of the left branches of the middle colic vessels, inferior mesenteric vein (IMV), and left colic vessels. A subtotal colectomy from terminal ileum to descending colon may also be performed for tumors at or distal to the splenic flexure, particularly in the setting of an obstructing tumor, where the colon proximal to the tumor cannot be evaluated for synchronous disease. The surgical approach to cancers in the descending colon also requires a left hemicolectomy and should involve ligation of the left colic vessels at their roots with preservation of the superior rectal (hemorrhoidal) artery, ligation of the IMV at the inferior border of the pancreas, and ligation of the arcade of vessels or left branch of the middle colic vessel at the proximal point of transection depending on the specific tumor location. A lesion in the sigmoid colon requires a high ligation of the inferior mesenteric artery (IMA) at its origin. High ligation of the IMV is usually performed to achieve adequate length for colorectal anastomosis. Once the specimen is completely removed, if the tumor is not obviously palpable, it is critical that the bowel is opened and examined to ensure that the pathology is adequately removed prior to proceeding with bowel anastomosis.

FUNDAMENTALS OF LAPAROSCOPIC COLON SURGERY

A successful laparoscopic colectomy requires a degree of planning that is often not part of an open colectomy. Patient positioning is critical in laparoscopic colectomy. For most laparoscopic operations, the patient is placed in the low lithotomy position to allow for a surgeon or assistant to stand between the legs as well as have access to the rectum for circular stapling devices and intraoperative endoscopy. Both arms should be carefully padded at all pressure points and tucked at the sides, with the hands well protected from the moving parts of the lower extremity stirrups. Specific attention should be given to securing the patient to the bed to avoid slipping during surgery. This can be achieved with the help of foam padding under the patient and placement of straps from the operating table across the patient’s chest. It is crucial for patients in the lithotomy position to have their knees in even profile with their torso to avoid collision of the laparoscopic instruments with the lower extremities.

When the planned operation is a laparoscopic right hemicolectomy for a definitively localized tumor and there is no risk of the need for intraoperative colonoscopy, positioning the patient supine with only the left arm tucked is an appropriate and simpler alternative. Once the patient is secured, this should be confirmed by tilting the table in all extreme positions. Careful positioning will allow the patient to be placed safely in the deep Trendelenburg position, the reverse Trendelenburg position, and lateral rotation, thereby allowing gravity to function as a retractor.

The choice of a straight laparoscopic approach versus a hand-assisted laparoscopic approach, especially in complex cases and the obese population, is largely a matter of surgeon preference. The hand-assisted approach is rarely of significant benefit in right colectomy but can be very useful in expediting an operation or enabling a laparoscopic approach in left-sided or total colectomy. In a prospective randomized study, hand-assisted laparoscopic colectomy resulted in significantly shorter operative times and fewer conversions while maintaining clinical outcomes similar to those of straight laparoscopic techniques for patients undergoing left-sided colectomy and total abdominal colectomy. In most instances, an extraction site of approximately 3 to 5 cm in length will be required depending on the size of the specimen and the patient’s body habitus. This extraction incision is slightly larger (6 to 8 cm) when a hand-assisted approach is used. This extraction incision, which typically starts out as a working port, which is then enlarged for specimen removal, can be made around the umbilicus, the lower midline or Pfannenstiel, or at a planned ostomy site.

In open surgery, a colectomy can be performed effectively without the use of special energy delivery devices. In laparoscopic surgery, however, vessel-sealing energy devices have been revolutionary in easing some of the technical challenges surgeons would face without them. These include ultrasonic shears and bipolar sealing devices. The Harmonic Scalpel (Ethicon Endosurgery, Cincinnati, OH) is approved for sealing vessels up to 5 mm. The LigaSure (Covidien, Mansfield, MA) and EnSeal (Ethicon Endosurgery) are bipolar sealing devices that are effective for sealing vessels of up to 7 mm in diameter. All of the vascular pedicles that may need to be divided in a colectomy (ileocolic, middle cerebral artery, IMV, IMA) can usually be safely sealed with the EnSeal or LigaSure, making them currently the most commonly used energy delivery devices in laparoscopic colectomy. Thermal spread does extend for 2 to 3 mm, however; therefore, care must be exercised when using these close to adjacent structures such as bowel to avoid inadvertent thermal injury. Lastly, although these energy devices have become safe alternatives to vascular staplers and clips, their efficacy is diminished when applied to calcified arteries. Therefore, vascular staplers and clips should be considered instead when a calcified mesenteric vascular pedicle is encountered.

COLONIC MOBILIZATION

There are several acceptable approaches to mobilizing and resecting segments of the colon for cancer, and expert surgeons advocate various techniques. Our description here provides general technical principles and anatomic landmarks that should be applicable to all patients. There are two prevalent approaches to mobilization of the colon: medial to lateral and lateral to medial. Many surgeons find that a lateral to medial approach, performed similarly in both open and laparoscopic cases, is more straightforward. However, most of the early pioneers in laparoscopic colon surgery described a medial to lateral dissection, a technique that is not commonly employed for standard open resections. This technique advocates vascular isolation and high ligation first, followed by dissection into the retromesocolic plane to separate the mesocolon from the retroperitoneum, with lateral attachments of the colon left intact until the end of the dissection. Proponents of the medial to lateral approach point out that leaving the lateral attachments intact until the mesocolon is dissected and ligated provides upward retraction and exposure of the mesentery to facilitate high ligation and keeps the redundant of a laterally mobilized colon out of the way.

Regardless of the technique advocated, depending on the patient, each approach may have substantial advantages over the other. Therefore, it is wise for a surgeon to be
versatile and familiar with anatomy and various approaches for dissection whether operating openly or laparoscopically in case of unexpected pathology or other anatomic obstacles that a patient may present.

**OPEN RIGHT COLECTOMY**

The patient is placed supine on the operating table. A vertical midline incision is made, mostly cephalad to the umbilicus, and exposure of the operative field is established with a self-retaining retractor such as the Bookwalter. Thorough examination of the peritoneal cavity for metastatic disease is performed with particular focus on potential metastasis to the liver, peritoneal surfaces (carcinomatosis), and ovaries. The resectability of the tumor is determined, and if the tumor is adherent to adjacent viscera, an en bloc resection should be performed. It is uncommon for a right colon cancer to be unresectable, and careful review of the preoperative staging CT scan usually avoids encountering an unresectable tumor intraoperatively as a surprise. When, on occasion, an unresectable tumor is encountered due to extensive involvement of the vena cava, head of the pancreas, or superior mesenteric artery, a palliative resection or intestinal bypass is recommended.

The operation is commenced with retraction of the cecum anteriorly and medially, and the peritoneal attachments of the inferolateral portions of the cecum and the terminal ileum are divided with electrocautery. With appropriate retraction on the cecum, sharp dissection is used to release the mesentery from the retroperitoneum. At this point, the right ureter can usually be seen laterally, crossing the iliac artery at its point of bifurcation [see Figure 3]. The lateral peritoneal attachment of the colon (i.e., the white line of Toldt) is sharply incised, allowing for lateral to medial mobilization of the right colon and mesentery. The retroperitoneal surface should deliberately be left intact and the mesentery sharply peeled off it. Dissecting into the retroperitoneum can lead to losing the proper dissection plane and inadvertent mobilization and injury of the right kidney, ureter, or duodenum. The duodenum should always be identified and preserved during a right colectomy as the colon mesentery is mobilized medially and dissected apart from the mesentery, pushing it back toward the retroperitoneum. This maneuver will facilitate high ligation of the colon mesentery without risking injury to the duodenum. The hepatic flexure must also be completely released. The suspensory ligaments of the hepatic flexure should be ligated in a hemostatic fashion as large veins are often present within them, which can retract and bleed. While taking down the hepatic flexure, a decision should be made regarding whether an omentectomy will be performed. It is generally accepted

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**Figure 3** Anatomic relations between the colon and the retroperitoneal organs.
that partial omentectomy should be performed in the case of malignancies near or distal to the hepatic flexure. Next, the lesser sac must be entered to mobilize the proximal transverse colon. The most common approach to doing this is by lifting the omentum anteriorly and incising the avascular attachment of the posterior leaflet of the omentum to the anterior surface of the colon. If the omentum is planned to be resected en bloc with the transverse colon, the gastrocolic omentum itself is divided, leaving a small portion of omentum attached to the stomach and gastroepiploic vessels. As the hepatic flexure and proximal transverse colon are mobilized toward the middle colic vessels, excessive medial traction must be avoided as that may lead to tearing of vessels, including the gastrocolic trunk, superior mesenteric vessels, and branches of the pancreaticoduodenal vessels, especially as they converge over the head of the pancreas, where these vessels will retract and lead to troublesome bleeding.

Once mobilization of the colon and mesentery is complete, the sites of proximal and distal transection of the bowel are determined. Proximally, transection of the terminal ileum is usually standard within 5 to 10 cm of the ileocecal valve. The distal site of transection is determined by whether a standard right hemicolectomy is planned versus an extended right hemicolectomy when the tumor involves or is distal to the hepatic flexure. A standard right hemicolectomy is appropriate for tumors proximal to the hepatic flexure, removing the right branch of the middle colic artery along with the associated nodal tissue as its distal transection site. When an extended right hemicolectomy is required, the dissection of the retroperitoneal plane from the mesocolon is extended distal to the main middle colic arterial trunk anterior to the pancreas, where it is ligated and included in the resected specimen. An extended right hemicolectomy requires considerably more effort than a standard resection, not only in isolating and ligating the middle colic pedicle at its origin but also perhaps more so in ensuring adequate mobility and perfusion of the remaining transverse colon and splenic flexure for the creation of an ileocolic anastomosis. Since the distal transverse colon and splenic flexure will no longer receive blood flow from the middle colic artery, its perfusion is dependent on collateral circulation via the marginal artery arising from the left colic vessels. Although this collateral circulation is usually sufficient, there may be some patients, especially those with vascular disease, in whom the distal transverse colon or splenic flexure is no longer adequately perfused for anastomosis. If the remaining perfusion is questionable, the resection should be continued to include the remaining transverse colon and splenic flexure and an ileum to descending colon anastomosis should be planned.

Once the proximal and distal transection of bowel is performed along with mesenteric division and vascular pedicle ligation according to the location of the tumor, the specimen is liberated and an ileocolic anastomosis may be performed. A variety of anastomotic techniques may be performed, and these are generally categorized as stapled versus hand sewn. In a recent meta-analysis, stapled ileocolic anastomoses demonstrated a lower leak rate compared with hand sewn, although the rates of reoperation and other anastomotic complications were not significantly different. Therefore, the selection of anastomotic technique should ultimately be determined by the experience and preferences of the operating surgeon. The authors prefer a stapled side-to-side functional end-to-end anastomosis (EEA). Regardless of the chosen technique, the anastomosis should be performed on well-perfused small bowel and colon in antimesenteric areas where the staple or suture lines do not disrupt mesenteric blood flow, cause bleeding or hematoma at the anastomosis, or incorporate excessive serosal fat appendages. Furthermore, special attention must be paid to ensuring proper orientation of the small bowel mesentery and preventing the small bowel from twisting proximal to the anastomosis. Traditional teaching has also been to close the resulting mesenteric defect to reduce the risk of an internal hernia and obstruction, but a recent study suggested that leaving the defect open does not lead to any significant consequences.61

**LAPAROSCOPIC RIGHT COLECTOMY**

The steps for a laparoscopic right colectomy [see Video 1] are very similar to those described above for open right colectomy when a lateral to medial dissection is chosen. The patient is positioned for a laparoscopic approach, as previously described, and ports are positioned after establishing pneumoperitoneum with CO₂ and placed in the steep Trendelenburg position with the right side elevated [see Figure 4]. The small bowel is swept out of the pelvis and to the left, and the omentum is also swept over the liver and into the epigastrium. The cecum is grasped through the left lower quadrant port, typically by the pericecal or periappendiceal appendages, and retracted anterioy and medially [see Figure 5]. The surrounding peritoneal attachments are incised with laparoscopic scissors with a cautery attachment through the right suprapubic port, and the lateral to medial mobilization is completed as described for open right colectomy.

When a medial to lateral approach is preferred, the cecum is grasped and retracted anteriorly and laterally to place the ileocolic vascular pedicle on stretch and the peritoneal surface is incised along the posterior groove of the pedicle to create a retromesenteric window [see Figure 6]. The avascular plane between the mesentery and the retroperitoneum is identified and bluntly dissected all the way to the abdominal wall laterally and the transverse colon...
Figure 4  Port positioning for laparoscopic colectomy. (a) Right colectomy port placement. (b) Left colectomy port placement.

Figure 5  Laparoscopic colectomy: right hemicolecctiony. Right colon mobilization.

Figure 6  Laparoscopic colectomy: right hemicolecctiony. Right colon mesenteric dissection.
superiorly. The duodenum must be identified and dissected off the mesentery during dissection prior to ligating the ileocolic pedicle at its origin with a vessel-sealing device such as the LigaSure or EnSeal. The remainder of the ascending colon mesentery is divided up to and including the right branch of the middle colic artery. This leaves only a thin layer of lateral attachments of the ascending colon and terminal ileum as well as the hepatic flexure holding the right colon. These attachments are then easily incised to release the terminal ileum such that it could easily be exteriorized through an umbilical extraction incision.

Whether a lateral to medial or medial to lateral dissection is undertaken, as the hepatic flexure is approached, the patient should be repositioned in the reverse Trendelenburg position, still with the right side up, allowing the weight of the transverse colon to provide caudad retraction on the hepatic flexure. The attachments of the hepatic flexure can then be dissected posteriorly off the retroperitoneum and divided with a vessel-sealing device. The omentum and entrance into the lesser sac for transverse colon mobilization can be approached similarly to the description for open right hemicolectomy. Once the transverse colonic dissection is past the midline as referenced by the falciform ligament, the colon is replaced in its anatomic position. If a medial to lateral dissection was performed, the colon is at this point ready to be exteriorized as the mesentery is already divided. For a lateral to medial dissection, a high ligation of the vascular pedicles and adjacent mesentery must still be performed either intracorporeally or extracorporeally through the abdominal incision.

On complete laparoscopic mobilization of the bowel from terminal ileum to transverse colon and division of the vascular pedicle(s) and mesenteric attachments, the cecum is grasped with a locking grasper through the right suprapubic port. The terminal ileum and distal point of colonic transection should easily reach the anterior abdominal wall prior to releasing pneumoperitoneum to ensure adequate mobility for specimen extraction and extracorporeal anastomosis. The umbilical camera trocar is then enlarged to 3 to 5 cm length depending on the size of the patient and anticipated preoperatively, a ureteral stent should be considered as discussed earlier. The points of transection in a left colectomy are not as standard as a right colon resection. Depending on the location of the tumor, proximal margins are defined as the distal transverse colon or somewhere along the descending colon according to the principle of having a minimum of a 5 cm clear margin on either side of the tumor. The distal margin has been described as the rectosigmoid junction or the sigmoid colon, again depending on the location of the tumor along the significant distance between the rectosigmoid junction and splenic flexure. The operation that is undertaken should respect basic oncologic principles as previously discussed, with resection of one blood vessel proximal and one distal to the tumor. If nodal disease is apparent outside the scope of standard mesenteric resection, then a broader resection, including retroperitoneum and adherent peritoneal structures, should be undertaken for locoregional control. Another important determinant of the points of transection in a left colectomy is blood supply. A tension-free anastomosis with good blood supply is critical to minimize the risk of an anastomotic leak. When the tumor is in the sigmoid colon, the distal margin will be the rectosigmoid junction and the IMA should be divided near its origin with the mesentery in its distribution incorporated in the specimen. If a resection is planned that incorporates the sigmoid colon as the distal portion of the anastomosis, as it would be for a descending colon or splenic flexure tumor, then it is important to carefully preserve the sigmoid arteries arising from the IMA to maintain perfusion of the distal side of the anastomosis. The portion of colon that comprises the proximal portion of the anastomosis, usually the transverse colon, should be mobilized
sufficiently to allow a tension-free anastomosis. This often requires proximal division of the IMV and the complete mobilization of the splenic flexure.

Once the lateral to medial mobilization of the colon is completed according to the extent of resection required by the tumor location, the points of transection are selected and the colon is divided proximally and distally with a gastrointestinal stapler. The associated mesentry surface is scored with cautery and then serially clamped and ligated with absorbable sutures or with an energy delivery device according to the oncologic and blood supply considerations described above. This liberates the specimen, and an anastomosis is then performed. A stapled side-to-side colocolic anastomosis is generally discouraged in the left colon as these anastomoses may create a dilated reservoir. A hand-sewn EEA is preferred in these circumstances. Colorectal anastomoses can be hand-sewn or stapled using an EEA stapling device according to the preference and experience of the surgeon. We generally perform these anastomoses with the EEA stapler.

When the sigmoid colon is resected as part of the specimen and a colorectal anastomosis is planned, an EEA stapler can be used to easily and reliably perform an EEA into the upper rectum as long as the surgeon adheres to a few technical principles. The largest stapler that will fit into the rectum and colon is selected; placing sizers in the rectum and colon for a test run prior to committing to a stapler size is recommended. Avoid using EEA staplers smaller than 28 to 29 mm for a colorectal anastomosis to minimize the risk of stricture. If a 28 to 29 mm or larger stapler is not able to fit into the rectal stump, it usually indicates that the stump is composed of distal sigmoid colon, which usually has a narrower luminal caliber than the true rectum and may be associated with diverticular disease. When this occurs, it is advised that further resection is performed toward the rectum rather than forceful placement of the stapler into the stump or using a smaller caliber EEA stapler.

Once the surgeon is confident that the EEA stapler will reach the top of the rectal stump, the EEA anvil is secured into the colon with a monofilament purse-string stitch around the cut edge of the colon tied in place. This must be done precisely to incorporate full thickness of the colon in its entire circumference to avoid any gaps in the circular staple line on the proximal side of the anastomosis. The stapler is placed through the anus into the rectum and guided such that the spike of the stapler can be protracted adjacent to the transverse staple line on the rectal stump rather than through it, which runs the risk of separating the staple line. Another technical pitfall to avoid is deploying the spike of the stapler too far from the transverse staple line, which would align the circular staples line adjacent to the transverse staple line, creating an ischemic ridge of tissue at the anastomosis, which renders the anastomosis at risk for dehiscence [see Figure 7]. After engaging the anvil to the spike of the stapler, the stapler is fired and removed from the rectum with gentle twisting motions. The tissue donuts are removed from the stapler and examined for completeness. The pelvis is then filled with irrigation fluid, and a rigid proctoscope or flexible sigmoidoscope is inserted into the rectum. With the colon clamped proximal to the anastomosis, the rectum is insufflated with air to determine if there is any air leak from the anastomosis. An advantage of using a flexible sigmoidoscope for this step instead of the traditional rigid proctoscope is that the surgeon and any other assistant involved can clearly visualize the anastomosis on a high-resolution monitor and assess its integrity and hemostasis. In cases where an air leak is appreciated, the anastomosis should either be reinforced with sutures and reevaluated or completely resected and reconstructed. If the surgeon is not fully satisfied with the repair of an air leak, a temporary diverting ileostomy is the safest course of action.

**Figure 7** Configuration of an end-to-end stapled colorectal anastomosis. (a) Double-staple colorectal anastomosis (ideal). (b) Double-staple colorectal anastomosis (avoid). EEA = end-to-end anastomosis.
LAPAROSCOPIC LEFT COLECTOMY

The laparoscopic approach to sigmoid and descending colon mobilization is very similar to the open approach when the lateral to medial dissection is employed. The patient is positioned in low lithotomy for a laparoscopic approach, as previously described, and ports are positioned after establishing pneumoperitoneum with CO₂ and placed in the steep Trendelenburg position with the left side rotated anteriorly [see Figure 4]. The small bowel is swept out of the pelvis and to the right, and the omentum is also swept into the right upper quadrant. The sigmoid is grasped and retracted medially, and the lateral adhesions are taken down with cautery and bluntly as necessary [see Figure 8]. Medial traction placed on the peritonealized surfaces provides visualization of the avascular plane between the mesentery and retroperitoneum to facilitate gentle and bloodless dissection. This dissection proceeds proximally to the splenic flexure and distally to the pelvic brim, where the left ureter is identified. As in right colon mobilization, the plane between the mesentery of the colon and retroperitoneum is often more medial than expected. The unsuspecting surgeon can easily dissect too lateral, close to the lateral abdominal wall, penetrate the retroperitoneum, and lead to dissection behind the kidney. Once the dissection reaches the upper extent of the descending colon, the patient is shifted into the reverse Trendelenburg position, still with the left side rotated anteriorly, and splenic flexure mobilization proceeds. Once the left colon is completely mobilized, proximal ligation of the vascular pedicles and mesentery is performed according to the tumor location and patient anatomy.

When a medial to lateral approach is performed, the left colon mesentery is visualized medially down to its origin as the lateral attachments hold up the colon and mesentery. The IMV and IMA vascular pedicles are identified with upward traction on the mesentery. A reliable anatomic landmark to identifying the IMV is the ligament of Treitz. The peritoneal surfaces on the caudal side of the IMV and IMA are incised to find the avascular plane between the mesentery and the retroperitoneum. This plane is bluntly dissected all the way to the abdominal wall laterally and the transverse colon/splenic flexure superiorly. When in the proper plane, this dissection is bloodless. Bleeding indicates that the surgeon has likely penetrated either the retroperitoneum or the colon mesentery and should modify the approach to find the correct plane. The left ureter must be identified during dissection prior to any vascular ligation. The IMA and/or IMV pedicles are ligated with a vessel sealing device such as the LigaSure or EnSeal according to the tumor location and vascular supply considerations. This leaves only a thin layer of lateral attachments of the sigmoid and descending colon as well as the splenic flexure holding the left colon. These attachments are then easily incised to release the entire left colon, and the patient is similarly repositioned to the reverse Trendelenburg position for splenic flexure mobilization.

Whether a lateral to medial or medial to lateral dissection is undertaken, for resections that include the sigmoid colon and/or upper rectum, dissection should proceed distally into the pelvis to mobilize the upper rectum. This can be performed laparoscopically or using open techniques directly through a small lower midline or Pfannensteil incision that is planned for specimen extraction. The mesentery and other fatty tissue are then cleared to the bowel wall of the rectum/rectosigmoid junction, allowing for division of the bowel in a region that has minimal adherent fat or mesentery. If this mesenteric clearing is not performed, especially in obese patients, fitting a stapling device across the bowel will be problematic. An endoscopic articulating stapling device with a 3.5 mm staple height (4.1 mm when the bowel is thicker as with the rectum) is placed through a right lower quadrant port and fired across this cleared area for distal transection of the bowel. The number of staple loads fired to transect the bowel should be minimized as multiple crossing staple lines could place the quality of the anastomosis at risk. Alternatively, the distal transection could be performed directly through the extraction or hand-assisted port incision with a single firing of a transverse stapling device. The distal margin of the specimen is then manually exteriorized through the planned extraction incision after placement of a wound protector to deliver the tumor, intact mesentery, and whatever proximal level of colon (descending or transverse) transection is required according to the tumor location. The proximal margin of bowel is divided extracorporeally, but the surgeon must be confident that there is enough mobilized and well-perfused proximal bowel to return into the peritoneal cavity for a tension-free anastomosis. Typically, if the proximal bowel can be stretched to the symphysis pubis through a lower

Figure 8  Laparoscopic colectomy: left hemicolecotomy and sigmoid resection. Sigmoid mesentery and pelvic dissection.
midline or Pfannensteil extraction incision, there will be adequate length for a pelvic anastomosis. The colorectal anastomosis is performed with an EEA stapling technique as described earlier for open left colectomy. If the extraction incision required to remove the specimen accommodates visualization of the rectal stump, the EEA stapling can be performed under direct vision. Otherwise, the proximal colon is returned to the peritoneal cavity with the anvil secured in it, the extraction incision is either closed or sealed with the wound protector, and pneumoperitoneum is reestablished. The EEA stapling is then performed intra-corporeally, adhering to the same technical and quality control principles as previously described. If the colectomy is for a proximal descending colon or splenic flexure tumor, then a colocolonic anastomosis between the transverse colon and sigmoid colon is required. This usually cannot be performed with an EEA stapler because the transanally placed stapler cannot reach the sigmoid stump. In these situations, the sites of proximal and distal transection should be mobilized sufficiently to allow an extracorporeal hand-sewn anastomosis.

**Spleenic Flexure Mobilization**

Spleenic flexure mobilization is a critical and often under-appreciated technical element of left-sided colectomy. It allows the surgeon to release the transverse and descending colon from the left upper quadrant, facilitating reach of the bowel for a well-perfused and tension-free anastomosis. Depending on the patient’s anatomy and body habitus, the splenic flexure mobilization can often be the most challenging task for the surgeon to perform during a left colectomy or proctectomy. The difficulty is primarily due to issues regarding exposure and the risk of injuring the splenic capsule, vessels within the splenocolic ligament that can retract and bleed, or injury to the colon wall or mesentery. Stretching the descending colon down toward the pelvis or resecting a shorter segment of colon to leave enough, but poorly perfused, length of colon for anastomosis may result in an anastomosis that is under tension and/or ischemic, which places the patient at higher risk for anastomatic leak that could have been avoided with splenic flexure mobilization.

When performed during an open operation, the midline incision used generally needs to extend above the umbilicus, although there are occasional patients in whom the splenic flexure is unusually mobile or low where the mobilization can still be performed through a primarily infraumbilical incision. In exposing the splenic flexure, a self-retaining retractor is used, elevating the ring or fixed bar so that retractors pull the abdominal wall anteriorly as well as toward the left upper quadrant. It is usually helpful to reposition the center of the retractor ring cephalad and toward the left upper quadrant after completing the sigmoid and pelvic dissection. It is also helpful for the assistant surgeon to stand between the patient’s legs for better visualization, especially with high and difficult flexures. Complete splenic flexure mobilization usually requires a bidirectional approach: clockwise from transverse colon to splenic flexure or counterclockwise from descending colon to splenic flexure [see Figure 9].

The counterclockwise approach requires that the surgeon lift the plane of the dissected descending colon, exposing the attachments of the splenic flexure to the retroperitoneum and proceeding toward the transverse colon. The proper plane here is again closer to the colon, and not recognizing it will lead to the deeper and more lateral retroperitoneal plane misleading the surgeon posterior to the left kidney. With a hand in the plane posterior to the colon providing gentle traction toward the right lower quadrant, the tissue attaching the apex of the flexure to the spleen is exposed and divided. This requires suture ligation or division using an energy delivery device; otherwise, vessels within this tissue can retract toward the spleen and then bleed. Care should be taken with this maneuver to avoid excessive traction on the splenocolic ligament, which can result in avulsion of the splenic capsule and troublesome bleeding that, on occasion, requires splenectomy to control. To minimize this risk, the surgeon should gently expose these attachments with a finger or right angle clamp underneath the attachments and allow them to be divided in situ, closer to the bowel wall, instead of attempting to retract them anteriorly. There is no need to dissect near the spleen itself; the colon needs to be mobilized, not the spleen. As the apex of the flexure is released, dissection proceeds medially. Attention must be paid during this dissection to avoid injuring the pancreas and duodenum laying directly posterior and medial to the splenic flexure. The lesser sac can be entered through the gastrocolic omentum, leaving the omentum on the transverse colon, or the omentum can be manipulated superiorly and the lesser sac entered from beneath the omentum along the border of the transverse colon, leaving the omentum attached to the stomach. The counterclockwise dissection often reaches a point where the exposure becomes suboptimal or the planes of dissection become less clear; this will be the point where dissection should be converted to a clockwise direction from the transverse colon to splenic flexure. As the lesser sac is opened and omental attachments are released, the remaining attachments of the splenic flexure become obvious and are released. The medial extent of transverse colonic dissection depends on the distance it needs to be mobilized to reach the site of anastomosis without tension.

**Laparoscopic Spleenic Flexure Mobilization**

Laparoscopic mobilization of the splenic flexure is similar to that described above but often more challenging than the open approach, particularly in obese patients with high flexures. Placing an additional trocar in the right upper quadrant is very helpful, allowing the surgeon to retract the omentum and stomach anteriorly/cephalad, thereby giving better exposure to the lesser sac. The hand-assisted laparoscopic approach is a valuable tool to overcome these challenges and provide the tracton needed instead of laparoscopic graspers with patients anticipated to have a difficult flexure. Placing the patient in the reverse Trendelenburg position with the left side rotated anteriorly is key to establishing the needed exposure for the counterclockwise and clockwise dissections described.

**Total Abdominal Colectomy with Ileorectal Anastomosis**

A total abdominal colectomy may be indicated in cases where a patient is diagnosed with HNPCC, attenuated FAP,
synchronous cancers in the right and left colon, or an acutely obstructing left colon cancer with unknown status of the proximal colon. The technical aspect of the total colectomy is a conglomeration of the descriptions above for the segmental colectomies. The terminal ileum must be mobilized from its lateral attachments to reach the rectum without tension and without any twisting of the mesentery to avoid ischemia and obstruction. Given the usual size discrepancy between the ileum and rectum, attention must be given to proper sizing of the EEA circular stapler. The anvil of the EEA stapler should be secured into the ileum such that it is not a tight fit and is not incorporating the mesentery of the ileum into the anastomosis. According to the preference of the surgeon, the antimesenteric side of the ileum can be anastomosed to the end of the rectum or an EEA can be performed.

**POSTOPERATIVE CARE**

Care after colectomy is primarily a function of three main goals: (1) adequate pain control, (2) awaiting the return of bowel function, and (3) vigilance for complications of surgery. Patient-controlled analgesia is widely accepted as effective management of postoperative pain, although many protocols call for the use of epidural catheters when appropriate. The routine use of nasogastric tubes after colectomy is no longer considered acceptable. Similarly, a course of antibiotics longer than 24 hours postoperatively is also not recommended. Early enteral feeding has been proven to be safe. Once patients are tolerating a low-residue diet, which decreases the local inflammatory response at the anastomosis, and passing flatus or stool, they can be discharged home, with follow-up after 2 weeks.

Fast-track protocols have been developed and studied in multiple institutions in the hope of creating uniformity of care and decreasing postoperative stay. Common characteristics of these protocols are fluid minimization both in the operating room and postoperatively, epidural use, and early enteral feeding. Further components of fast tracking include Foley catheter removal on postoperative day 1, no oral bowel preparation, scheduled nonnarcotic analgesia (e.g., intravenous ketorolac or oral acetaminophen), and early ambulation. These strategies have commonly been shown...
to decrease length of stay by 4 to 6 days without increasing readmissions and potentially decrease complications by nearly 50% in open colorectal surgery. The efficacy of fast-track protocols has been demonstrated in laparoscopic surgery as well, with fast-track patients having shorter times to enteral feeding (decreased by 1 day) and first bowel movement (decreased by 1 day), shorter lengths of stay (3 versus 4 to 5 days), and fewer complications (15 to 29% versus 25 to 56%).

**Complications**

Complications are best minimized through careful planning and adherence to the principles of safe surgical technique. Despite this, complications will occur, even in the most skilled and experienced hands. The ability to recognize and successfully manage complications is often what distinguishes the most capable surgeons. Colectomy is associated with a distinct set of complications, in addition to those common to any abdominal surgery requiring general anesthesia [see Table 1]. The rates of these complications, although never completely eliminated, may be minimized by following national guidelines for prevention and treatment.

A survey of all complications specific to colectomy requires a dedicated review. One complication, however, requires special attention: the dreaded complication of anastomotic leak. Clinically significant anastomotic leaks probably occur more frequently in daily practice than the surgical literature admits, which is often biased to report our successes rather than our failures. If we focus on the reported leak rates from the CLASICC, COLOR, and COST trials, which are the results of a highly selected group of surgeons, anastomotic leaks occur in 2 to 6% depending on where in the colon the anastomosis is made. In general, the more distal the anastomosis, the higher the rate of leakage. This rate should be distinguished from distal colorectal anastomoses after proctectomy, where leak rates are significantly higher, in the range of 10 to 20%, especially in the setting of neoadjuvant radiation therapy.

The goals in management of an anastomotic leak are to effectively treat the leak and control sepsis. The treatment approach is individualized to the location and severity of the leak and the condition and comorbidities of the patient. Management of the stable patient without signs of peritonitis usually begins with imaging to identify and localize the process. A CT scan of the abdomen and pelvis with triple contrast (oral, intravenous, and rectal) is the imaging modality of choice. Large collections are often amenable to percutaneous drainage. In the era of modern CT scanning and interventional radiology, the routine practice of repeat laparotomy, abdominal washouts, and large sump drains is usually not necessary and can be reserved for patients who fail to respond to, deteriorate following, or are not candidates for percutaneous drainage. On the other hand, management of the patient with progressive generalized peritonitis requires resuscitation, broad-spectrum antibiotics, and urgent laparotomy. If the findings at exploration show ischemia and necrosis of greater than one third of the anastomosis, the anastomosis should be resected with creation of an end stoma. If the findings identify a smaller leak with healthy bowel, the anastomosis can usually be salvaged with suture repair, washout with drainage, and proximal diversion with a loop ileostomy.

Another common anastomotic problem is bleeding, which varies in severity, but most cases are mild and self-limited. Significant anastomotic bleeding occurs approximately 1% of the time, which can usually be successfully managed with endoscopic epinephrine injection or clip application at the bleeding site. If this fails and the anastomosis is proximal, selective endovascular embolization may be an option. When bleeding is massive and results in hemodynamic instability, the patient is best returned to the operating room for surgical intervention. Anastomotic strictures can occur in up to 10%, which may be related to anastomotic compromise or subclinical leak secondary to ischemia, tension, or inflammation. Although assessment of blood flow, tension, and bowel appearance as discussed in the technical descriptions earlier makes anastomotic complications less likely, these will still occur. Finally, mortality may occur in 1% or more of colectomy cases, although this risk depends heavily on patient preoperative risk factors, emergent indications for surgery, and the complexity of the surgery itself.

One notable theme that has emerged in the recent literature investigating the quality of surgical care is the concept of “rescue.” In examining hospitals with widely varying death rates, it has been demonstrated that the underlying rate of serious complications is similar across these hospitals. What is markedly different is the ability of hospitals to respond quickly and adequately to prevent worsened morbidity or mortality from a complication of surgery. This ability to “rescue” patients is an emergent property of various aspects of each hospital, including nursing care, ancillary staff, and culture. It is incumbent on each surgeon who performs colectomies to be part of a system that is focused not only on preventing complications with meticulous surgical technique but also in recognizing them and treating them quickly and appropriately.

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Table 1 Complications of Colectomy

| Complications common to any abdominal surgery requiring general anesthesia | DVT and PE |
| Complications specific to colectomy | Urinary tract infection |
| Injury to the spleen mandating splenectomy | Enterocutaneous fistulas |
| Injuries to the genitourinary structures | Extremity nerve injury secondary to positioning |
| Small bowel obstruction | Anastomotic leak |

DVT = deep vein thrombosis; PE = pulmonary embolism.

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References


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