Concepts in Surgery of the Large Intestine

53

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Introduction

Surgery with its subspecialties remains the queen of all medical disciplines. Second to none, it combines a proactive attitude and risk taking with knowledge and skills when facing the sometimes enormous intellectual and technical challenges in the management of a wide spectrum of different diseases, all of which keep changing and evolving at an unparalleled speed.

As the field constantly evolves with high-tech tools and diagnostics, there is unquestionably a high pressure from patients and the public alike to obtain and demonstrate high quality education and training, remain up-to-date and knowledgeable, while being patient-friendly, modern, safe, and cost-conscious all at the same time. The large variety of old and new tools and techniques for more detailed diseases result in increasingly complex management algorithms that offer a great opportunity for success, but also carry risks, traps, and pitfalls.

This chapter provides from a surgical perspective an overview over the intellectual, technical, and decision-making challenges within the colorectal specialty. It defers comprehensive disease presentations and review of pathophysiological and epidemiological details to respective texts. The focus here is to emphasize specific aspects that are relevant for establishing safe practice patterns and allowing for a structured development of surgical strategies—in general and with a focus on the most recent trends. While the surgical dissection of a particular anatomy should largely be the same regardless of the target pathology or the technical modality, it is often more a matter of the when, how much, and what type of reconstruction that optimize the surgical outcomes.

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Diagnostics

Modern evaluation for colorectal symptoms and diseases has become a lot more sophisticated in the last 20–30 years. Radiographic, endoscopic, pathological, as well as biochemical and molecular analytical tools and combinations thereof have found their way into daily routine. Goal is to better characterize nonmalignant and malignant conditions in order to define subgroups and develop tailored treatment plans.

Prime examples include colorectal cancer at all stages. At the prevention level, increasingly consistent guidelines have defined risk groups and established the start, appropriate tools, and interval/frequency of screening (Verma et al. 2015; Ransohoff and Sox 2016). Screening aims at identifying and eliminating precancerous lesions or detecting less advanced tumors such that the eventual cancer incidence and mortality can be reduced by 75–90% and 50–60%, respectively (Loberg et al. 2014; Winawer 2014). Colonoscopy remains the gold standard for screening and is recommended to start no later than 50 years of age in average risk individuals (Bibbins-Domingo et al. 2016). However, it is important to identify increased risk constellations (positive family history, African-American ethnicity, Ashkenazi Jews, known genetic treats, inflammatory bowel disease), for which screening has to start at an earlier time point. Alternative screening modalities include CT colonography, or fecal DNA or FIT (Quintero et al. 2012).

Once a colonic lesion has evolved, advanced endoscopic techniques allow for removal, marking/tattooing, or placement of colonic stents. Cross-sectional imaging such as ultrasound, CT scan, MRI, PET scan, or interventional radiology have become a lot more sensitive and precise and hence play an important role in defining the exact nature and pretreatment staging. More importantly, however, they delineate the normal and pathological anatomy in a way that should allow a surgeon and associated specialties to define operability and resectability, as well as the appropriateness, role, and sequence of various treatment modalities.

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Immunohistochemical, molecular, and genetic profiling provide information about current and future risks for the individual as well as for the family members (Chubb et al. 2015). Furthermore, it may help shaping the decision-making process about the value and extent of additional prophylactic surgeries (e.g., more extensive colorectal resection, hysterectomy), surveillance, and adjuvant treatment modalities. To name a few examples, MSI-high tumors are characterized by a less well-differentiated tumor histopathology, decreased response rates to 5-FU-based chemotherapy, and yet paradoxically an overall better survival (Saridaki et al. 2014; Erstad et al. 2015). Or, chemotherapy with cetuximab is contraindicated because largely ineffective in patients with *KRAS*-mutated tumors (Van Cutsem et al. 2009).

Similar to the abovementioned example of colorectal cancer, and without going into every single detail, other benign and malignant colorectal conditions rely on their own set of disease-specific characterization to guide their evaluation and treatment. The value of such parameters should not be underestimated. It is very well imaginable, not to say likely, that future research will bring to light even more detailed molecular and genetic features. Those will broaden our understanding of normal and disease processes. They may replace conventional staging and predictive/prognostic parameters and help prevent, understand, diagnose, and manage diseases more precisely.

Nonsurgical Treatments

Management of numerous diseases and pathologies that traditionally were without exception in the surgery bucket has evolved over the past 2–3 decades. Better knowledge has resulted in improved strategies and optimized outcomes. For example, routine postoperative management has changed from a passive waiting to a proactive enhanced recovery after surgery (ERAS) protocol to accelerate return of bowel function and reduce complications (Mortensen et al. 2014; Carmichael et al. 2017). Powerful new nonsurgical tools have been developed in many fields including management of cancer, inflammatory bowel disease, or complex abdominal infections including postsurgical or disease complications. While many of those new treatments have added value and improved outcomes, the expanded number of options frequently also add to the complexity of surgical decision-making.

For example, introduction of biological treatments for inflammatory bowel disease has on the one hand been able to control more severe disease presentations that previously only had steroids and a few immunosuppressive drugs available before curative surgery had to come in (Ford et al. 2011). On the other hand, it remains to be seen whether those new drugs truly reduce the overall need for surgical intervention or only delay it with a shift of the curve to the right. Additional concerns include that presence of such complex pharmacological and biological interventions alter the surgical field, suppress healing capacity, and potentially disproportionately increase peri- and postoperative risks, such that the traditional two-stage operations for ulcerative colitis more frequently give way to a three-stage approach (Devaraj and Kaiser 2015a).

Multimodality treatment for rectal cancer has shifted from postoperative adjuvant treatment to preoperative neoadjuvant chemoradiation for locally advanced disease. While this approach has been shown to reduce the incidence of local tumor recurrence, it has typically not resulted in prolonged survival but increased the risks of postsurgical complications such as anastomotic leaks, hence necessitating a higher probability of a diverting ileostomy. On the other hand, this approach has resulted in a new management entity of patients who show a complete clinical response after neoadjuvant chemoradiation and may choose/be offered to forgo the standard of care oncological resection and pursue a watch and wait approach ("Habr-Gama").

Management of metastatic colorectal cancer has become exceedingly complex with some patients being candidates for treatment in curative intent, others being potentially curable, while the remaining majority still asks for optimized palliative treatment (Tol et al. 2009). The benefit should not be underestimated as the overall survival for metastatic colorectal cancer has increased from just a few months to over 2 years with some living with metastatic diseases even more than 5–10 years. All such patients will have to be analyzed individually, best through interdisciplinary tumor board discussions, as to whether they are benefiting from systemic treatment first, or whether a diverting stoma or removal of the primary tumor prior or in between treatment cycles is prudent to prevent or treat tumor complications. Last but not least, modern radiation techniques including gamma knife, radiofrequency ablation, and others allow for nonsurgical "resection" for areas with recurrent or metastatic disease.

The evolution of interventional radiology has greatly improved management of complex patients whose only surgical alternatives would be massive surgery (for example, total abdominal colectomy) or exploration/reoperation at a suboptimal time point. Examples include severe lower GI bleeding, abdominal infections with abscess formations (such as diverticulitis, postsurgical, Crohn disease, appendicitis, and others), or tumors/masses not yet specified/characterized.

Surgical Tools

The armamentarium of surgical tools has rapidly expanded. The introduction and fast pace evolution of minimally invasive surgery has turned a necessity into a booming industry that has contributed on a number of different fronts including energy delivery, laparoscopic, robotic and endoscopic or transanal tools for access, visualization, instrumentation, and retrieval. The major surgical platforms to play a role for the abdomen and large intestines are:

- Open surgery: single site/single organ, combo multiple sites, multivisceral (same location), major en-bloc resections
- Laparoscopic surgery (LS): straight multiport LS, hand-assisted LS (HALS), single incision LS (SILS)
- Robotic surgery
- Transanal surgery: conventional, transanal endoscopic microsurgery (TEMS), transanal minimally invasive surgery (TAMIS), transanal total mesorectal excision (taTME)
- Endoscopic interventions: polypectomy, endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD), stent placement, tattooing
- Combined endoscopic-laparoscopic surgery (CELS)

This growth unquestionably has expanded horizons and, on the one hand, offers less aggressive options for standard surgeries and, on the other hand, allows for tackling more advanced and complex diseases. However, there is also competing overlap between the various techniques, which has added cost, and an incredible incidence of noncompatible systems and subjective preferences. Oversight and careful consideration of objective benefits and cost with a comprehensive institution-wide infrastructure and equipment plan with space for both growth and restrictions alike are among the most challenging tasks modern leadership is faced with (Zelhart and Kaiser 2017).

Perioperative Management

Over the past 20–30 years, the perioperative management of patients with colorectal operations has dramatically changed. A more proactive and standardized approach aims at reaching quality benchmarks. Specific efforts are in reducing surgical site infections, shortening the postoperative ileus, optimizing pain management, reducing secondary morbidity (DVT, atelectasis/pneumonia), optimizing fluid management, overall shortening of the length of stay, and avoiding unnecessary readmissions (Table 53.1).

Table 53.1 Components of modern perioperative management

Time period	Detail/discussion points/variations
Preoperative	
Bowel preparation	Various protocols, +/− oral antibiotics
Preoperative fasting	6–8 hours per ASA guidelines, except: Essential medications with water Carbohydrate-rich drink 2 hours before surgery
Skin decontamination	Prewash with chlorohexidine
Intraoperative	
Antibiotic prophylaxis	Appropriate selection dependent on case, 24 hours maximum
Maintenance of euvolemia	Avoidance of fluid overload and/or underresuscitation
Maintenance of normal body temperature	
Maintenance of normal blood glucose	
DVT/PE prophylaxis	Initiation preoperatively (in absence of contraindications)
Type of surgery	Minimally invasive vs most efficient
Postoperative	
Optimized fluid maintenance	Administration of adequate fluid until return of bowel function
Catheters/drains	Avoidance/discontinuation of NGT, Foley catheter, drains at earliest possible moment
Antibiotics	Routine coverage for the perioperative 24-hour period In case of contamination or underlying infection/sepsis, continuation of therapeutic antibiotics
Diet	Unless specific contraindications, early postoperative e feeding starting POD#0-1, advance as tolerated to regular diet as tolerated
Ambulation/ Activity	Emphasize early mobilization and encourage ambulation starting on POD0
DVT/PE prophylaxis	Continued from preoperative or initiated within 24 hours (in absence of contraindications)
Respiration	Encourage deep inspiration with incentive spirometer Chest physical therapy and inhaler treatment individualized Adequate pain control
Pain	Multimodality approach (preferably opiate-sparing): Gabapentin Acetaminophen Opiates as needed Local or systemic anesthetics (e.g., lidocaine) NSAIDS: concern about increased anastomotic leak rates, renal failure, peptic ulcer

A number of those factors are included and summarized in enhanced recovery after surgery (ERAS) protocols with early mobilization and early feeding (Carmichael et al. 2017). In addition, there is an impetus to use minimally invasive surgically surgery techniques wherever possible, and to minimize the use of drains and catheters. Preoperative fasting for 6–8 hours as required by traditional anesthesia protocols has also been challenged insofar as the prolonged absence of enteric stimulation was shown to rather diminish the bowel recovery than improve it. ERAS protocols therefore include a carbohydrate boost drink even within less than 6 hours without increased risk of aspiration.

Preoperative bowel cleansing remains a matter of debate as to whether it is necessary in the first place, and whether it should include antibiotics. Unquestionably for left-sided anastomosis, a stool load represents a clear disadvantage, whereas for right-sided anastomoses, that may not be relevant. But a proper bowel cleansing offers a number of advantages including the ability to perform intraoperative colonoscopy if necessary, advance staplers, or to carry out intracorporeal anastomoses without spillage of enteric contents.

Much debate continues about the safest way to perform a bowel anastomosis and remains a matter of surgeon's preference and diligence. Staplers have largely facilitated the process but maintaining solid skills for hand-sewn techniques is crucial. In general, it is recommended to achieve a tension-free reach, preserve an excellent blood supply on both sides of the anastomosis, achieve a negative air leak test, and potentially cover the anastomosis with other tissues such as an omental flap.

While many trends appear to result in improved care and outcomes, there is one serious trend that works in the opposite direction. In a nationwide epidemic, obesity, morbid obesity, and superobesity have become so prevalent that we have dramatically shifted our perception of "normal weight patients." A normal body mass index (BMI) in the past is used to be defined as being between 20 and 25. Nowadays, a BMI of 30–35 is the new norm and does not really change any of the surgical strategies and techniques. However, beyond that, there are truly superobese patients with BMIs above 40, 50, up to 80! It is not difficult to recognize that even the most sophisticated techniques may hit substantial obstacles that result in less perfect dissections, as well as increased surgical and general morbidity and mortality. It is very likely that over time, this may cause a "worsening" of the overall outcomes—unless the data are normalized to the respective BMIs.

Diseases

Colorectal Polyps

The majority of colorectal lesions are of epithelial origin and develop on the mucosal surface as a polyp. Descriptively, polyps can be classified by size and appearance, for example as diminutive, flat/sessile, or pedunculated. More sub- or extramucosal pathologies (e.g., lipoma, carcinoid, GIST, lymphoma, Kaposi, and others) should be kept in mind when assessing a specific irregularity. Benign epithelial polyps without malignant potential include the non-adenomatous polyps (e.g., hamartomatous, inflammatory, or small hyperplastic polyps). More relevant are the polyps that carry a potential risk of malignant transformation and consist of adenomatous polyps, very large hyperplastic, or serrated polyps. The risk of high-grade dysplasia or cancer in an adenomatous polyp increases with size and depends on its predominant feature (villous > tubulovillous > tubular).

The transition from a polyp with malignant potential through dysplasia to an invasive cancer is a fairly slow process that may take years, except if genetic mutations cause a dramatic acceleration (Hadac et al. 2015). This generally allows for adequate screening and intervention with removal of precursor lesions as a means for risk reduction (Meester et al. 2015). As long as dysplastic cells in a polyp do not cross the boundaries of the mucosa (basement membrane and muscularis mucosae), there is no access to lymphovascular and vascular structures and therefore no risk for metastases.

Detection and removal of premalignant lesions is the primary task of advanced endoscopic techniques which are in the realm of colorectal and some general surgeons (Lieberman et al. 2012). Depending on the size and shape, cold forceps polypectomy, snare polypectomy, endoscopic mucosal resection (EMR), or endoscopic submucosal dissection (ESD) may be utilized. A number of additional tools allow for control of bleeding, approximation of the defect, and specimen retrieval. And last but not least, a difficult endoscopic polypectomy may be monitored and supported by a simultaneous laparoscopy and bowel manipulation (combined endoscopic laparoscopic surgery, CELS). If a lesion is located in the rectum, transanal endoscopic microsurgery (TEMS) or transanal minimally invasive surgery (TAMIS) may allow for a removal without a segmental resection (Devaraj and Kaiser 2015b).

With availability of these sophisticated tools that aim at avoiding a bowel resection, the true art comes to the decision-making about the appropriateness of a specific approach as

Table 53.2 Appropriateness of various approaches to colorectal lesions

	Endoscopic/TEMS/TAMIS	CELS	Resection
Appropriate	Noncancerous polyp: Single Manageable number of polyps Small, stalk, easy lift Cancerous polyp: Complete excision with 2 mm negative margin	Noncancerous polyp: Difficult access In peritonealized portions Cancerous polyp: Complete excision with 2 mm negative margin	Noncancerous polyp: Multiple locations Too large Extending over several folds Not amenable to EMR/CELS Poor lift Recurrent polyps Genetic cancer syndromes Cancerous polyp: incomplete excision, less than 2 mm margin, lympho-vascular invasion Invasive cancer T1-4 Nx
Debatable	Lesions with high chance of incomplete excision Lesions with high risk of perforation/bleeding T1 cancer Polyps in Lynch syndrome	Lesions with high chance of incomplete excision Lesions with high risk of perforation/bleeding T1 cancer	Any of the above in high risk patients (operability)
Contraindicated	FAP, aFAP, MAP (except for biopsy confirmation)	FAP, aFAP, MAP	Non-adenomatous polyps Endoscopically manageable polyps

opposed to a resective surgery (Table 53.2). Without any doubt, true polyposis syndromes are not appropriate for non-surgical including endoscopic management except for diagnostic purposes. Good indications are single or a limited number of benign lesions that are either small, on a narrow stalk, or easily lift with submucosal injection. In skilled hands, the absolute size may need to be taken into consideration but is not necessarily a limiting factor. If the number or size of such lesions render them unamenable to endoscopic management, deep rather than mucosal three-quadrant tattooing and good documentation is crucial to identify the correct target segment at the time of the surgical resection.

Colorectal Cancer

The complexity of colorectal cancer management to a large degree lies in the limited individual predictability and the resulting threat of the disease to the overall survival (Kaiser et al. 2013). Surgical resection remains with few exceptions the only potentially curative treatment for colorectal cancer. However, from historically being an easily defined treatment target, the modern approach has become a very challenging intellectual exercise. Not only are there multiple presentations and symptoms, stages and even within respective stages a large variability, but there are also on a pathophysiological level a number of different genes and risk constellations to be taken into account (Punt et al. 2017). The treatment strategy depends on elective versus emergency presentation, stage of the disease at the time of the presentation, resectability of the tumor, overall patient performance status and operability, predisposing underlying pan-colonic diseases or gene mutations, and others (Chang et al. 2012; Langman et al. 2017).

The surgical management has overall been relatively well-defined in regard to the goals that should be achieved (Chang et al. 2012; Langman et al. 2017). However, the tools and pathways as well as timing to pursue those goals still lack uniform consensus and frequently need to be determined on an individual basis through interdisciplinary tumor board discussions.

Outcomes parameters include overall survival, cancer-specific survival, disease-free survival, local recurrence rates, stoma-free survival rates, other quality of life parameters, as well as rate of treatment-related dose-limiting short-term as well as long-term toxicity (Rivoirard et al. 2016). Treatment parameters for unresected disease include rate of tumor progression, tumor response and regression rates, complete remission, and progression-free interval. Additional surgical quality parameters include the completeness and integrity of the specimen (mesocolon, mesorectum), resection margins (proximal, distal, circumferential), lymph node harvest, conversion rates for minimally invasive approaches, perioperative morbidity and mortality, anastomotic leak rate, return of bowel function, length of hospital stay, or time to initiate chemotherapy.

The role and timing of other treatment modalities (systemic chemotherapy or radiation treatment) depends on the tumor stage at the time of presentation and further has to distinguish between colon cancer and rectal cancer. In absence of distant metastases (stage IV disease) or tumor invasion into surrounding structures (T4), the primary tumor should be addressed in curative intent. Tumor adjacency or invasion of surrounding structures may require multivisceral

resections, but if critical structures or locations (e.g., iliac blood vessels, lateral pelvic sidewall) are involved, the tumor may be unresectable. In the majority of cases, surgical resection represents the first step for localized or locoregional colon cancers, followed by adjuvant chemotherapy for stage III and selected high risk stage II patients. In contrast, stage II/III rectal cancer (as defined by being within 15 cm of the anal verge or distal to the coalescence of tenia) are typically offered neoadjuvant chemoradiation prior to a surgical resection unless stage uncertainty (stage I versus stage II), radiation-sparing protocols, or other favorable situations allow for a surgical resection and subsequent tailored adjuvant chemoradiation based on the definitive pathological tumor stage. Current research efforts including development of MRI criteria aim at more specifically identifying patients who benefit from the neoadjuvant and/or adjuvant treatment in general and specifically from radiation to justify the long-term side effects (Chand et al. 2015).

If stage IV is identified at the time of diagnosis, systemic treatment is the primary strategy but management of the primary tumor needs to be individualized based on its symptomatology (obstruction, perforation, bleeding) and the overall tumor burden. The metastatic tumor manifestations should be classified as resectable, potentially resectable, or unresectable. Based on that, the multidisciplinary team should define whether the goal remains possible cure, best palliation, or is indeterminate until the response to systemic treatment can be assessed. In the comparably small subgroup of stage IV patients that aim for a surgical resection of the primary and metastatic sites in curative intent, one of the unsolved discussions is whether they should be resected at the same time, or in a staged approach. In the latter case, it remains a matter of debate whether the systemic disease or the primary tumor should be addressed first.

Preoperative evaluation and staging of colorectal tumors includes histopathological evaluation, local and systemic staging, and clearance of the rest of the colon (Table 53.3).

Table 53.3 Workup for colorectal cancer

	FIRST choice	Alternatives
Pathology	Conventional histopathology + immunohistochemistry and MSI testing	Specific tumor profiling in selected cases PCR
Colon	Full colonoscopy	CT colonography, contrast enema
Local tumor staging	Colon cancer: CT abdomen/pelvis with oral/IV and possible rectal contrast Rectum: MRI or ultrasound	PET/CT scan
Systemic tumor staging	CT chest/abdomen/pelvis	PET/CT scan
Assessment of operability	Individualized	

Colon Cancer

Depending on the location of a primary tumor, standard extents of resection have been defined, largely based on the respective blood supply and lymph node drainage. A high ligation of the vascular pedicles and dissection along the natural, embryologically defined planes aims at achieving an intact mesocolic resection with an adequate lymph node harvest to assure a representative lymph node analysis and tumor staging (Bokey et al. 2016). Harvesting or reporting less than 15 lymph nodes may result in understaging of the tumor. The defined segmental oncological resections represent the minimally necessary extent for a specific cancer location. In case of multiple primary tumors, underlying genetic diseases (such as Lynch syndrome, FAP and attenuated FAP, or MYH-associated polyposis), or inflammatory bowel disease, more extensive risk-reducing prophylactic resections may be appropriate even before an invasive cancer develops (Church and Simmang 2003; Herzig et al. 2017). With relatively rare exceptions, resections that do not extend into the rectum will not require creation of a stoma under elective circumstances. It may be necessary under emergency conditions, certain high risk constellations, or in case of a complication (anastomotic leak), which should not exceed 2–5% overall.

In contrast to other disease managements (e.g., breast cancer or melanoma), the technique of sentinel lymph node dissection has not gained traction in colorectal surgery as studies had failed to show reproducibility and predictability.

While historically the open resection technique was defined as the standard, minimally invasive approaches (such as laparoscopic) have established themselves through well-designed prospective randomized trials as being either equivalent or even superior if done by appropriately trained surgeons. Yet, and likely due to the complexity of such techniques, the market penetration has only slowly increased over the last 15 years. Benefits of the laparoscopic as opposed to open approach include not only the smaller and often more cosmetic incisions but also a decreased negative impact on the physiology of the intestines, overall reduced postoperative ileus, as well as decreased long-term complications of hernias and adhesions (Chang et al. 2012; Langman et al. 2017). Parallel to increased use of minimally invasive techniques, introduction of the previously mentioned enhanced recovery after surgery (ERAS) protocols have contributed to faster return of bowel function and decreased length of hospital stay (Carmichael et al. 2017; Devaraj and Kaiser 2015a).

Rectal Cancer

Even though colon and rectal cancer in many aspects are comparable, there are significant differences about the tumor characteristics and behavior, the tumor geography with proximity to other relevant structures, as well as functional aspects. The latter are related to the bowel control, sexual

function and fertility, as well as urinary function. The closer a lesion is to the pelvic floor and sphincter complex and the larger it is, the higher is the likelihood to require at least a temporary if not a permanent stoma. Even if ultimately, the intestinal continuity can be preserved, the price tag may be a substantial impact on the function with a non-negligible incidence of potentially incapacitating low anterior resection syndrome (LARS). Locally advanced tumors (stages II/III) are typically treated with neoadjuvant chemoradiation unless an obstruction requires a temporary diversion or definitive resection (see section on large bowel obstruction) (Sauer et al. 2004). The chemoradiation is offered in two different setups which have not been compared in a systematic fashion. The short course is more common in Europe and involves 5 days of radiation with a total of 2500 cGy, followed by surgery after roughly 1 week (Lutz et al. 2016). The advantage of this approach is its fairly short sequence and likely lower cost, but obviously tumor regression by the time of surgery cannot be expected. The long course is the most common setting in the USA and involves typically 5040 cGy radiation and 5-FU-based chemotherapy over the course of 5–6 weeks; surgery is performed after an interval of 6–8 weeks from the last radiation to allow for regeneration of damaged noncancerous tissues and continued tumor regression. In fact, there is a 15–25% chance of a complete clinical and pathological response of the tumor such that some centers offer a Habr-Gama watch and wait approach (Kosinski et al. 2012).

The standard, however, remains an oncological surgical resection. It has become very clear that in no other disease is surgical technique of such importance when it comes to reducing the risk of local recurrence (Peeters et al. 2007; van Gijn et al. 2011; Nelson et al. 2017). A mesorectal excision follows the natural planes with the goal to preserve the hypogastric nerve plexus, avoid the dangerous presacral veins, and most importantly to obtain a specimen with a complete mesorectum and an intact fascial envelope. Such a conscious and specimen-oriented dissection has the best chance to achieve a negative circumferential radial margin (CRM) and has been associated with lower incidence of local recurrences. While the proximal margin is defined by the vascular pedicle, the necessary minimal distal margin has been a matter of debate. Ideally, a 5 cm margin should be attempted unless that would involve resection of the sphincter complex. In the cases of the lower one third of the rectum, a 2 cm is desirable, a 1 cm margin acceptable, and a negative margin potentially sufficient. However, if a tumor reaches the sphincter complex, an abdomino-perineal resection with permanent colostomy is typically the surgical treatment of choice. In some cases of distal rectal cancer, a partial sphincter preservation can be obtained by performing an intersphincteric dissection. The external sphincter muscle is left intact, but the internal sphincter is sacrificed at the intersphincteric groove with a colo-anal pull-through and hand-sewn anastomosis. That preservation of seemingly normal anatomy however comes at the price of decreased functionality with passive incontinence particularly at nighttime. For the very low anastomosis (colo-anal anastomosis), creation of a 5–6 cm long colonic J-pouch may obviate some of those functional issues particularly in the first 1–2 years. The low pressure reservoir with reversed peristalsis may have the benefit of reduced urgency; in the long run, however, the advantage disappears and there may in fact be a risk of stool clustering with fecal outlet obstruction. Such a pouch should not be done for mid to upper level rectal anastomoses.

In case of tumors reaching the mesorectal envelope or invading surrounding structures, more extensive resections including the anterior pelvic compartments ("pelvic exenteration") or the sacrum (sacrectomy) may be appropriate choices if a negative margin can be achieved. As the size of the resulting defect may not allow for direct tissue approximation and closure, advanced planning for possible transposition of a myo-cutaneous flap is necessary. Under special circumstances, such aggressive resections may even be justified for best palliation of highly symptomatic tumors even without being able to achieve cure. Again, depending on the specific circumstances and whether the pelvic floor is preserved or involved, there may still be an opportunity to restore continuity. Alternatively, one or even two ostomies will have to be created.

A lot of discussion and ongoing controversy in the management of rectal cancer is related to the following areas:

1. Role of local excision: The transanal local excision under either direct view or by means of TEMS or TAMIS excises the lesion in either superficial or full thickness fashion, but leaves the lymph nodes behind. Even for a T1 lesion, the chance of having positive lymph nodes is in the range of 6–13%. Even in the most selected favorable subgroup of rectal cancer patients (T1, well differentiated, no negative features, less than 25% of the circumference), the local recurrence rates after local excision are shockingly high (up to 20% in some series). This unfavorable outcome cannot be explained just by unexcised lymph nodes alone, but probably results from a direct implantation of exfoliated cancer cells into the wound. Hence, unless a patient displays a relevant surgical or operative risk, a proper oncological resection should be recommended—even if that would entail an abdomino-perineal resection with a permanent colostomy (Devaraj et al. 2016).
2. Noninferiority trials of transabdominal minimally invasive approaches (laparoscopic, robotic): It should be noted that rectal cancers were originally excluded from the early laparoscopy trials in the early 2000s, and laparoscopy was only later introduced as experience overall

expanded. More recently, however, two large trials raised some concerns that the laparoscopic arms were not able to achieve an equal specimen quality as conventional open surgery (Fleshman et al. 2015). Robotic surgery particularly in the narrow deep pelvis has gained a lot of traction, but there is no objective proof of superiority yet (Zelhart and Kaiser 2017; Collinson et al. 2012).

3. Abdominal versus transanal oncological resection: The gold standard that finally has been established over many years of surgeon's education is the abovementioned abdominal total mesorectal excision. A still relatively limited number of proponents increasingly push for an oncological resection through a transanal minimally invasive approach. The transanal total mesorectal excision (taTME) is challenging and associated with a not negligible incidence of unusual complications (e.g., urogenital). At the present time, that technique should therefore be monitored and reserved to specialized centers only (Denost et al. 2014).
4. Role and timing of multimodality treatment, that is, patient selection, duration of radiation (short course versus long course), timing and interval in relations to surgery, radiation-sparing protocols. The goal of future research efforts is to optimize outcomes and avoid undertreatment, while minimizing side effects and limiting overtreatments.
5. Complete response after neoadjuvant chemoradiation: In locally advanced rectal cancer, neoadjuvant chemoradiation is initiated with the intent to later perform the surgical resection. As stated above, however, a subset of patients achieves a complete clinical and even pathological response. The value of the standard-of-care resection with its morbidity as opposed to a monitoring remains a matter of debate and ongoing research (Kosinski et al. 2012).

Hereditary Cancer Syndromes

The most important among a much larger number of genetic cancer syndromes are Lynch syndrome (aka HNPCC, autosomal dominant), familial adenomatous polyposis or its attenuated form (FAP, aFAP, autosomal dominant), or MUTH-associated polyposis (MAP, autosomal recessive) (Church and Simmang 2003; Church and Ashburn 2017). The basic workup and management do not necessarily differ from sporadic colorectal cancer. However, hereditary cancer syndromes test our intellectual fitness and demand sophistication because they have a huge potential for negligence and inadequate care. The genetics introduce additional levels of complexity related to the extent and intensity of the immediate care to be delivered, surveillance of the intestines as well as non-intestinal organ systems, identification and management of known gene mutation carriers, family members at risk, and family planning (Espenschied et al. 2017). The hereditary cancers often affect younger patients and hence have to be suspected in any young patient. It is increasingly recommended practice that pathologists routinely perform a base array of tissue testing in any colorectal cancer (Kastrinos and Syngal 2012). It should be noted that there are families with a significant colorectal cancer incidence in whom no known genetic defect can be identified as off now. If a genetic syndrome is known or newly established, there is not only a need to address a single cancer, but also the entire cancer predisposition with the respective lifetime risk of subsequent colorectal and extraintestinal malignancies. Ideally, a surgical intervention is to be carried out before the cancer develops, that is, as early as the age of 18–30. In the case of the pan-colonic polyposis syndromes, that translates into a proctocolectomy, or occasionally a total colectomy if the rectum is relatively spared. In Lynch syndrome, the decision relates to the question whether in addition to the minimum standard oncological resection a prophylactic resection should be included (Lynch and Lynch 2013). Examples are a subtotal colectomy rather than a right hemicolectomy, or in women with completed family planning inclusion of a hysterectomy in addition to the colon resection (Herzig et al. 2017).

Additional management decisions which go beyond the scope of this chapter are the relative resistance of Lynch syndrome to 5-FU-based chemotherapy, the type and timing of genetic counseling and testing for family members, as well as appropriate surveillance versus intervention strategies in known gene carriers (Lynch and Lynch 2013).

Carcinomatosis

Presence of peritoneal seeding is usually a poor prognostic parameter. It may be detected at the time of a planned or emergency surgery or become visible on cross-sectional imaging. Particularly primary tumors reaching the serosal surface or resulting in a perforation at the tumor are at high risk of tumor implants. Surgical intervention only rarely has a chance for lasting success and should therefore be exerted with the respective restriction. Stoma creation, internal bypass, placement of a gastrostomy or jejunostomy tube, and occasionally endoscopic stenting are among the limited options. Only extremely rarely are cases suitable for cytoreductive surgery and heated intraperitoneal chemotherapy (HIPEC). This treatment requires surgical skills and interdisciplinary expertise about appropriate disease and patient selection and should be limited to respective centers (Franko et al. 2012; Braam et al. 2015).

Colorectal Cancer Superimposed on Inflammatory Bowel Disease

Inflammatory bowel disease is a recognized high risk constellation for the development of colorectal cancer (Choi

et al. 2017). Routine surveillance with systematic biopsies aims at detecting dysplasia as cancer precursor and is recommended to begin no later than 7–8 years after onset of the disease. However, detection of malignancy may be challenging (Verma et al. 2015) as it may not always form a visible "mass," and (b) as multifocal cancers may arise. Any high grade dysplasia, raised lesion with dysplasia (RLD, formerly known as "dysplasia-associated lesion or mass" or DALM), colonic "stricture," or multifocal low grade dysplasia warrant a surgical intervention even if an invasive cancer has not (yet) been confirmed (Devaraj and Kaiser 2015b). In absence of distant metastases or carcinomatosis, surgical resection is the treatment of choice and entails a complete proctocolectomy, with or without a restorative ileal J-pouch-anal anastomosis (IPAA) (Ross et al. 2014). As the small bowel is very radiation sensitive and imaging staging unreliable in the setting of colitis, any cancer involving the rectum should always undergo neoadjuvant chemoradiation prior to surgery.

Anal Cancer

The pathology, pattern of spreading, the proximity to the pelvic floor and sphincter complex, and last but not least the treatment concept make anal cancer distinctly different from rectal cancer (Kaiser 2009). Even though it predated the HIV epidemic, a dramatic increase has been observed since its onset, particularly as the highly active antiretroviral therapy has dramatically reduced the mortality from the viral infection and immunosuppression as such. The overwhelming histopathology is squamous cell carcinoma which is associated with oncogenic strains of the human papilloma virus. Adenocarcinoma is rare and may arise from anal glands. Anal melanoma is the third most common melanoma location and has frequently a dismal prognosis.

The tumor staging of anal cancer is different from colorectal cancer insofar as the T-stage is defined by size and not by depth of invasion. If a lesion does is more external and does not reach the anal canal, it is treated like a skin cancer by surgical excision. If the anal canal is involved with squamous cell cancer, the primary treatment is chemoradiation (Nigro protocol with mitomycin or cisplatin) whereas surgery in form of an abdomino-perineal resection is reserved for treatment failures (Geh et al. 2017).

Nonsquamous cell malignancies of the anus have a much worse prognosis. Anal adenocarcinoma is treated like distal rectal cancer with chemoradiation, followed by an abdominoperineal resection. Select cases of early melanoma are curable with the abdomino-perineal resection, but frequently the disease is already systemic and the prognosis dismal. Immunotherapy and potentially radiation can be considered for palliation.

Diverticulitis

The clinical presentations of diverticulitis are wide-ranging from asymptomatic, to mild, to complicated and even life-threatening severity (Feingold et al. 2014). One should always be aware that about 5% of typical diverticulitis symptoms are in fact caused by a locally advanced cancer. For management and treatment of true diverticulitis in the short and long run, it is of utmost importance to classify the disease. CT scans with at least oral and intravenous contrast, possibly even rectal contrast, are the gold standard imaging for diagnosis and classification of diverticulitis, whereas MRI or ultrasound are possible but less commonly used. On the one hand, one should distinguish between an acute index presentation and hospitalization as opposed to a patient presenting for possible elective management. Different classification systems have been suggested. The two preferred ones from a practical standpoint are (A) the Ambrosetti classification and (B) the modified Hinchey classification. The Ambrosetti classification aims at distinguishing uncomplicated from complicated episodes of diverticulitis based on the presence or absence of extra luminal air or radiographic contrast. The modified Hinchey classification defines different severity stages based on a combination of clinical, CT, and possibly intraoperative findings.

The overwhelming majority of patients with diverticulitis do not need an operation. Their disease is mild, uncomplicated, and responds very quickly to a short course of antibiotics. It is also clear that the most severe forms of diverticulitis with perforation and diffuse peritonitis usually require a surgical intervention. The standard approach for these severe forms has been a Hartmann resection with creation of an end colostomy. However, depending on the patient's overall condition, the intraoperative findings, and the quality of the bowels, alternative strategies may be pursued such as performing a primary anastomosis with or without proximal diversion.

It becomes more of a decision-making challenge in defining the best route in patients with intermediate severity disease or in patients who eventually recover from one or several episodes of diverticulitis (Table 53.4). For the acute episode, it is usually advisable to define a limited period of conservative management by which a definitive improvement of all parameters should be observed (72 hours of adequate treatment). The management could consist of antibiotics alone, or be combined with placement of CT-guided drains to pericolonic or pelvic abscesses. If there has not been adequate improvement within that timeframe, it is best to proceed with a resective surgery—unless re-imaging shows a drainable abscess at that point. Laparoscopic lavage was temporarily en vogue as a nonresective surgery to clean out the abscess, but the results have

Table 53.4 Surgical management for diverticulitis

	Emergency	Urgent/non-resolving	Elective
Surgery = default or highly recommended	MHC III/IV with diffuse peritonitis	MHC I –II managed medically without response in 72 hrs MHC III/IV initially managed conservatively but insufficient response Complicated diverticulitis with abscess not amenable to CT-guided drainage, not improving or worsening Diverticular stricture with complete or progressive LBO Fistulization with sepsis	Multiple episodes with increasing frequency or severity, particularly if requiring hospitalizations Conservatively managed complicated diverticulitis MHC Ib, II, III, IV Persistent pathology on imaging Smoldering disease Stricture Fistulization (bladder, vagina, skin) High-risk constellations (immunosuppression, planned chemotherapy)
Observation or medical management	Highly selected MHC III/IV with benign clinical symptoms	MHC I –II and highly selected MHC III/IV with benign clinical symptoms Complicated diverticulitis with abscess amenable to CT-guided drainage, or improving to initial medical management Partial SBO/LBO	Complete resolution of one or several minor episodes Uncomplicated diverticulitis in young patients

MHC Modified Hinchey classification, *LBO* Large bowel obstruction, *SBO* Small bowel obstruction

been clearly suboptimal such that the technique should be discouraged. The resection eliminates the inflamed bowel and extends distally from the coalescence of the colonic tenia to where proximally to bowel consistency becomes normal (regardless of whether diverticula are left behind) (Feingold et al. 2014). A primary anastomosis may be reasonable, if the patient is stable and the intraoperative findings and bowel quality are of favorable condition; if not, a Hartmann resection with end colostomy remains a prudent choice. Wherever possible despite the active infection and altered anatomy, it is recommended to perform a resection that would satisfy oncological benchmarks if the pathology showed a cancer.

For patients who have overcome an acute episode of diverticulitis, it is best practice to arrange for a colonoscopy 6 weeks after the episode to rule out (A) a cancer at the site of the inflammation, and (B) synchronous colonic pathology. In contrast to the past, recommendations about elective surgery rely less on the absolute age or an absolute number of episodes, rather than on signs of complications and persistent disease (Devaraj et al. 2016). One should keep in mind though that these sequelae are more likely to occur in patients whose initial presentation was more severe. Evidence of fistulization (colo-vesicular or colo-vaginal), and stricture formation with potentially obstructive symptoms are relatively obvious surgery indications. Trickier to define and recognize are signs of smoldering disease with persistent and potentially nonspecific symptoms, recurrent episodes after short periods of quiescence, or worsening symptom behavior. Evidence of an abscess or contained perforation have been associated with a high probability of recurrent attacks and disease complications (Devaraj et al. 2016; Lamb and Kaiser 2014).

Elective surgery has a much higher probability of being successfully done in minimally invasive approach and without a temporary ostomy. More important than doing a fancy operation though is to do a good and safe operation. If that for specific reasons is not achievable with the minimally invasive surgery, a primarily open or conversion to open approach is a prudent decision.

Large Bowel Obstruction

There are a number of different pathologies that can lead to a large bowel obstruction. The most common ones include cancer, a stricture resulting from diverticulitis, ischemia, previous surgery or inflammatory bowel disease, or a colonic volvulus. Colonic pseudo-obstruction (Ogilvie syndrome) has similar symptoms and imaging features but lacks a physical site of obstruction and rather represents an acute colonic dysmotility. Management of a true large bowel obstruction depends on the acuity and completeness of the obstruction and to minor degree also on whether the ileocecal valve is competent and results in a more dangerous closed loop obstruction. The obstruction interferes with the passage of stool and may result in obstipation and distention of the prestenotic bowel a with high stool burden. If this evolves slowly, the bowel may have time to gradually dilate substantially without perforation; otherwise it potentially suffers impairment of the bowel wall perfusion, blood supply, and eventually its integrity resulting in pneumatosis coli or a perforation. While the absolute diameter of the colon does not strictly correlate with the risk of perforation, a diameter of more than 6 cm in the transverse colon and more than 10 cm in the cecum should be cause for concern.

The tools to address the cause and consequences of the obstruction have to be individualized and tailored to the specific circumstances. In general terms, they include one of the five options (Chang et al. 2012; Kaiser 2009):

1. Discontinuous resection (Hartmann resection)
2. Resection of the obstructing segment with primary anastomosis, with or with on-table lavage, and with or without a proximal protective stoma
3. Proximal diversion alone
4. Resection of the obstructing segment and the entire distended colon proximal to the obstruction (e.g., total abdominal colectomy for a sigmoid obstruction), either with an ileostomy or ileo-colonic/-rectal anastomosis
5. Endoscopic placement of a self-expanding metal stent as bridge to surgery or even as definitive treatment

When defining the ultimate strategy in an individual patient, it is important to safely avert the immediate danger, but to also keep quality of life aspects and the future treatment needs in mind. This latter aspect can create a number of dilemmas. For example, a metal stent might seem an attractive option for a patient with metastatic cancer because, in absence of a surgical wound, it allows for almost immediate initiation of palliative chemotherapy. However, one of the most effective biological anticancer drugs, bevacizumab, has a relative contraindication because of a substantially increased risk of stent perforation. Or, an ileostomy is often easier to manage than a transverse colostomy and hence the stoma of choice under elective circumstances. Under emergency conditions, however, if only a stoma is created for the large bowel obstruction, a loop colostomy is preferred as an ileostomy would neither decompress the colon quickly enough nor at all, and it may not allow for a subsequent evaluation of the prestenotic colon. Creation of a loop colostomy should be planned in a location that the patient can take care of, and it should again not become a handicap for subsequent surgical interventions. Exact analysis of the current and potentially future blood supply in light of past or future resections should assure negative interferences by the temporary intervention. Examples could include disruption of the marginal blood supply from the middle colic artery during creation of a left-sided transverse colostomy in a patient whose inferior mesenteric artery was or will be resected.

Fistulization (Bladder, Vagina, Skin)

A number of different diseases or conditions can result in formation of an unintended direct communication between the colon, rectum, and/or small intestine to a non-intestinal structure such as the urinary system (bladder, urethra), female organs (vagina, uterus, tubes), or the skin. The most common causes include diverticulitis, cancer, Crohn disease, radiation, or postsurgical complications from an enterotomy, anastomotic leak, or a stapler injury. Symptoms are not specific and include continuous or intermittent passage of bacteria, gas, or obvious stool, and variable signs of infection, sepsis, or obstruction.

The diagnostic and management strategy depends on the acuity of local and systemic symptoms, the suspected or proven underlying disease process, and the interval to previous interventions. It is crucial to define the location and exact level of the fistula, particularly whether it originates from the mid to distal rectum or higher than that. This aspect may determine whether the problem is potentially accessible via a perineal approach or will require an abdominal approach. A perineal/transanal approach for appropriate distal rectal defects may entail a local repair, for example, by means of an endorectal advancement flap or a muscle interposition. More proximal pathologies or very advanced distal pathologies typically involve a surgical resection of the causative bowel segment and depending on the underlying pathology the adjacent involved structures.

One of the key assessments to be made is to determine (A) whether the pathology is amenable to cure, (B) whether restoration of the intestinal continuity is possible and prudent, (C) whether that can be achieved in a single-stage surgery or will require a staged approach, and (D) what the optimal timeline would be. In particular, the surgeon needs to determine whether a definitive single-stage surgery can primarily be carried out, or whether a 2-stage or even a temporizing measure only (stoma) will first be needed to gain time and allow for symptoms and tissues to cool off. Technically, that decision depends on whether there is a healthy receiving bowel segment and anatomy distal to the pathology to allow for an anastomosis. In addition, the patient's overall condition, hemodynamic stability, nutritional status, as well as the tissue quality have to be taken into consideration.

To illustrate a few selected examples:

1. Colo-vaginal/-vesical fistula from diverticulitis: These conditions are usually a chronic manifestation and can be addressed with a single-stage sigmoid resection whereby the colon is "pinched off" the corresponding structure. That defect on the vagina or bladder may be oversewn but usually heals without any problems.
2. Colo-vaginal/-vesical fistula from cancer: The resection on the intestinal side should be the same oncological resection, but on the bladder or vaginal side, a resection with appropriate margins needs to be achieved.
3. Recto-urinary/-vaginal fistula: Often times, when the patient is highly symptomatic or within a critical time period after a previous intervention, it is prudent to first perform a diverting stoma to allow tissues to cool off. An elective intervention can be planned after a few months

once a comprehensive workup has been completed and a strategy developed. Exception would be a locally advanced cancer which may need a radical multivisceral resection or palliative diversion in conjunction with non-surgical management.

Lower GI Bleeding

Bleeding is an unspecific symptom from a wide spectrum of different causes and locations anywhere in the GI tract. Minor bleedings or anemia is worked up on an outpatient basis. Acute brisk and life-threatening lower GI bleeding requires decisive actions to prevent a patient's fatal deterioration (Newman et al. 2012; Strate and Gralnek 2016). If the bleeding origin is clear (e.g., cancer, colitis), a targeted specific intervention needs to be carried out. More difficult are massive lower GI bleedings of unknown origin. Unfortunately, characteristic locations vary for different bleeding causes. For example, diverticular bleeding more commonly originates on the left-sided colon, whereas bleeding from arteriovenous malformations typically stems from the right-sided colon. Immediate resuscitation and transfusions aim at maintaining hemodynamic stability and coagulation factors. If possible, diagnostics aim at positively grossly identifying the bleeding site; interventional radiology further has the potential to selectively stop a visible hemorrhage by means of highly selective embolization. If the bleeding remains unlocalized and associated with extensive transfusions and hemodynamic instability, a total colectomy needs to be carried out.

Ischemia

Ischemic colitis and enteritis are caused by an inadequate blood flow to the viscera. The severity depends on the cause of the underperfusion, the location, level and extent, the acuity of onset, and the presence of collaterals. The mucosa is commonly the most sensitive layer of the bowel wall. The majority of intestinal ischemia does not result in transmural necrosis (nongangrenous ischemia). It may be transient or become a chronic condition and turn into a stricture. Only an estimated 15–20% of intestinal ischemias progress to gangrenous ischemic colitis with a high mortality with or without surgery.

The treatment ranges from conservative management for milder to moderate forms to a resection of the affected bowel segments. For severe and life-threatening presentations, the extent of resection ought to be complete and may even reach a total abdominal colectomy and small bowel resection as long as there if sufficient residual small bowel to maintain the nutritional needs. If the extent of ischemia is too widespread and not compatible with survival, palliative end-of-life measures are to be initiated.

Inflammatory Bowel Disease

One of the key parameters for surgical decision-making in patients with inflammatory bowel disease is the nature and manifestation of the underlying disease. Ulcerative colitis is theoretically curable with surgery but only about 30% of patients require a resection. In contrast, Crohn disease is not curable as it can affect the entire gastrointestinal tract from mouth to anus; yet, at least 70–80% of patients need at least one surgery in their lifetime, mostly for disease complications rather than for cure. Additional factors include the acuity of the presentation, short-term or long-term complications, as well as the response to medical management.

Ulcerative Colitis

The surgical approach to patients with ulcerative colitis is a primary or staged proctocolectomy, regardless of the extent of inflammation (Ross et al. 2014). The goal is to achieve cure from the disease and/or from side effects of the medications, minimize disease-specific short- and long-term morbidity and disability, and to carry out a safe reconstruction with a high life-style quality. The most common form of reconstruction with a greater than 90% success rate is an ileal J-pouch-anal anastomosis (IPAA); but an end ileostomy or in select cases a continent ileostomy (Kock pouch, T-pouch) may be preferable or appropriate. Based on the disease behavior and treatment response, there are four categories when a surgical intervention is indicated (Devaraj and Kaiser 2015a):

1. Life-threatening complications, such as fulminant colitis, toxic megacolon, perforation, or uncontrolled bleeding (rare).
2. Colorectal cancer development: An estimated 18–20% of patients develop cancer before the time when routine surveillance is recommended (7–8 years post onset), and 2% of patients develop a cancer despite regular surveillance. Surgical resection is invariably the treatment of choice for single or multifocal loco-regional colorectal cancers, strictures, high grade dysplasia, or multifocal low-grade dysplasia that has been confirmed by an expert pathologist. A minor exception in regard to treatment sequence is a biopsy-proven cancer of the rectum, which—as stated in the rectal cancer section above—should trigger neoadjuvant chemoradiation prior to surgery. More debated and controversial is non-adenoma-like low grade dysplasia that is not associated with regenerative atypia or detected

in flat mucosa. Some favor a colectomy while others lean towards a more conservative approach with short-interval monitoring.

3. Insufficient response to medical management, steroid-dependence, or relevant side effects from medical management: This largest category of patients to consider a colectomy is the least defined one. There are a few objective parameters of response (e.g., mucosal healing) or lack thereof (steroid-refractoriness, steroid dependence, treatment-refractoriness). As long as there is no immediate danger, the decision when expectations are not met anymore should be left to the well-informed patient. The decision to move toward surgery is not a defeat of the gastroenterologist, but a very reasonable and predictable step toward elimination of the chronic illness.

Under elective circumstances and a fairly healthy patient without excessive immunosuppression, a restorative total proctocolectomy (with or without diverting loop ileostomy) is the procedure of choice. Under suboptimal disease or patient conditions, it is prudent to avoid the challenges of the pelvic dissection and pouch creation at first. The project is split into stages with the goal to eliminate the majority of the disease first (total colectomy with end ileostomy) and allow the patient to recover and come off the medications. Only at a later elective stage are the rectum removed and the pouch created.

Crohn Disease

The primary management of patients with Crohn disease is always medical. Introduction of biologicals has clearly added value to the armamentarium. Surgery is reserved mostly for disease complications such as fibrostenotic disease with stricture formation, suppurative disease with intestinal or perianal abscess and fistula formation, bleeding, or formation of a cancer (Strong et al. 2007). The surgical approach needs to be individualized and can consist of a resection with or without a primary anastomosis, a diversion or staged proctocolectomy. The goal is to eliminate the disease complication as such or to minimize the impact of stool, both with the intent to allow for further medical management. Perianal disease may often only be palliated, occasionally be cured; in very refractory situations, however, a proctectomy with stoma is needed. In a small contrast to ulcerative colitis where an urgent intervention is limited to a total colectomy, Crohn patients with severe colitis need to be assessed as to the future option to restore continuity or not. In the presence of rectal and severe perianal disease, a complete proctocolectomy/ileostomy with mucosal stripping of the entire anal canal down to the anal verge should be done; the pelvic floor and sphincter complex can be preserved but are permanently closed.

A pouch procedure is generally not prudent in patients with Crohn disease. Under comparably rare and favorable circumstances, the Crohn disease is limited to colitis without any evidence of small bowel or perianal disease. In such selected patients, a restorative proctocolectomy with IPAA may be considered at experienced centers with reasonable short-term outcomes but a substantially higher rate of pouch losses over time.

Indeterminate Colitis

Pathological feature overlap occurs in up to 15% of patients with inflammatory bowel disease. As absence of any small bowel disease or perianal disease is a defining necessity to distinguish it from Crohn disease, the management strategies for indeterminate colitis are the same as for pure ulcerative colitis. The long-term success and pouch retention rates, however, are a bit lower though.

C. difficile Colitis and Other Colitides

Clostridium difficile infection (CDI), the leading cause of hospital-acquired diarrhea, affects gastrointestinal surgeons in two situations: (1) as a complication of unrelated treatments, or (2) when severe and life-threatening colitis asks for their judgment and surgical skills (Kaiser et al. 2015). Similar to ulcerative colitis, *C. difficile* colitis and many other infectious colitides are primarily managed conservatively. On a comparably rare occasion, however, any colitis can be complicated by a fulminant or toxic presentation which represents the common final pathway of a decompensated colon. If not swiftly addressed by a surgical intervention, the mortality rate is typically very high. If the point of no return has already been crossed, even the surgical intervention may not be timely enough anymore to reverse the downhill spiral. The actual decision-making process is frequently difficult. It needs to strike a balance between too aggressive and too passive in order to avoid unnecessary colectomies as much as unnecessary deaths. Discrete signs of deterioration such other organ failures need to be recognized (Kaiser et al. 2015).

With few exceptions, the surgical management includes a total abdominal colectomy with creation of an end ileostomy. Depending on the overall course of the patient and the underlying pathology, the patient at a later time may be a candidate for a restoration. In the case of ulcerative colitis, this would be a completion proctectomy with IPAA, in other colitides an ileo-rectostomy.

For nontoxic refractory or relapsing *C. difficile* colitis, less invasive interventions have included fecal microbiota transfer (FMT) or creation of a loop ileostomy with colonic washouts.

Volvulus

A volvulus combines the symptomatology and pathophysiology of a large bowel and intestinal ischemia. An axial rotation of the colon around its mesentery and vascular pedicle results in a closed loop obstruction and strangulation of the volvulized segment as well as an obstruction of the colon proximal to the volvulus. Untreated, both areas may progress to gangrene and perforation. The sigmoid colon is the most common site (60–75% of the time), followed by the cecum and the transverse colon. Early diagnosis and treatment are crucial before irreversible tissue injury occurs (Table 53.5). Keys to successful management are connecting the dots between potentially unspecific symptoms, clinical signs, and radiographic images (plain, CT scans) (Vogel et al. 2016).

If there are established signs of advanced strangulation with ischemia or perforation, a swift surgical exploration is inevitable. In absence of tissue injury, however, the immediate goal is to avert deterioration and irreversible bowel damage. For sigmoid volvulus, a rigid or flexible sigmoidoscopy as first measures is able to successfully detorse and decompress the bowel in 85–90% of times. Because of the high rate of recurrent volvulus, a (semi-) elective surgical intervention with resection is nonetheless recommended. The exception to a resection is a cecopexy which can be achieved with a temporary tube cecostomy.

When there is evidence or suspicion for gangrene or perforation, an urgent or emergency exploration with a surgical resection is always warranted. The extent and the type of reconstruction versus stoma creation depend on the condition of the remaining bowels and the patient's overall condition.

Pelvic Floor Dysfunction and Organ Prolapse

The pathologies discussed in this section represent a combination of functional disorders with a morphological component (Bordeianou et al. 2014). The pelvic organs can develop an increasingly visible positional instability that is either limited to one of the three compartments or affects all of them to a degree. From a colorectal or general surgery standpoint, the rectal instability is obviously the primary focus (Varma et al. 2011). But it is always important to inquire about and assess the anterior and middle compartments as well. Changes may occur at any age and evolve as a gradual or synchronous appearance of pelvic floor descent, rectocele, intussusception, hemorrhoidal, mucosal, or full thickness rectal prolapse. Isolated rectal instability can affect both genders with no or only a limited number of specific risk factors being identified (e.g., cystic fibrosis in children), whereby parity is not typically associated with a higher incidence. Multi-compartmental instability more commonly affects women, specifically multiparous women who develop various degrees of cystocele, uterine, or vaginal vault prolapse (Le Normand et al. 2017).

A large number of such patients have associated functional problems, broadly labeled as pelvic floor dysfunction. They range from chronic constipation to irritable bowel syndrome, possible urinary and fecal urgency and incontinence. It cannot be distinguished with certainty whether some of those functional problems are cause, effect, or completely unrelated innocent bystanders, and vice versa the visible pathology does not necessarily correlate with a particular dysfunction. The one exception is the observation that chronic rectal prolapse over time almost invariably results in fecal incontinence as the sphincter complex suffers a continued and repeated stretch injury. Before committing on a particular strategy and surgical treatment, it is therefore of utmost importance to clarify the various components and define treatment goals with realistic expectations (Varma et al. 2011). To rule out a "lead point" (e.g., tumor, polyp) or other synchronous colonic pathologies of higher priority, a flexible sigmoidoscopy or colonoscopy should have been performed within a reasonable proximity to the decision-making. Furthermore, it is prudent to involve respective specialists from the associated disciplines of urogynecology or urology to define

Table 53.5 Surgical management of volvulus

	Volvulus without gangrene		Volvulus with gangrene/perforation	
	Sigmoid	Cecal/transverse colon	Sigmoid	Cecal/transverse colon
Urgent action	Rigid/flexible sigmoidoscopy decompression If not successful: surgery	Colonoscopic decompression vs Immediate surgery: Resection Tube cecostomy	Surgery: Segmental resection with anastomosis Hartmann resection Subtotal colectomy with ileostomy or anastomosis	Surgery with ileostomy vs anastomosis: Ileocecal resection Right hemicolectomy
Elective action	Sigmoid resection	Ileocecal resection Right hemicolectomy Tube cecostomy	n/a	n/a

whether a combined approach might offer an opportunity and have a better chance of success.

As for the rectal prolapse component, different surgical approaches are possible, none of which has a 100% guarantee of success. Broadly, one can distinguish between a perineal versus an abdominal approach (Varma et al. 2011; Hotouras et al. 2015).

The perineal approaches are generally less invasive and better tolerated. This is a not negligible advantage for a subgroup of rectal prolapse patients who are elderly, frail, and have a reduced operability. If necessary to avoid a general anesthesia, the surgery could be performed in spinal anesthesia. However, the success rates are substantially lower than for an abdominal repair for rectal prolapse. The two main techniques are the Delorme and the Altemeier procedure. The Delorme entails a mucosal stripping of the prolapsing rectum with repositioning by means of a muscle plication. The Altemeier procedure is a perineal proctectomy and anastomosis, which is often combined with a levatoroplasty. There is no clear guidance which of the two to choose in a particular patient, except that the Altemeier repair is the treatment of choice for an incarcerated necrotic rectal prolapse.

The abdominal approaches are more successful, but also more invasive as they require general anesthesia with often steep Trendelenburg positioning. Different access modalities are utilized including open, laparoscopic, or robotic surgeries. Within the abdomen and pelvis, the strategies range from a resection of the floppy redundant bowel with or without a rectopexy, a rectopexy alone, typically with an implant (synthetic mesh or biological graft), or they can entail a multicompartmental resuspension effort.

Generally speaking, synthetic implants provide a much better durability; despite negative publicity, the risk of infection is comparably low if there is no direct contact of the mesh with for example the small bowel. Nonetheless, some surgeons and even some companies have been discouraged by the threat of litigation surrounding synthetic mesh implants.

It has been a matter of controversy whether the resection of the redundant sigmoid colon might prove beneficial beyond the prolapse correction as such for the management of the underlying constipation. In other contexts though, such a limited resection has rarely been effective to have a meaningful impact on the constipation. The downside of a resection not only relates to the simple fact that an anastomosis is created and potentially could leak but also that use of a synthetic mesh is generally not recommended when open bowel is handled because of the risk of contamination. Importantly, a resection is contraindicated in patients who previously had a perineal resection as a non-perfused bowel segment could result if the unidirectional blood supply from proximal is also interrupted. The appropriate choice for such patients is therefore to either repeat a perineal repair or to perform a suspension procedure.

A recent trend in the management of rectal prolapse has been the introduction of the laparoscopic anterior mesh rectopexy, supposedly because it is less interfering with the innervation and structure of the rectum than a posterior rectopexy. Long-term comparisons between a poster and anterior mesh rectopexy or different types of implants are still pending.

The majority of patients who suffer from preexisting fecal incontinence may experience an improvement of their sphincter function once the prolapse has been successfully corrected. However, the extent of improvement can neither be predicted nor promised as to whether it is sufficient to provide the patient with adequate quality of life or whether subsequent treatment will be needed. The value of preoperative anophysiology testing is rather limited as the distorted, potentially swollen, and prolapsing rectum blurs many of the test parameters, such that the result is not superior to an educated digital rectal exam. Comprehensive functional pelvic floor testing is more appropriate after a sufficient period of recovery after a successful rectal prolapse repair. Only at that time may it help to strategize on further treatment options. A limited number of patients with rectal prolapse and severe and likely irreversible sphincter dysfunction may primarily elect to have a colostomy created rather than going to a number of procedures with persistent uncertainties.

Stoma Creation and/or Takedown

An ostomy (aka stoma) is intentionally created to allow for a controlled decompression and elimination of waste, or to divert stool from a more distal area of concern (anastomosis, inflammation, rectovaginal fistula, incompetent sphincter muscle, etc.). Ostomies remain one of the "necessary evils" of colorectal surgery. Much worse than having an ostomy is having a bad ostomy. Appropriate anticipation and planning help in optimizing the manageability of the ostomy. Critical parameters are the decision whether to do an ileostomy or a colostomy, either of which has distinct advantages and disadvantages. Furthermore, it is important to analyze the current and future blood supply to all remaining bowel segments; it should be avoided under all circumstances to jeopardize the perfusion and create avascular bowel segments. An example could be a left-sided colon that after a low anterior resection is dependent on the mid colic artery. Last but not least, ostomy planning should assure that no unvented bowel segments be created that could blow out, for example, Hartmann resection that would leave behind a blind stump proximal to a complete distal obstruction.

References

Bibbins-Domingo K, Grossman DC, et al. Screening for colorectal cancer: US preventive services task force recommendation statement. JAMA. 2016;315(23):2564–75.

Bokey L, Chapuis PH, et al. Long-term results following an anatomically based surgical technique for resection of colon cancer: a comparison with results from complete mesocolic excision. Color Dis. 2016;18(7):676–83.

Bordeianou L, Hicks CW, et al. Rectal prolapse: an overview of clinical features, diagnosis, and patient-specific management strategies. J Gastrointest Surg. 2014;18(5):1059–69.

Braam HJ, Boerma D, et al. Cytoreductive surgery and HIPEC in treatment of colorectal peritoneal carcinomatosis: experiment or standard care? A survey among oncologic surgeons and medical oncologists. Int J Clin Oncol. 2015;20(5):928–34.

Carmichael JC, Keller DS, et al. Clinical practice guidelines for enhanced recovery after colon and Rectal surgery from the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons. Dis Colon Rectum. 2017;60(8):761–84.

Chand M, Evans J, et al. The prognostic significance of postchemoradiotherapy high-resolution MRI and histopathology detected extramural venous invasion in rectal cancer. Ann Surg. 2015;261(3):473–9.

Chang GJ, Kaiser AM, et al. Practice parameters for the management of colon cancer. Dis Colon Rectum. 2012;55(8):831–43.

Choi CR, Bakir IA, et al. Clonal evolution of colorectal cancer in IBD. Nat Rev Gastroenterol Hepatol. 2017;14(4):218–29.

Chubb D, Broderick P, et al. Genetic diagnosis of high-penetrance susceptibility for colorectal cancer (CRC) is achievable for a high proportion of familial CRC by exome sequencing. J Clin Oncol. 2015;33(5):426–32.

Church JM, Ashburn JH. Regarding the clinical practice guidelines for the surgical treatment of patients with lynch syndrome. Dis Colon Rectum. 2017;60(7):e595–6.

Church J, Simmang C. Practice parameters for the treatment of patients with dominantly inherited colorectal cancer (familial adenomatous polyposis and hereditary nonpolyposis colorectal cancer). Dis Colon Rectum. 2003;46(8):1001–12.

Collinson FJ, Jayne DG, et al. An international, multicentre, prospective, randomised, controlled, unblinded, parallel-group trial of robotic-assisted versus standard laparoscopic surgery for the curative treatment of rectal cancer. Int J Color Dis. 2012;27(2):233–41.

Denost Q, Adam JP, et al. Perineal transanal approach: a new standard for laparoscopic sphincter-saving resection in low rectal cancer, a randomized trial. Ann Surg. 2014;260(6):993–9.

Devaraj B, Kaiser AM. Surgical management of ulcerative colitis in the era of biologicals. Inflamm Bowel Dis. 2015a;21(1):208–20.

Devaraj B, Kaiser AM. Impact of technology on indications and limitations for transanal surgical removal of rectal neoplasms. World J Surg Proc. 2015b;5(1):1–13.

Devaraj B, Liu W, et al. Medically treated diverticular abscess associated with high risk of recurrence and disease complications. Dis Colon Rectum. 2016;59(3):208–15.

Erstad DJ, Tumusiime G, et al. Prognostic and predictive biomarkers in colorectal cancer: implications for the clinical surgeon. Ann Surg Oncol. 2015;22(11):3433–50.

Espenschied CR, LaDuca H, et al. Multigene panel testing provides a new perspective on lynch syndrome. J Clin Oncol. 2017;35(22):2568–75.

Feingold D, Steele SR, et al. Practice parameters for the treatment of sigmoid diverticulitis. Dis Colon Rectum. 2014;57(3):284–94.

Fleshman J, Branda M, et al. Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. JAMA. 2015;314(13):1346–55.

Ford AC, Sandborn WJ, et al. Efficacy of biological therapies in inflammatory bowel disease: systematic review and meta-analysis. Am J Gastroenterol. 2011;106(4):644–59, quiz 660.

Franko J, Shi Q, et al. Treatment of colorectal peritoneal carcinomatosis with systemic chemotherapy: a pooled analysis of north central cancer treatment group phase III trials N9741 and N9841. J Clin Oncol. 2012;30(3):263–7.

Geh I, Gollins S, et al. Association of Coloproctology of Great Britain & Ireland (ACPGBI): guidelines for the management of cancer of the colon, rectum and anus (2017) - anal cancer. Color Dis. 2017;19 Suppl 1:82–97.

Hadac JN, Leystra AA, et al. Colon tumors with the simultaneous induction of driver mutations in APC, KRAS, and PIK3CA still progress through the adenoma-to-carcinoma sequence. Cancer Prev Res (Phila). 2015;8(10):952–61.

Herzig DO, Buie WD, et al. Clinical practice guidelines for the surgical treatment of patients with Lynch syndrome. Dis Colon Rectum. 2017;60(2):137–43.

Hotouras A, Ribas Y, et al. A systematic review of the literature on the surgical management of recurrent rectal prolapse. Color Dis. 2015;17(8):657–64.

Kaiser AM. McGraw-Hill Manual Colorectal Surgery. Access Surgery; 2009. Retrieved November 14, 2022, from https://accesssurgery.mhmedical.com/book.aspx?bookID=425.

Kaiser AM, Etzioni DA, et al. Chapter 36: tumors of the colon. In: Zinner MJ, Ashley SW, editors. Maingot's abdominal operations. New York: McGraw-Hill Publisher; 2013.

Kaiser AM, Hogen R, et al. Clostridium difficile infection from a surgical perspective. J Gastrointest Surg. 2015;19(7):1363–77.

Kastrinos F, Syngal S. Screening patients with colorectal cancer for Lynch syndrome: what are we waiting for? J Clin Oncol. 2012;30(10):1024–7.

Kosinski L, Habr-Gama A, et al. Shifting concepts in rectal cancer management: a review of contemporary primary rectal cancer treatment strategies. CA Cancer J Clin. 2012;62(3):173–202.

Lamb MN, Kaiser AM. Elective resection versus observation after nonoperative management of complicated diverticulitis with abscess: a systematic review and meta-analysis. Dis Colon Rectum. 2014;57(12):1430–40.

Langman G, Loughrey M, et al. Association of Coloproctology of Great Britain & Ireland (ACPGBI): guidelines for the management of cancer of the colon, rectum and anus (2017) - pathology standards and datasets. Color Dis. 2017;19 Suppl 1:74–81.

Le Normand L, Cosson M, et al. Clinical practice guidelines: synthesis of the guidelines for the surgical treatment of primary pelvic organ prolapse in women by the AFU, CNGOF, SIFUD-PP, SNFCP, and SCGP. J Gynecol Obstet Hum Reprod. 2017;46(5):387–91.

Lieberman DA, Rex DK, et al. Guidelines for colonoscopy surveillance after screening and polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology. 2012;143(3):844–57.

Loberg M, Kalager M, et al. Long-term colorectal-cancer mortality after adenoma removal. N Engl J Med. 2014;371(9):799–807.

Lutz MP, Zalcberg JR, et al. Second St. Gallen European Organisation for Research and Treatment of Cancer Gastrointestinal Cancer Conference: consensus recommendations on controversial issues in the primary treatment of rectal cancer. Eur J Cancer. 2016;63:11–24.

Lynch HT, Lynch PM. Colorectal cancer: update on the clinical management of Lynch syndrome. Nat Rev Gastroenterol Hepatol. 2013;10(6):323–4.

Meester RG, Doubeni CA, et al. Variation in adenoma detection rate and the lifetime benefits and cost of colorectal cancer screening: a microsimulation model. JAMA. 2015;313(23):2349–58.

Mortensen K, Nilsson M, et al. Consensus guidelines for enhanced recovery after gastrectomy: Enhanced Recovery After Surgery (ERAS(R)) Society recommendations. Br J Surg. 2014;101(10):1209–29.

Nelson H, Machairas N, et al. Evidence in favor of standard surgical treatment for rectal cancer. JAMA Oncol. 2017;3(7):885–6.

Newman J, Fitzgerald JE, et al. Outcome predictors in acute surgical admissions for lower gastrointestinal bleeding. Color Dis. 2012;14(8):1020–6.

Peeters KC, Marijnen CA, et al. The TME trial after a median follow-up of 6 years: increased local control but no survival benefit in irradiated patients with resectable rectal carcinoma. Ann Surg. 2007;246(5):693–701.

Punt CJ, Koopman M, et al. From tumour heterogeneity to advances in precision treatment of colorectal cancer. Nat Rev Clin Oncol. 2017;14(4):235–46.

Quintero E, Castells A, et al. Colonoscopy versus fecal immunochemical testing in colorectal-cancer screening. N Engl J Med. 2012;366(8):697–706.

Ransohoff DF, Sox HC. Clinical practice guidelines for colorectal cancer screening: new recommendations and new challenges. JAMA. 2016;315(23):2529–31.

Rivoirard R, Duplay V, et al. Outcomes definitions and statistical tests in oncology studies: a systematic review of the reporting consistency. PLoS One. 2016;11(10):e0164275.

Ross H, Steele SR, et al. Practice parameters for the surgical treatment of ulcerative colitis. Dis Colon Rectum. 2014;57(1):5–22.

Saridaki Z, Souglakos J, et al. Prognostic and predictive significance of MSI in stages II/III colon cancer. World J Gastroenterol. 2014;20(22):6809–14.

Sauer R, Becker H, et al. Preoperative versus postoperative chemoradiotherapy for rectal cancer. N Engl J Med. 2004;351(17):1731–40.

Strate LL, Gralnek IM. ACG clinical guideline: management of patients with acute lower gastrointestinal bleeding. Am J Gastroenterol. 2016;111(4):459–74.

Strong SA, Koltun WA, et al. Practice parameters for the surgical management of Crohn's disease. Dis Colon Rectum. 2007;50(11):1735–46.

Tol J, Koopman M, et al. Chemotherapy, bevacizumab, and cetuximab in metastatic colorectal cancer. N Engl J Med. 2009;360(6):563–72.

Van Cutsem E, Kohne CH, et al. Cetuximab and chemotherapy as initial treatment for metastatic colorectal cancer. N Engl J Med. 2009;360(14):1408–17.

van Gijn W, Marijnen CA, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer: 12-year follow-up of the multicentre, randomised controlled TME trial. Lancet Oncol. 2011;12(6):575–82.

Varma M, Rafferty J, et al. Practice parameters for the management of rectal prolapse. Dis Colon Rectum. 2011;54(11):1339–46.

Verma M, Sarfaty M, et al. Population-based programs for increasing colorectal cancer screening in the United States. CA Cancer J Clin. 2015;65(6):497–510.

Vogel JD, Feingold DL, et al. Clinical practice guidelines for colon volvulus and acute colonic pseudo-obstruction. Dis Colon Rectum. 2016;59(7):589–600.

Winawer SJ. Long-term colorectal-cancer mortality after adenoma removal. N Engl J Med. 2014;371(21):2035–6.

Zelhart M, Kaiser AM. Robotic versus laparoscopic versus open colorectal surgery: towards defining criteria to the right choice. Surg Endosc 2017; epub ahead of print. https://doi.org/10.1007/s00464-00017-05796-00462.