Ulcerative Colitis: Surgical Management

49

Karen N. Zaghiyan and Phillip R. Fleshner

Key Concepts

- Multidisciplinary management and early surgical referral are crucial in the management of ulcerative colitis patients with moderate to severe colitis. While dysplasia screening and management is changing, surgical referral remains a cornerstone in the management of multifocal and high-grade dysplasia.
- Ileal pouch-anal anastomosis is the standard surgery for medically refractory disease, cancer, or dysplasia. One, two, or three-stage surgery may be chosen and tailored to various patient factors including preoperative nutritional status, corticosteroid use, and intraoperative factors.
- Alternative approaches such as total proctocolectomy with end ileostomy, continent ileostomy, and ileorectal anastomosis are options that may be considered in select patients.
- Long-term functional outcomes of patients undergoing surgery for ulcerative colitis including bowel, sexual, and urinary function, as well as fertility preservation, are important considerations and should be discussed preoperatively and monitored closely in the postoperative setting.

Introduction

Ulcerative colitis (UC) is a diffuse inflammatory disease of the mucosal lining of the colon extending from the rectum proximally and manifests clinically as diarrhea, abdominal pain, fever, weight loss, and rectal bleeding. While medical therapy is generally first-line, surgery is often required in patients with medically refractory disease, toxic colitis, dysplasia, or malignancy. This chapter summarizes the surgical options, decision-making, and techniques surrounding these operations.

K. N. Zaghiyan · P. R. Fleshner (✉)
Cedars Sinai Medical Center, Department of Surgery, Los Angeles, CA, USA

Indications for Surgery

Approximately 30% of patients with UC will undergo surgery in their lifetime. In a majority of patients, surgery is recommended and scheduled electively, while 10% require emergent surgery due to various indications. The type of surgery is dependent on the indication for surgery and patient factors.

Elective Surgery

Elective indications for surgery include medically refractory colitis, complications, or side effects associated with medications, extraintestinal manifestations, growth retardation in children, as well as dysplasia or cancer.

Medically refractory colitis and its associated complications make up approximately 70% of the overall surgical cohort [1]. Since the United States Food and Drug Administration approval of infliximab for moderate to severe UC in 2005, several additional biologics have become available options for patients with medically refractory colitis. Medical decision-making has become more complex, and patients are frequently exposed to multiple biologics before proceeding to surgery. During this time, exposure to corticosteroids may increase surgical risk, and nutritional status may decline. An important role of the physician is to guide the patient during their medical journey while preventing them from experiencing complications that may occur as a result of prolonged intractable disease and steroid exposure. Timelines and goal setting can help patients feel in control of their health decisions when facing potential surgery. Shared decision-making may be facilitated through early surgical evaluation prior to exhaustion of all medical options. A survey of UC patients having surgery suggested that over 50% of patients felt that they should have undergone surgery at an earlier time-point [1]. Thus, it is the responsibility of physicians to provide patients with realistic expectations relating

S. R. Steele et al. (eds.), *The ASCRS Textbook of Colon and Rectal Surgery*, https://doi.org/10.1007/978-3-030-66049-9_49

to their disease treatment and status to allow patients to make appropriate and timely decisions when surgery is inevitable.

Colorectal cancer (CRC), high-grade dysplasia or multifocal low-grade dysplasia are additional indications for colectomy. The overall rate of colorectal cancer in patients with UC is 3.7%. However, this risk begins to increase with the duration of disease from 2% at 10 years after the onset of UC, to 8% at 20 years after disease onset and 18% at 30 years after disease onset [2]. Patients with a young age at diagnosis, pancolitis, moderate to severe UC, family history of CRC, and presence of primary sclerosing cholangitis are also at higher risk of CRC [3]. For patients with a UC diagnosis greater than 8 years, colonoscopy surveillance every 1–2 years has been recommended using chromoendoscopy or high-definition colonoscopy with random quadrant biopsies every 10 cm [4]. During colonoscopy, targeted biopsies of any raised lesions are also performed. In the past, any high-grade dysplasia in the setting of UC was an indication for colectomy. In addition, patients with multifocal low-grade dysplasia were also referred for colectomy. However, the recently published SCENIC guidelines have changed the management of endoscopically detected dysplasia in UC. The guidelines make an important distinction between visible and invisible (random) dysplasia as well as polypoid and non-polypoid lesions. The current consensus statement, albeit based on very low-quality evidence, recommends that endoscopically resected polypoid dysplastic lesions may undergo surveillance colonoscopy rather than colectomy. The SCENIC guidelines also recommend endoscopic surveillance of non-polypoid (flat) dysplasia; however, this recommendation remains conditional and controversial with other guidelines suggesting referral to surgery [4]. The SCENIC guidelines have also challenged the routine use of random quadrant biopsies in UC cancer surveillance [5].

The management of invisible dysplasia has also been challenged. Data with low-definition endoscopes showed that 22% (18 of 81) of patients with invisible low-grade dysplasia [5, 6] and 32–42% of patients with invisible high-grade dysplasia [7] who underwent a colectomy had colorectal cancer in the pathology specimen. These rates supported the recommendation for colectomy in patients with high-grade and even low-grade dysplasia. However, the SCENIC guidelines suggest that these high rates of CRC may be irrelevant in the current high-definition endoscope era. This rationale is supported by the much lower rate of invisible dysplasia (10%) among all biopsies showing dysplasia in the current era vs 87% of biopsies with dysplasia performed prior to high-definition endoscopy or chromoendoscopy [8]. This suggests that older studies reporting a high rate of CRC with invisible dysplasia may be a result of previously unrecognizable lesions prior to the routine availability of modern endoscopic techniques. Thus, the current SCENIC recommendation for invisible dysplasia, confirmed by a gastrointestinal pathologist, is referral to an inflammatory bowel disease (IBD) center with experience in chromoendoscopy and high-definition colonoscopy. If an endoscopically resectable visible lesion is identified and in the area of the previous invisible dysplasia, then the patient may be entered into an intensive screening program. If no visible lesion is identified, patients with high-grade dysplasia are referred for colectomy, whereas patients with low-grade dysplasia are frequently offered surveillance with a greater likelihood for surgical referral in the setting of multifocal low-grade dysplasia.

Elective surgical options include total proctocolectomy with an end or continent ileostomy; ileal pouch-anal anastomosis (IPAA) performed in one, two, or three stages; or total abdominal colectomy with an ileorectal anastomosis. The choice of elective procedure is individualized based on clinical and patient factors and is discussed later in this chapter.

Emergent Surgery

Emergent indications for surgery include acute severe ulcerative colitis (ASUC) not responding to medical therapy, sepsis, toxic megacolon, perforation, or severe bleeding. Perforation and severe bleeding occur less commonly but are emergent indications for surgery. ASUC may range in severity and its response to medical therapy. ASUC can quickly progress to sepsis or toxic megacolon requiring emergency surgery.

Toxic megacolon is a life-threatening condition, combining ASUC with radiologic dilation of the colon, either total or segmental. Whereas patients with a dilated colon without signs of toxicity can be offered an initial trial of conservative management with bowel rest and serial abdominal exams, signs of sepsis including fever, tachycardia, or progressive abdominal pain are indications for urgent colectomy.

Approximately 25% of patients with UC will develop ASUC requiring hospital admission [9]. ASUC is diagnosed according to the modified Truelove and Witts criteria, combining bloody stool frequency ≥6 per day with at least one systemic toxicity such as a heart rate >90 bpm, temperature >37.8 °C, hemoglobin level of <10.5 g/dL, or an erythrocyte sedimentation rate >30 mm/hr [10]. In these patients, initial treatment includes intravenous corticosteroids, along with supportive measures such as intravenous fluids and electrolyte replacement, thromboprophylaxis, and nutritional support. Concomitant infectious etiology, most importantly from *Clostridioides difficile* or cytomegalovirus (CMV), must be ruled out. Approximately 30–40% have a partial or no response to this initial treatment approach. In the prebiologic era, patients with steroid-refractory ASUC underwent urgent colectomy [11]. While the current standard of care for patients with steroid refractory ASUC includes inpatient inf-

liximab (IFX) or cyclosporin (Cys), colectomy rates remain high, ranging from 13% to 25% in-hospital and approach 50% at 1 year [12–14]. In a recent study of 270 patients hospitalized with ASUC between 2002 and 2017, a multivariable logistic regression model identified that previous treatment with thiopurines or anti-TNFs (hazard ratio [HR], 3.86; 95% CI, 1.82–8.18), *Clostridioides difficile* infection (HR, 3.73; 95% CI, 1.11–12.55), serum level of C-reactive protein above 30 mg/L (HR, 3.06; 95% CI, 1.11–8.43), and serum level of albumin below 3.0 g/dL (HR, 2.67; 95% CI, 1.20–5.92) were associated with increased risk of colectomy. A risk prediction score was developed, with each item assigned a score of 1. The cumulative risks of colectomy within 1 year in patients with scores of 0, 1, 2, 3, or 4 were 0%, 9%, 11%, 51%, and 100%, respectively [15]. Despite these statistics, the threshold for surgery remains high, with surgery being considered only when all medical options have been exhausted. Unfortunately, this approach results in an increased risk of surgical morbidity (over 50%) and in-hospital mortality (8%) [16]. We therefore advocate for early surgical evaluation in hospitalized patients with ASUC, with surgery being considered an alternative to medical management rather than a final resort after failure of medical therapy.

In the emergent setting, the preferred surgical approach is a total abdominal colectomy with end ileostomy. The rectum, even if diseased, can generally be left as a Hartmann's stump. When there are concerns about the integrity of the rectal staple or suture line, the rectum can be delivered to the skin as a mucous fistula or as a subcutaneous rectal stump, whereby the closed rectal stump is placed subcutaneously beneath the surgical wound to minimize intraabdominal complications of a stump blowout [17, 18]. The primary consideration when performing an urgent colectomy is to avoid a pelvic dissection as this may hinder future restoration of intestinal continuity and increase the risk of autonomic nerve injury and bleeding complications both in current and future operations. Removal of the diseased colon is generally sufficient to allow the patient to come off of immunosuppressive medications and regain nutritional status and overall health. Completion proctectomy with or without IPAA can be later performed in the elective setting.

Surgical Options and Postoperative Outcomes

Preoperative Planning

Once the decision for surgery is made, several steps should be taken in the preoperative period to optimize surgical outcomes. Preoperative consultation with an enterostomal therapist should be arranged to allow for ostomy site marking and preoperative counseling [19]. Preoperative small bowel evaluation, if one has not been performed in the recent past, is important to exclude small bowel inflammation and confirm the diagnosis of ulcerative colitis. A steroid taper should be considered as tolerated to minimize perioperative steroid dose. In preparing for surgery, the surgeon should also take the lead on perioperative corticosteroid dosing. With the exception of patients with documented adrenal insufficiency, a perioperative corticosteroid stress dose is not recommended and may in fact increase infectious complications. Rather, patients with prolonged steroid exposure should be maintained on their preoperative steroid dose in the perioperative period with a steroid taper on hospital discharge [20]. Preoperative nutritional optimization, and when available, referral to a dietician is important, especially in patients with preoperative weight loss or hypoalbuminemia. Prehabilitation consisting of preoperative oral nutritional supplementation alone or combined with an exercise program has been suggested to improve postoperative recovery and reduce postoperative hospital stay in patients undergoing colorectal surgery, although data specific to surgery for inflammatory bowel disease is limited [21, 22]. An oral antibiotic combined with mechanical bowel preparation should be ordered to minimize postoperative infectious complications [23].

Ileal Pouch-Anal Anastomosis

In 1978 Parks and Nichols described the ileal pouch-anal anastomosis (IPAA) [24], which has since become the standard operation in patients desiring restoration of intestinal continuity and may be performed in one, two, or three stages. In this operation, a near complete proctocolectomy is performed, and an ileal pouch is either stapled or hand-sewn to the anal canal. While the original operation described by Sir Alan Parks included a complete stripping of the rectal mucosa and creation of a triple-loop S-pouch, a majority of centers now preserve the anal transition zone and perform a stapled anastomosis between the ileal J-pouch and anal canal. When patients are considered appropriate candidates for upfront restorative proctocolectomy with IPAA, single stage (restorative proctocolectomy, ileal pouch-anal anastomosis without diverting ileostomy) or two-stage IPAA (restorative proctocolectomy, ileal pouch-anal anastomosis with diverting ileostomy) may be considered. While some centers have advocated for a single-stage approach, a staged IPAA is a far more common and prudent approach. Creation of a diverting ileostomy at the time of IPAA prevents catastrophic septic complications in the event of an anastomotic leak. The ileostomy can later be reversed in 2–3 months. Alternatively, total abdominal colectomy with end ileostomy may be performed first, allowing the patient to recover and

regain nutritional health and later return for completion proctectomy and IPAA.

Prior to embarking on this operation, the integrity of the anal sphincter mechanism must be assessed. Patients should be motivated and willing to cope with potential postoperative complications as the surgical approach may result in impaired function, especially in patients with preexisting fecal incontinence. Ileal pouch-anal anastomosis may be performed using laparoscopic or open technique. In the elective setting, a laparoscopic approach is preferred and offers short-term benefits such as reduced minor complications and shorter hospital stay [25]. Over the long-term, a laparoscopic IPAA may reduce postoperative adhesions and offer female patients improved fertility [26]. In this chapter, a laparoscopic IPAA is described; however the nuances and key technical steps are similar irrespective of open, straight laparoscopic, hand-assisted laparoscopic or robotic approach. The surgeon is advised to use the approach that is safest in their hands, based not only on the patient's clinical condition but also surgeon experience and skill level.

Operative Technique

The patient is brought to the operating room and placed in the modified lithotomy position [27]. An orogastric tube is inserted to decompress the stomach. Trocars are placed in three positions: 11 mm umbilical port for the camera, 5 mm suprapubic port, and a 12 mm port at the future ileostomy site (Fig. 49.1). This allows adequate visualization while at the same time maximizing cosmesis in these often young patients. After creation of pneumoperitoneum, the small bowel is evaluated for Crohn's disease and the abdomen explored for any evidence of bowel perforation (purulent drainage or abscess). Abdominal colectomy is performed in a standard fashion, with close to bowel mesenteric dissection, preservation of the ileocolic artery, and avoiding injury to the duodenum, stomach, small bowel loops, spleen, and pancreas. A 10 mm laparoscopic vessel sealer is used for the majority of the dissection. Colectomy is performed from right to left. The lateral attachments are taken down, and the hepatic flexure is mobilized (Fig. 49.2a). The ileocolic pedicle is identified and preserved. The mesenteric window distal to the ileocolic artery is incised, and the transverse mesocolon and gastrocolic ligament are divided (Fig. 49.2b). The lesser sac is entered (Fig. 49.2c), small bowel loops are swept to the right, and the ligament of Treiz is identified and protected. Care is taken to avoid injury to the stomach, pancreas, and spleen as the splenic flexure is taken down (Fig. 49.2d). The remaining mesentery is divided close to the colon, and the dissection is carried down to the pelvic brim. At this point, decision must be made to proceed with or abort proctectomy and IPAA. Assessment of small bowel mesenteric length for pouch reach at this point is critical. If the mesentery is foreshortened or thick due to fat infiltration, the upper rectum should be cleared of its mesentery with superior rectal artery preservation, stapled closed with an endo-GIA stapler (Fig. 49.2e) and the ileal pouch aborted. It is our approach to extract the specimen through the future ileostomy site. The 12-mm trocar is removed, and the fascial opening is enlarged in a cruciate fashion and rectus muscle split to accommodate two fingers. A wound protector is inserted, and the rectosigmoid colon is delivered through this incision. The ileum is left attached and transected flush with the cecum extracorporeally with a GIA stapler to prevent staple line blowout during extraction. The remaining mesentery is divided with the vessel sealer, close to the bowel in order to preserve the ileocolic pedicle and future perfusion to the ileal pouch. In the event that the colon or mesentery is too thick to safely deliver the intact specimen through the ileostomy site, a small Pfannenstiel incision can be made for extraction. The end ileostomy is then matured and a transanal drain placed to decompress the rectal staple line. In severely malnourished patients when there is concern over the integrity of the rectal staple line, an alternative approach to the abdominal stump is to create a subcutaneous stump or mucous fistula.

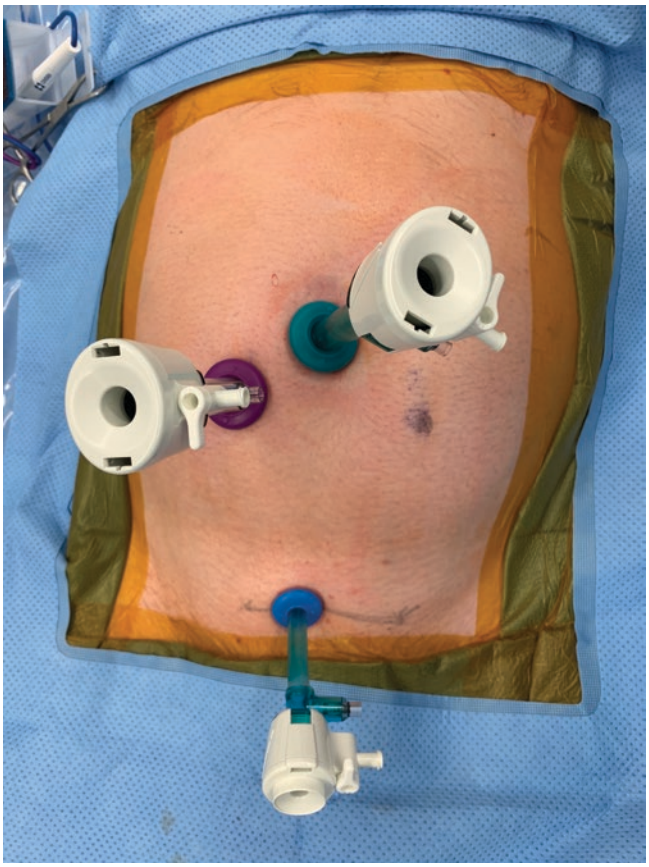

Fig. 49.1 Trocars placement for laparoscopic colectomy. A 12 mm trocar at the future ileostomy site may be used for insertion of Endo-GIA stapler. This site can be later enlarged to create the ileostomy aperture and for specimen extraction

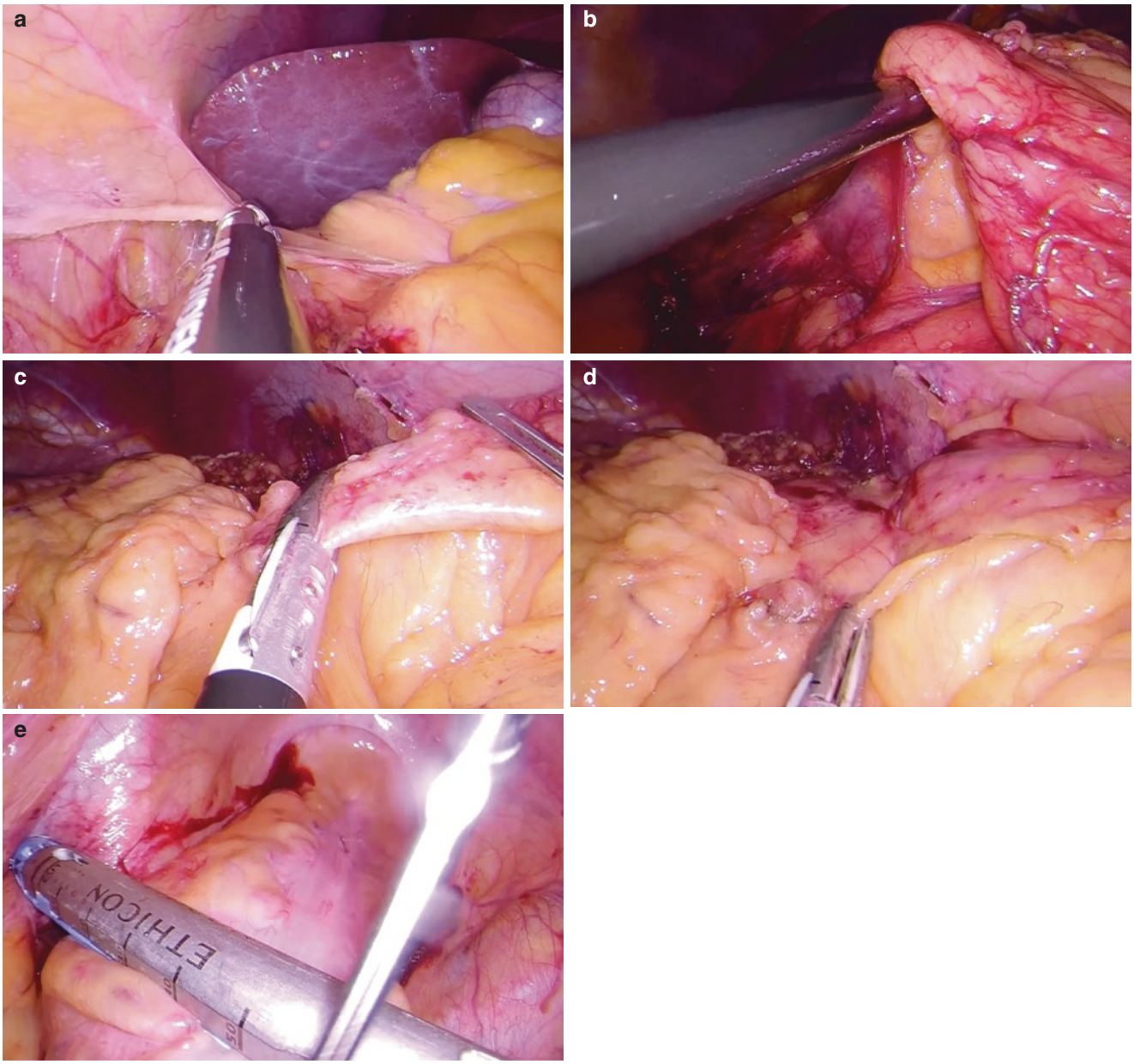

Fig. 49.2 Technical steps of laparoscopic abdominal colectomy. (**a**) The right colon is mobilized in a lateral to medial fashion toward the hepatic flexure, (**b**) the mesenteric window distal to the ileocolic artery is opened, and the mesenteric dissection is taken toward the transverse mesocolon, (**c**) the greater omentum and transverse mesocolon may be divided together or separated to gain entry into the lesser sac, (**d**) the splenic flexure is taken down working form right to left, and (**e**) the rectum is divided intracorporeally using one or two firings of a 60 mm endo-GIA stapler

If there is adequate pouch reach and the patient's clinical condition is conducive to IPAA, then the rectal dissection is carried to the pelvic floor. This dissection may be continued laparoscopically, or, alternatively, a Pfannenstiel incision can facilitate open proctectomy, while still maintaining cosmesis and minimizing incision size and associated complications. The superior rectal artery is divided with the vessel sealer, and entry is gained into the presacral space. It is our practice to perform the posterior dissection in the relatively bloodless total mesorectal excision plane. However, an alternative option, popularized by increased availability and comfort with the use of vessel sealers, is the intramesorectal or close rectal dissection to further reduce the risks of autonomic nerve injury [28]. Anterior dissection is carried close to the rectum preserving the rectoprostatic fascia in men and rectovaginal septum in women, and the lateral stalks are divided close to the rectum, again to minimize injury to autonomic nerves in the setting of benign disease. Anteriorly, the dissec-

tion is carried to the level of the prostate in men and the mid-portion of the vagina in women. Posteriorly, the dissection is carried past the end of the coccyx. When a double stapled anastomosis is planned, the rectum may be stapled closed and transected at the level of the puborectalis muscle using an articulating endo-GIA stapler or right-angle linear stapler leaving a 1–2 cm cuff of rectal mucosa.

Next the ileal reservoir is created (Fig. 49.3). The terminal ileum is aligned in a J configuration, and the pouch constructed with either a continuous absorbable suture or stapling device. Both limbs of the J should measure approximately 15–25 cm in length, the exact length guided by where the pouch reaches deepest into the pelvis. The prospective apex of the pouch must reach beyond the symphysis

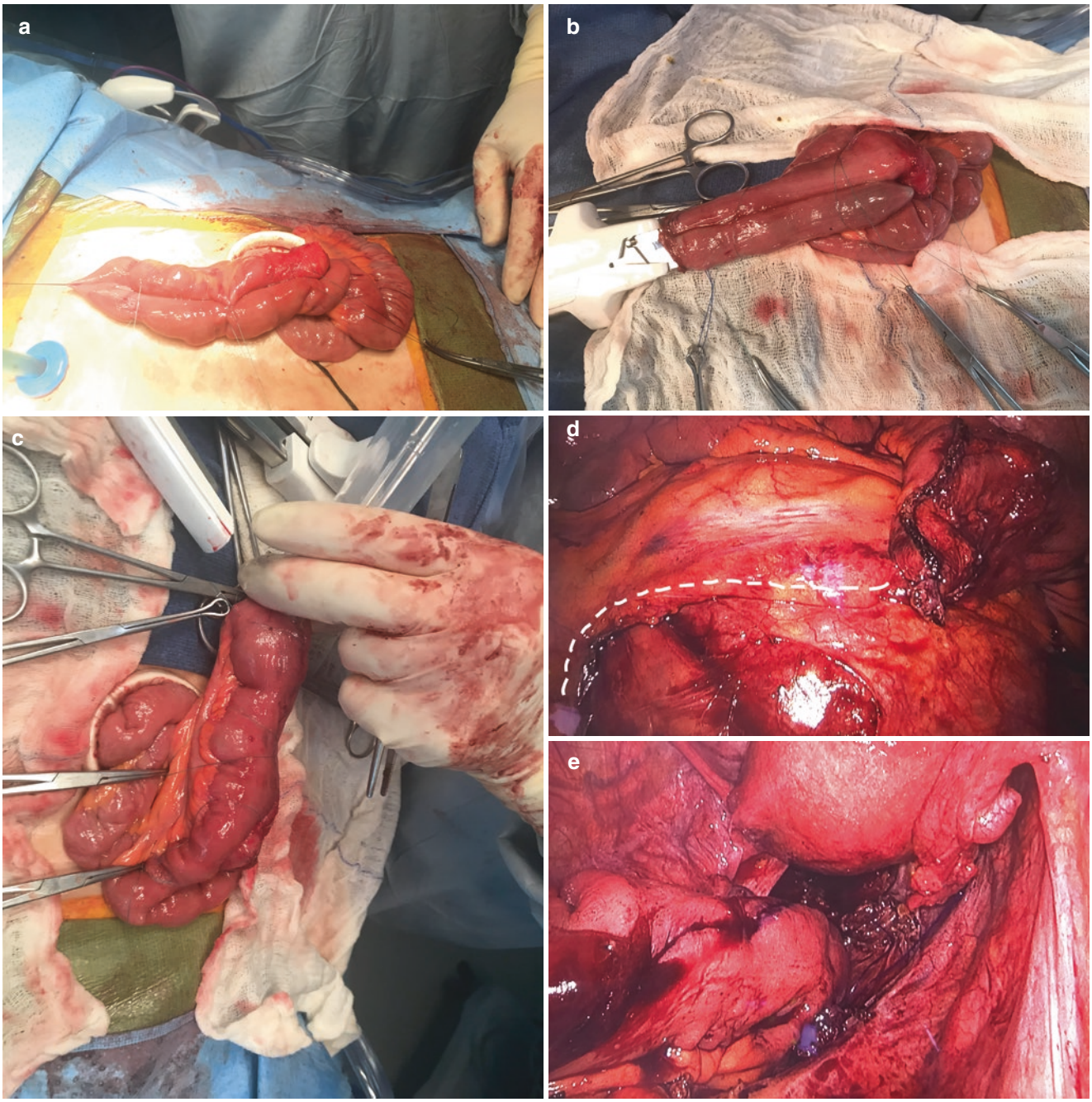

Fig. 49.3 Technical steps of ileal J pouch creation. (**a**) Pouch reach is assessed, and the apex of the pouch is chosen at the point of maximal reach beyond the pubic symphysis. An apical suture and additional aligning sutures are placed, (**b**) enterotomy is created at the apex of the pouch and linear cutting staplers are used to create the reservoir, (**c**) the pouch is air tested to assure absence of leaks, (**d**) the pouch is delivered back into the peritoneal cavity and oriented so that the mesentery is straight along the retroperitoneum (dotted line) to the duodenal sweep and proximal bowel loops are not tethered caudal to the pouch mesentery, and (**e**) the pouch is delivered to the pelvis for anastomosis

pubis in order to accomplish a tension-free ileoanal anastomosis. Selective division of mesenteric vessels to the apex of a proposed J-pouch will allow for more length. Superficial incision on the anterior and posterior aspects of the small bowel mesentery along the course of the superior mesenteric artery and mobilization of the small bowel mesentery up to and anterior to the duodenum are two additional important lengthening maneuvers.

In the case of a double-stapled anastomosis, after transection of the rectum at the level of the puborectalis muscle (Fig. 49.4a), the anvil of the midsized circular stapler device is inserted into the apex of the ileal pouch and secured in place using a running purse-string suture. Before proceeding with the anastomosis, integrity of the rectal staple line is tested using air insufflation. The stapler is placed transanally (Fig. 49.4b) and the trocar advanced through the transverse staple line and connected to the anvil (Fig. 49.4c) assisted by the abdominal operator, who ensures that no adjacent tissues are trapped within the stapling device as it is closed and fired (Fig. 49.4d). The integrity of the staple line may be checked digitally and confirmed using transanal air insufflation.

Alternatively, distal mucosal stripping may be performed with a hand-sewn ileal pouch anal anastomosis [29]. The use of a Lone Star™ retractor facilitates exposure and minimizes damage to the sphincter mechanism (Fig. 49.5a). A solution of dilute epinephrine (Fig. 49.5b) is injected into the submucosal plane to facilitate mucosectomy and minimize bleeding (Fig. 49.5c). The excised mucosa and remaining proximal rectum are removed, leaving a short cuff of denuded rectal muscle distally above the dentate line. The pouch is then pulled into the pelvis and the anastomosis carried out between the apex of the pouch and the dentate line, approximating full thickness of the pouch wall to the internal sphincter and anal mucosa (Fig. 49.5d). A proximal defunctioning loop ileostomy is created. One or two suction drains are placed in the presacral space and brought out through the lower abdominal quadrant. In the case of open proctectomy, placement of an anti-adhesion barrier around the stoma and underneath the incision should be considered to reduce the incidence and severity of postoperative abdominal adhesions [30]. Postoperative management is similar to that in patients who have had a low anterior resection. Ileostomy output can be quite high, since the stoma is more proximal than a traditional terminal ileostomy. Patients should be encouraged to keep themselves well hydrated. In some instances, antidiarrheal medication is prescribed. Enhanced recovery pathways including early diet advancement [31, 32], ambulation [33], and early urinary catheter removal [34] are safe in this patient population and have been shown to improve postoperative outcomes and hospital stay. Patients are discharged when tol-

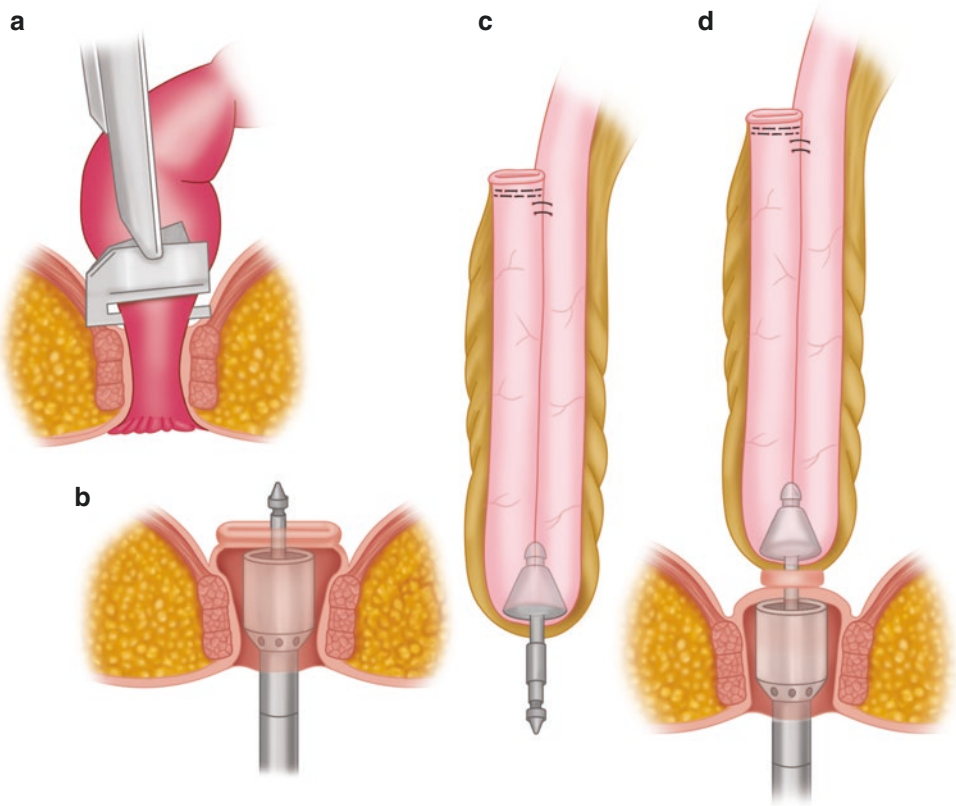

Fig. 49.4 Technical steps of double stapled ileal pouch-anal anastomosis. (**a**) The rectum is transected at the level of the puborectalis, and (**b**) the end-to-end anastomosis stapler is inserted transanally and guided by the abdominal operator through the transverse staple line; (**c**) the anvil placed in the J-pouch (**d**) and the anvil is connected to the transanal stapler and the stapler is closed and fired after assuring appropriate pouch orientation

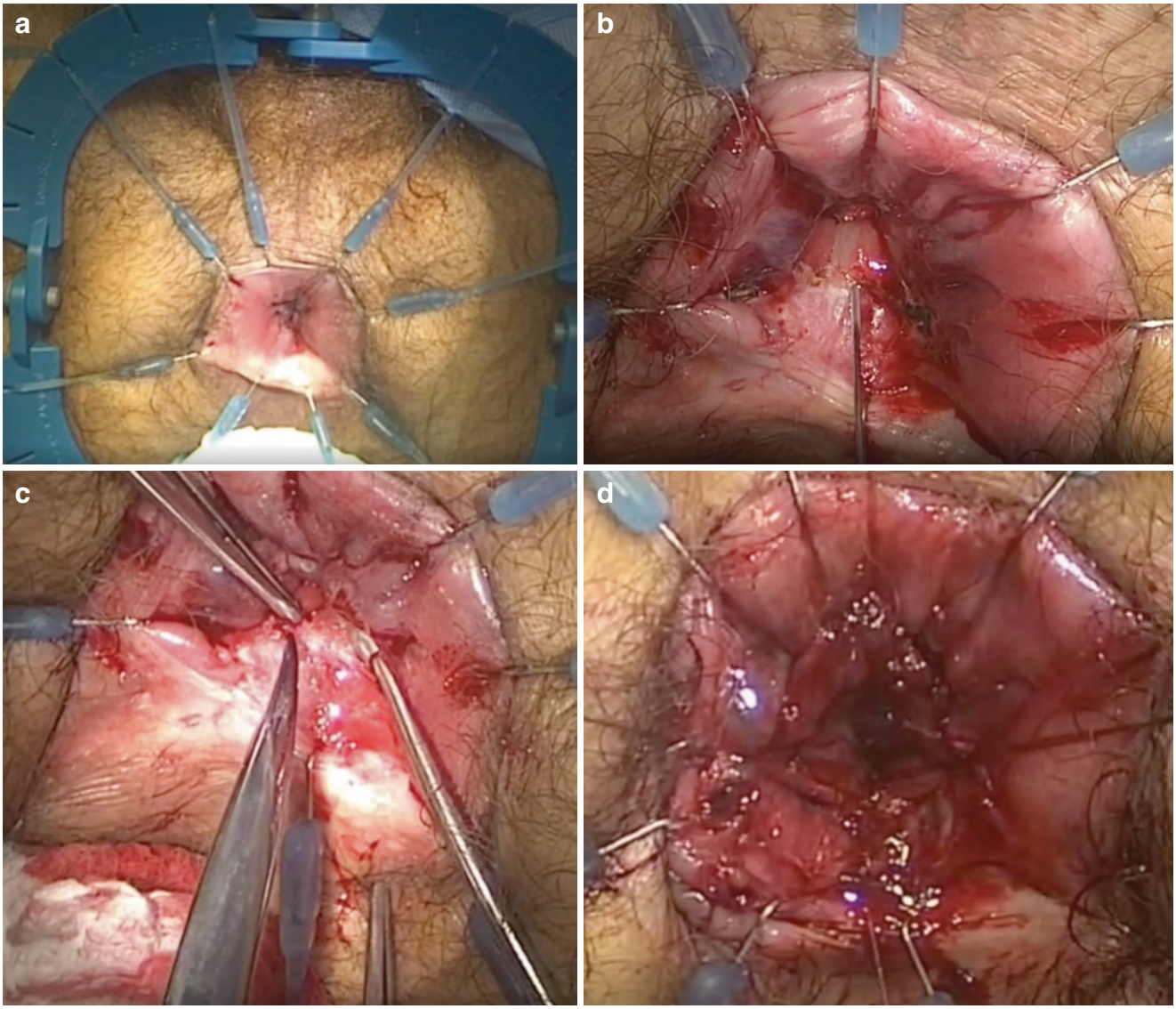

Fig. 49.5 Technical steps of mucosectomy with hand sewn ileal pouch-anal anastomosis. (**a**) Lone Star™ retractor facilitates anal retraction, (**b**) solution of dilute epinephrine is injected submucosally to help develop the dissection plane and minimize bleeding, (**c**) mucosectomy carried upward toward the distal aspect of the abdominal dissection at which point the mucosa is pushed upward and rectum transected, and (**d**) pouch is delivered to the pelvis and hand-sewn to the dentate line

erating a solid diet with adequate ileostomy output and free of signs of infection. Ileostomy may be closed approximately 6–8 weeks later. Before closure however the pouch is thoroughly investigated. Digital rectal examination is used to assess anal sphincter tone and detect anastomotic strictures or defects. The pouch is examined endoscopically to ensure that the suture lines are healed, and a contrast study is performed to detect pouch leaks, fistulas, and sinus tracts. Only after confirmation that pouch abnormalities are not present is the ileostomy closed.

Controversies

One-, Two-, or Three-Stage IPAA

In well-nourished patients undergoing an uncomplicated IPAA and tension-free anastomosis, a single-stage IPAA and omission of a diverting ileostomy have been considered. Proponents of a single-stage IPAA cite the high rate of ileostomy-related complications (43%) including obstruction (23%) and dehydration (25%) in addition to complications related to the ileostomy closure operation (29%) [35].

While level 1 evidence supporting or refuting a single-stage IPAA with omission of an ileostomy is lacking, retrospective reports of selective ileostomy omission suggest similar complication rates and overall long-term function as patients with a diverting ileostomy [36]. In a recent study of 317 diverted and 670 undiverted pouches, pouch leaks occurred in 13.7% ($n = 92$) of patients without diversion and 13.6% ($n = 43$) of patients with diversion. Five diverted patients (12%) developing a pouch leak and 41 (45%) undiverted patients with a pouch leak underwent unplanned trips to the operating room ($p < 0.01$). Ten out of 43 (27%) diverted patients with a pouch leak, and 53 of 92 (60%) of undiverted patients with a pouch leak underwent an unplanned ostomy within 200 weeks of surgery ($p < 0.01$). The rate of pouch salvage operations over total follow-up was similar between the two groups, 74% and 78% of patients with a pouch leak [37]. In another retrospective evaluation of 4031 IPAA patients, of whom 357 developed pelvic sepsis with a diverting ileostomy and 31 without, there was a higher rate of reoperation for diverting ileostomy (48%) in patients without diverting ileostomy at time of IPAA compared with patients with diverting ileostomy (12%); $p < 0.0001$. Five-year and 10-year follow-up however demonstrated no difference in pouch survival between groups, 99% vs 97%, and 88% vs 87%, respectively [38]. These studies are biased, as omission of a diverting ileostomy would only be considered in the most healthy patients having a straightforward operation. Considering the sequelae of a pelvic anastomotic leak and potential long-term effects on pouch function, it is the practice of the authors to perform routine diverting ileostomy in patients undergoing IPAA.

Many patients with UC are not appropriate candidates for upfront IPAA. In these patients, a three-stage IPAA may be offered. This approach involves initial total abdominal colectomy with end ileostomy. After several months of recovery, the patient may undergo completion proctectomy with ileal pouch-anal anastomosis and diverting loop ileostomy followed by ileostomy closure several months later. Patients best suited for a three-stage IPAA include not only hospitalized patients having urgent colectomy but also patients with preoperative malnutrition, high-dose steroids, obesity, cancer, female patients desiring pregnancy, or patients in whom there is diagnostic uncertainty (inflammatory bowel disease-unclassified).

Preoperative corticosteroids more than 20 mg/day and preoperative hypoalbuminemia (serum albumin <3 g/dL) are two factors that carry a significantly higher risk of postoperative pouch-related infectious complications [39, 40] and in the opinion of the authors are indications for initial total abdominal colectomy with staged IPAA. The implications of preoperative biologics have also been debated extensively. While several studies have suggested a higher rate of infectious complications in patients exposed to preoperative biologics, concerns over the retrospective nature of these studies and multiple confounders including concomitant treatment with corticosteroids have resulted in significant debate over this topic [41–44]. However, the recent PUCCINI study, a prospective, multicenter evaluation of 955 patients with inflammatory bowel disease undergoing abdominal surgery found that any infection (19% vs 20%) and surgical site infections (12% vs 13%) were similar in patients treated with or without anti-TNFs in the preoperative period [45]. While the effect of more recently available biologic drugs such as vedolizumab and ustekinumab are yet to be determined, there does not appear to be any robust data suggesting an independent impact on surgical morbidity in patients treated with these agents [46, 47]. Thus, preoperative treatment with biologic drugs does not appear to be an independent factor requiring initial colectomy with staged completion proctectomy and IPAA.

Obesity is an independent predictor of pouch abandonment [48] after IPAA. This is largely related to visceral fat deposition within the ileal mesentery limiting pelvic pouch reach. In addition, obese patients carry a higher risk of overall complications [49] as well as anastomotic leak [50] after IPAA. Patients having elective IPAA should therefore be counseled on preoperative weight loss when possible, and patients having a staged approach should be offered nutritional and weight loss counseling to achieve a BMI <30 kg/m^2 prior to IPAA. Patients with colon cancer in the setting of UC may be better served by a staged approach whereby the proctectomy and IPAA are performed at a later time after systemic chemotherapy in order to avoid a situation where pelvic infectious complications prohibit or delay timely chemotherapy.

Patients desiring pregnancy in the short-term after colectomy may also prefer a staged operation. In these patients, the risk of infertility related to pelvic dissection and IPAA surgery may be minimized by allowing the patient to attempt child bearing after total abdominal colectomy and end ileostomy. The patient may pursue completion proctectomy and restoration of bowel continuity when they have finished child-bearing. Lastly, in patients with inflammatory bowel disease unclassified, a staged approach can allow for pathologic evaluation of the colectomy specimen to guide surgical decision-making. Patients with Crohn's-like features may choose to delay IPAA to allow better diagnostic workup or avoid it all together.

While a three-stage IPAA is the common approach for patients initially undergoing total abdominal colectomy with end ileostomy, a modified two-stage IPAA has recently been described. In this approach, after initial total abdominal colectomy and end ileostomy, the patient returns for the second and final stage several months later (completion proctectomy, ileal pouch-anal anastomosis without diverting ileostomy). Proponents of this approach argue that patients

undergoing total abdominal colectomy and returning for surgery in overall good health and nutrition may be offered IPAA without diversion. In this approach, complications of ileostomy such as dehydration, electrolyte derangements, and the need for a third operation can be omitted. An initial report of this approach compared 23 patients who had a modified two-stage IPAA vs 31 patients who underwent a three-stage IPAA [51]. No patients having a modified two-stage IPAA had pouch-related complications requiring stoma creation. Total hospital cost and hospital stay were also lower in the modified two-stage group. In a more recent cohort comparing 223 patients who had a traditional two-stage IPAA (restorative proctocolectomy with ileal-pouch anal anastomosis and diverting loop ileostomy followed by ileostomy closure several months later) with 237 who had a modified two-stage IPAA, patients having a modified two-stage IPAA had a 4.7% rate of anastomotic leak versus 15.7% of patients having a traditional two-stage IPAA; $p < 0.01$ [52]. While these results appear promising, concerns over patient selection and the overall generalizability of this approach have limited widespread application. Prospective randomized studies may help shed more light on the overall applicability of the modified two-stage IPAA.

Optimal Pouch Design

In their initial description of the IPAA, Parks and Nichols constructed a three-limb "S" pouch with a hand-sewn pouch-anal anastomosis [24]. Several years later, Utsunomiya et al. reported on a two-limb "J" pouch, which, with the advent of the surgical stapler, became the procedure of choice due to its ease of construction [53]. As practice patterns have changed over time, a number of studies have compared both postoperative complications and functional outcomes between the different pouch designs (Fig. 49.6). The majority of these studies are limited to retrospective, single-center series of patients undergoing IPAA for either ulcerative colitis or familial adenomatous polyposis. With regard to short-term outcomes, a meta-analysis performed in 2007 of 23 studies found no difference in rates of anastomotic leak, pelvic sepsis, or pouch failure [54]. Long-term outcomes have been looked at in two large meta-analyses [54, 55] comparing pouch designs. Both studies concluded that J-pouches were subject to increased stool frequency with an average of one more bowel movement over 24 hours. All other functional outcomes however were equivalent between pouch designs.

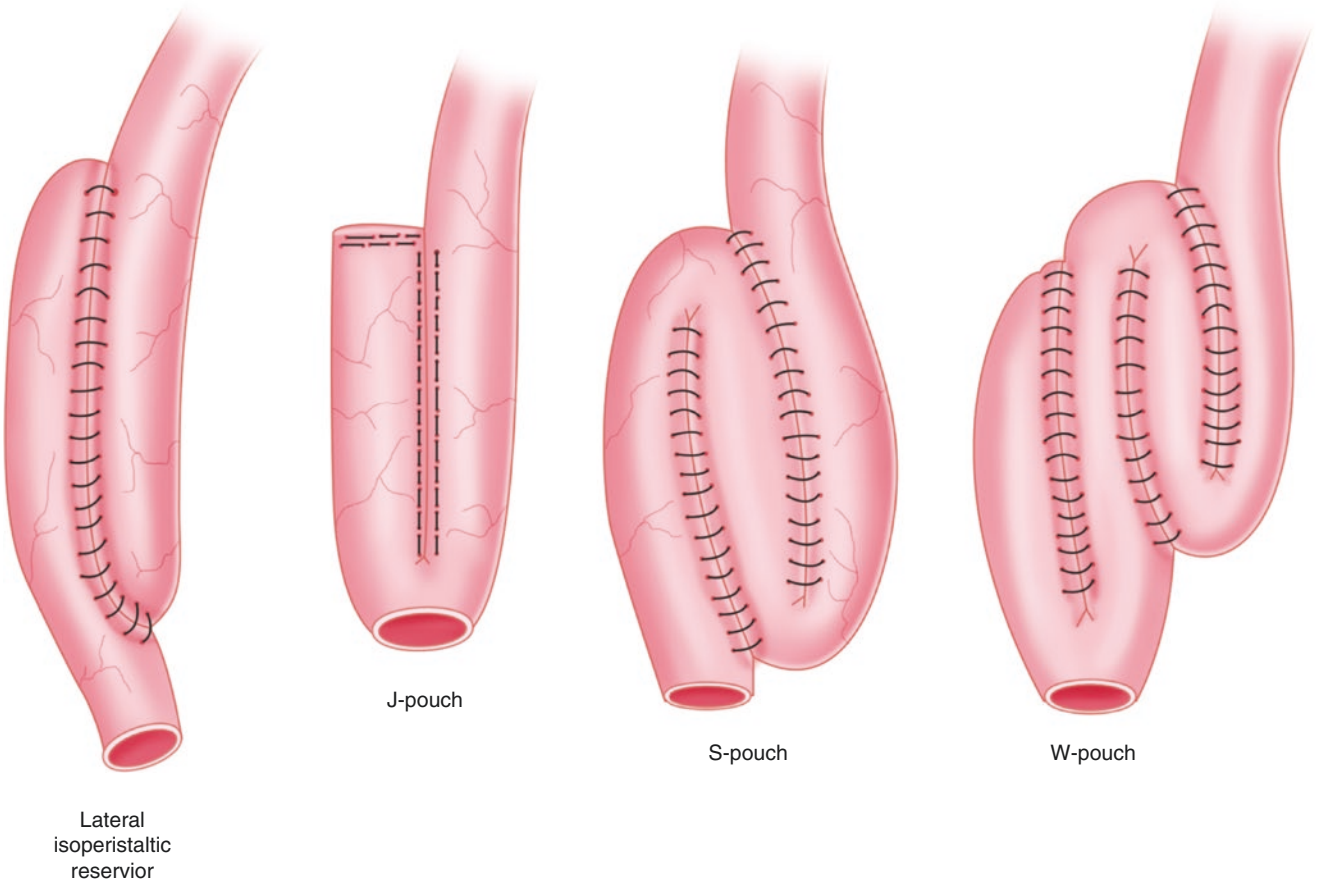

Fig. 49.6 Different ileal pouch configurations

Type of Anastomosis: Hand-Sewn or Stapled

While the original description by Parks and Nicholls in 1978 [24] suggested complete mucosectomy to the dentate line and hand-sewn anastomosis, stapling devices over the last three decades have become the default practice [56]. Several historical randomized trials [57, 58] compared mucosectomy and stapled IPAA in the 1990s, but none demonstrated the superiority of either technique. Small sample size and single institutional methods may account for such findings. Recent evidence has revealed equal long-term functional results comparing both anastomotic techniques [59], while short-term morbidity was consistently lower after stapled IPAA [60]. Regarding the risk of disease relapse or malignancy, the largest published series [61] did not find a higher rate of neoplasia in either the ATZ or pouch after a stapled procedure, while dysplasia or malignancy at the time of IPAA remain independent risk factors [62]. Thus, in patients presenting with colitis and rectal high-grade dysplasia or adenocarcinoma by the time of surgery, mucosectomy and hand-sewn IPAA should be strongly considered. Stapled anastomosis can be considered as the first choice in all other circumstances.

Transanal Pouch

An important yet technically demanding step in laparoscopic ileal pouch surgery is assuring the distal rectal transection is perpendicular to the pelvic floor. Often the angle for transection is oblique, resulting in the need for multiple stapler firings and an increased risk of anastomotic leak [63]. In addition, inadequate transection of the distal rectum may risk leaving a long rectal cuff behind resulting in an increased occurrence of cuffitis and/or pouch evacuation problems. The transanal J-pouch (ta-J-pouch) was developed in an effort to address technical shortfalls of the laparoscopic ileoanal pouch. Another advantage of this approach is the design of the ileoanal anastomosis, changing from a double staple with the potential creation of "dog ears" at the sides to a single stapled which can be easily reinforced transanally. Finally, the transanal platform allows an ergonomic dissection in a horizontal plane of the most distal and curved part of the rectum. Although short-term [64, 65] and long-term functional data [66] appear to support the role of a transanal approach to ileal pouch surgery, more robust data with increased surgical experience is eagerly awaited.

Ileorectal Anastomosis

While IPAA remains the gold standard surgical approach for ulcerative colitis, recent series of ileorectal anastomosis (IRA) for UC have suggested similar long-term functional results and quality of life. Proponents of IRA report advantages including the lower technical demand compared with IPAA, the ability to perform a single stage operation and elimination of a pelvic dissection, and the potential associated complications such as pelvic sepsis, poor function, pouchitis, sexual and urinary dysfunction, and female infertility.

Technical aspects of the operation are similar to the colectomy portion of IPAA. The ileocolic pedicle and superior rectal arteries are preserved. The ileum is transected flush with the cecum and rectum transected where the taenia coli splay. A 29 mm EEA stapler is used to provide a wide lumen and minimize stenosis. After extracorporeal transection of the ileum, the anvil is placed inside and secured with a 2–0 polypropylene purse-string suture. The bowel is re-delivered into the peritoneal cavity, pneumoperitoneum re-achieved, the ileal mesentery laid straight and flush with the retroperitoneum, and EEA anastomosis created and tested under water using flexible sigmoidoscopy. Fluorescence angiography can be used to assure perfusion to the anastomosis. In healthy, well-nourished patients with a tension-free and intact anastomosis, diverting ileostomy is generally not required.

Several studies have shown safety of IRA for UC with overall complications ranging from 24% to 28% and anastomotic leak rate of 3–4% [67–69]. Long-term failure rate is the most important concern and ranges from 18% to 49% [67, 69–71]. In a recent multicenter retrospective study of 343 patients undergoing IRA in France, multivariable analysis identified treatment with both immunosuppressants and anti-TNF before colectomy as independent predictors of IRA failure, whereas colectomy for severe acute colitis was associated with a decreased risk of IRA failure [72].

Another concern with IRA is development of dysplasia or cancer in the retained rectum. In a study published in 1981, overall cancer rate in 89 patients undergoing IRA for UC was 4.8%. This risk ranged from 0% in patients with disease less than 10 years to 13% after 25 years of disease. Patients with cancer or dysplasia in the colon at the time of colectomy had a higher risk of later developing cancer or precancer of the rectum. In patients with mild colonic dysplasia, the risk of rectal cancer or precancer was 22% (2 out of 9 patients), and in surviving patients with colon cancer or precancer, the risk of later developing rectal cancer or precancer was 71% (5 out of 7 patients) [73]. In a meta-analysis of patients with UC undergoing surgery, the risk of subsequent colorectal cancer in patients with a rectal stump, IRA or IPAA, was 2.1%, 2.4%, and 0.5%, respectively. While having an IRA or rectal stump compared with IPAA increased the risk of subsequent colorectal cancer (OR 6.4; 95% CI, 4.3–9.5), a history of colorectal cancer was the most important risk factor for development of CRC after both IRA (OR 12.8; 95% CI, 3.31–49.2) and IPAA (OR 15.0; 95% CI 6.6–34.5) [74].

While a history of colorectal cancer or high-grade dysplasia may portend an unnecessarily high risk of subsequent

dysplasia or rectal cancer after IRA, certain populations such as patients with acute severe colitis requiring urgent colectomy who are relatively naïve to biologics or immunomodulators, those with indeterminate colitis with relative rectal sparing, and patients possibly young female patients desiring to maximize fertility may be candidates for selective IRA. One important factor to consider when choosing to proceed with IRA is the functional capacity of the rectum as chronic UC may impede rectal compliance. Most importantly, the decision for IRA or IPAA should be made under the guidance of a skilled surgeon capable of performing both operations.

Continent Ileostomy

Although continent ileostomy is not primarily advised in patients needing a permanent fecal diversion, it may be a viable option in patients who have failed Brooke ileostomy or those who are candidates for an IPAA but cannot have a pouch because of rectal cancer, perianal fistulas, poor anal sphincter function, or occupations that may preclude frequent visits to the toilet. Suspicion of Crohn's disease contraindicates construction of a continent ileostomy, since the risk of recurrent disease in the pouch is increased which may necessitate resection of the entire pouch encompassing approximately 45 cm of viable small bowel and render the patient unable to maintain nutrition. Obesity and age over 40 years are associated with an increased risk of pouch dysfunction and represent relative contraindications to the continent ileostomy [75]. For patients considering continent ileostomy, an open discussion with the patient is important, stressing that although continence is likely, major complications often occur. These setbacks generally must be corrected surgically, sometimes leading to pouch excision and creation of a standard Brooke ileostomy. Only highly motivated, emotionally stable individuals should consider this procedure.

Operative Technique

After mobilization of the existing ileostomy from the abdominal wall, the reservoir is constructed. The continent ileostomy is created by using the terminal 45–50 cm of the ileum to create an aperistaltic reservoir as initially described by Kock [75] or as an S pouch. The outlet is constructed from the distal 3–5 cm of this segment, the nipple valve is created from the next 18 cm of bowel, and the remaining 30 cm is used for the pouch (Fig. 49.7a). Peritonectomy is performed overlying the mesentery supplying the nipple valve on both sides (Fig. 49.7b). This is performed to increase adhesion formation during intussusception of the nipple valve and prevent slippage. The pouch is oriented in the form of an S, and a posterior row of sutures is placed between each limb and an enterotomy made along the S-shape (Fig. 49.7b). A second posterior row of sutures is created to re-approximate the cut edges (Fig. 49.7c). The nipple valve is then created with three firings of the GIA stapler without the knife (Fig. 49.7d). A two-layer closure of the anterior portion of the pouch is then performed (Fig. 49.7e). A circumferential row of interrupted sutures are placed between the outlet and the pouch to help maintain the position of the nipple valve. The end of the ileum is then brought through the abdominal wall at the preoperatively identified site just above the escutcheon. The stoma is sutured flush with the skin and the pouch firmly anchored to the posterior rectus sheath (Fig. 49.7f). A wide plastic tube with large openings is placed into the pouch to allow gravity drainage of the pouch in the early postoperative period. This tube is occluded for progressively longer periods beginning 10 days after surgery until it can be removed for 8 hours without distress. At this point, the pouch is significantly expanded, the tube is removed, and drainage is achieved by intubating the pouch three times a day.

Postoperative Complications

Postoperative complications that occur with sufficient frequency are nipple valve slippage, pouchitis, intestinal obstruction, and fistula. Nipple valve slippage [76, 77] occurs because of the tendency of the intussuscepted segment to slide and extrude on its mesenteric aspect. Difficult pouch catheterization, chronic outflow tract obstruction, and incontinence ensue. Because of the frequency of this problem, many techniques other than simple surgical stapling have been described to stabilize the valve. Wrapping the valve with prosthetic materials does prevent valve slippage but also is accompanied by a potentially unacceptably high incidence of parastomal abscess and fistula formation [78]. Despite these technical modifications, nipple valve slippage remains the most common complication after continent ileostomy, occurring in almost 30% of patients [76–78]. Although nonoperative approaches have been attempted to correct this problem, surgical correction is virtually inevitable. The repair of the existing malfunctioning valve or creation of a new valve from the afferent ileal limb is performed.

Pouchitis is recognized in 25% of patients, making this the second most common postoperative complication after continent ileostomy [76–78]. Pouchitis refers to nonspecific inflammation that develops in the reservoir and is thought to result from stasis and overgrowth of anaerobic bacteria. Patients present with a combination of increased ileostomy output, fever, weight loss, and stomal bleeding. The diagnosis is made by history and confirmed by pouch endoscopy.

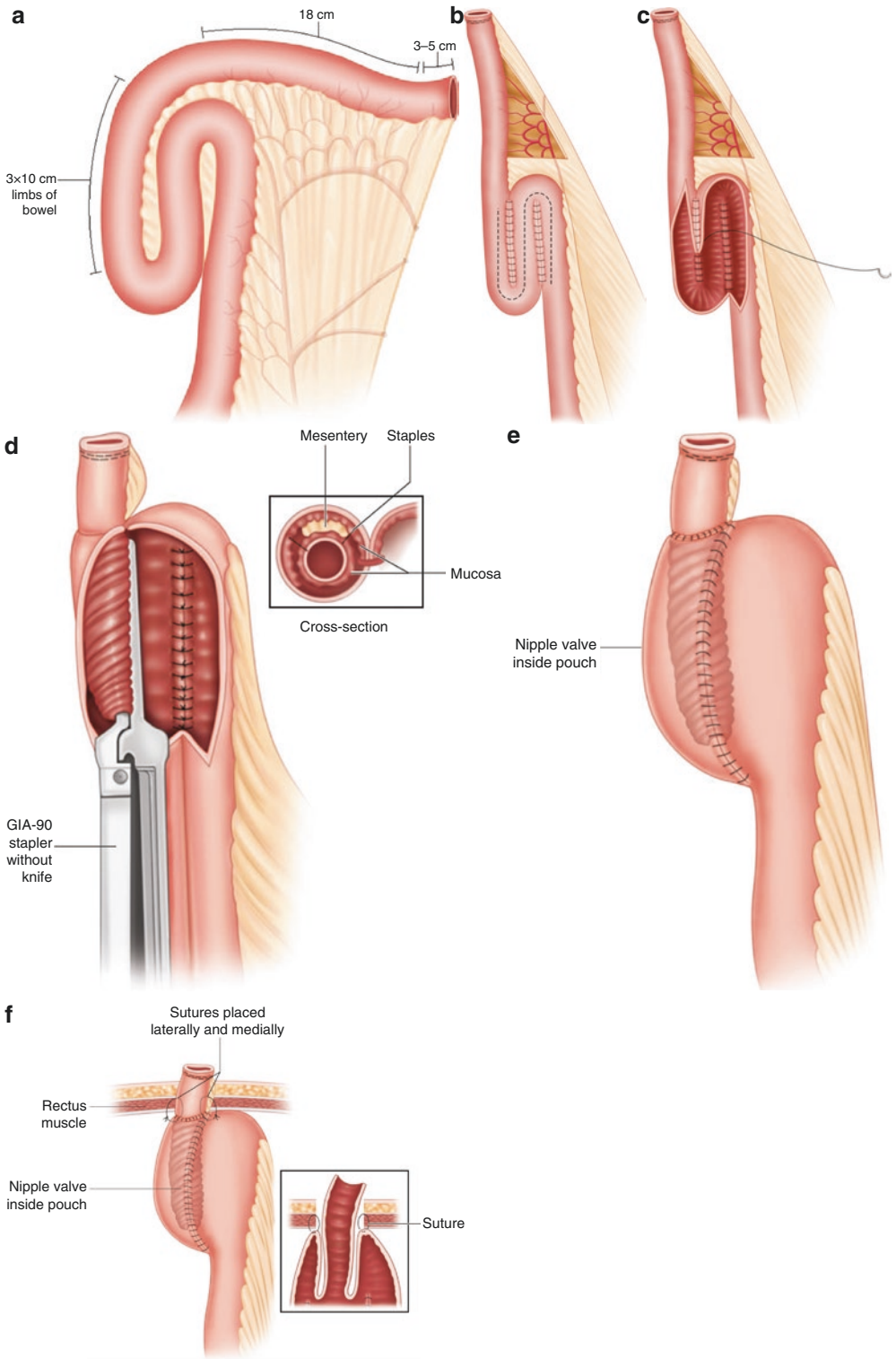

Fig. 49.7 Construction of a Kock Pouch. (**a**) About 45–50 cm of small bowel is used to create the Kock pouch. The distal 3–5 cm is used for the outlet, the middle 18 cm is used to construct the nipple valve, and the proximal 30 cm is utilized in creation of the pouch (**b**) The peritoneum overlying the mesentery to the nipple valve is excised. The S-shaped pouch is constructed by folding the proximal 30 cm of bowel into three 10 cm limbs with sutures placed between the limbs. An enterotomy is made (dotted line) starting at the distal aspect. (**c**) The posterior layer is created, (**d**) the nipple valve is created with three firings of a stapler without the knife, and (**e**) the anterior aspect of the valve is then completed with an inner and outer layer of sutures. To help maintain the nipple valve position, a row of interrupted sutures is placed between the pouch and the outlet. (**f**) After the stoma is delivered through the skin, sutures are placed between the pouch outlet and the posterior sheath of the abdominal wall on the lateral and medial aspects

Pouchitis usually responds to a course of antibiotics and continuous pouch drainage. Other complications include an incidence of intestinal obstruction after continent ileostomy of about 5%. Surgical intervention is mandatory when nonoperative therapy has been unsuccessful. The incidence of fistulas after creation of a continent ileostomy is approximately 10%. Fistulas most commonly originate in the pouch itself or at the base of the nipple valve. Pouch fistulas results from dehiscence of suture lines or rarely ileostomy tube erosion. These tracts may close with bowel rest, parenteral nutrition, and continuous pouch drainage. Fistulas from the base of the valve lead to incontinence, since ileal contents bypass the high-pressure zone of the nipple valve. These fistulas commonly arise with tearing of the sutures anchoring the pouch to the anterior abdominal wall. Valve fistulas rarely heal without operation. At laparotomy, the valve is excised, the pouch rotated, and a new continent valve constructed from the afferent tract.

Patient satisfaction with a continent ileostomy has been reported by some authors as being very high [79, 80]. Most patients note a marked improvement in their lifestyle, and almost all patients work and participate in social and recreational activities without restriction [76, 80]. These observations are understandable in that 90% of patients eventually have total continence after one or more procedures. On the other hand, their enthusiasm is surprising considering that complications are quite frequent and often require major surgical intervention [79, 80]. The often-advertised Barnett modification of the Kock pouch uses the afferent limb of small bowel to construct the nipple valve and wraps a portion of the residual efferent limb around the nipple valve [81]. Although designed to reduce the incidence of valve slippage and fistula formation, there are no controlled data to suggest that this modification is any better than the standard procedure most centers are using.

References

1. Grone J, Lorenz EM, Seifarth C, Seeliger H, Kreis ME, Mueller MH. Timing of surgery in ulcerative colitis in the biologic therapy era-the patient's perspective. Int J Color Dis. 2018;33(10):1429–35.
2. Eaden JA, Abrams KR, Mayberry JF. The risk of colorectal cancer in ulcerative colitis: a meta-analysis. Gut. 2001;48(4):526–35.
3. Yashiro M. Ulcerative colitis-associated colorectal cancer. World J Gastroenterol. 2014;20(44):16389–97.
4. Van Assche G, Dignass A, Bokemeyer B, et al. Second European evidence-based consensus on the diagnosis and management of ulcerative colitis part 3: special situations. J Crohns Colitis. 2013;7(1):1–33.
5. Laine L, Kaltenbach T, Barkun A, McQuaid KR, Subramanian V, Soetikno R. SCENIC international consensus statement on surveillance and management of dysplasia in inflammatory bowel disease. Gastrointest Endosc. 2015;81(3):489–501.e426.
6. Thomas T, Abrams KA, Robinson RJ, Mayberry JF. Meta-analysis: cancer risk of low-grade dysplasia in chronic ulcerative colitis. Aliment Pharmacol Ther. 2007;25(6):657–68.
7. Bernstein CN, Shanahan F, Weinstein WM. Are we telling patients the truth about surveillance colonoscopy in ulcerative colitis? Lancet. 1994;343(8889):71–4.
8. Kiesslich R, Goetz M, Lammersdorf K, et al. Chromoscopy-guided endomicroscopy increases the diagnostic yield of intraepithelial neoplasia in ulcerative colitis. Gastroenterology. 2007;132(3):874–82.
9. Dinesen LC, Walsh AJ, Protic MN, et al. The pattern and outcome of acute severe colitis. J Crohns Colitis. 2010;4(4):431–7.
10. Dignass A, Eliakim R, Magro F, et al. Second European evidence-based consensus on the diagnosis and management of ulcerative colitis part 1: definitions and diagnosis. J Crohns Colitis. 2012;6(10):965–90.
11. Jarnerot G, Rolny P, Sandberg-Gertzen H. Intensive intravenous treatment of ulcerative colitis. Gastroenterology. 1985;89(5):1005–13.
12. Williams JG, Alam MF, Alrubaiy L, et al. Infliximab versus ciclosporin for steroid-resistant acute severe ulcerative colitis (CONSTRUCT): a mixed methods, open-label, pragmatic randomised trial. Lancet Gastroenterol Hepatol. 2016;1(1):15–24.
13. Bernardo S, Fernandes SR, Goncalves AR, et al. Predicting the course of disease in hospitalized patients with acute severe ulcerative colitis. Inflamm Bowel Dis. 2019;25(3):541–6.
14. Chang KH, Burke JP, Coffey JC. Infliximab versus cyclosporine as rescue therapy in acute severe steroid-refractory ulcerative colitis: a systematic review and meta-analysis. Int J Color Dis. 2013;28(3):287–93.
15. Le Baut G, Kirchgesner J, Amiot A, et al. A scoring system to determine patients' risk of colectomy within 1 y after hospital admission for acute severe ulcerative colitis. Clin Gastroenterol Hepatol. 2020;10:S1542-3565(20)30029-X. https://doi.org/10.1016/j.cgh.2019.12.036. Epub ahead of print. PMID: 31927106.
16. Teeuwen PH, Stommel MW, Bremers AJ, van der Wilt GJ, de Jong DJ, Bleichrodt RP. Colectomy in patients with acute colitis: a systematic review. J Gastrointest Surg. 2009;13(4):676–86.
17. Carter FM, McLeod RS, Cohen Z. Subtotal colectomy for ulcerative colitis: complications related to the rectal remnant. Dis Colon Rectum. 1991;34(11):1005–9.
18. Gu J, Stocchi L, Remzi F, Kiran RP. Intraperitoneal or subcutaneous: does location of the (colo)rectal stump influence outcomes after laparoscopic total abdominal colectomy for ulcerative colitis? Dis Colon Rectum. 2013;56(5):615–21.
19. Bass EM, Del Pino A, Tan A, Pearl RK, Orsay CP, Abcarian H. Does preoperative stoma marking and education by the enterostomal therapist affect outcome? Dis Colon Rectum. 1997;40(4):440–2.
20. Zaghiyan K, Melmed GY, Berel D, Ovsepyan G, Murrell Z, Fleshner P. A prospective, randomized, noninferiority trial of steroid dosing after major colorectal surgery. Ann Surg. 2014;259(1):32–7.
21. Achilli P, Mazzola M, Bertoglio CL, et al. Preoperative immunonutrition in frail patients with colorectal cancer: an intervention to improve postoperative outcomes. Int J Color Dis. 2020;35(1):19–27.
22. Gillis C, Buhler K, Bresee L, et al. Effects of nutritional prehabilitation, with and without exercise, on outcomes of patients who undergo colorectal surgery: a systematic review and meta-analysis. Gastroenterology. 2018;155(2):391–410.e394.
23. Carmichael JC, Keller DS, Baldini G, 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.
24. Parks AG, Nicholls RJ. Proctocolectomy without ileostomy for ulcerative colitis. Br Med J. 1978;2(6130):85–8.
25. McKenna NP, Potter DD, Bews KA, Glasgow AE, Mathis KL, Habermann EB. Ileal-pouch anal anastomosis in pediatric NSQIP: does a laparoscopic approach reduce complications and length of stay? J Pediatr Surg. 2019;54(1):112–7.

26. Gorgun E, Cengiz TB, Aytac E, et al. Does laparoscopic ileal pouch-anal anastomosis reduce infertility compared with open approach? Surgery. 2019;166(4):670–7.
27. Yao L, Fleshner P, Zaghiyan K. Modified technique for laparoscopic total abdominal colectomy with stoma site specimen extraction - stage one of a three-stage ileal pouch anal anastomosis. Presented at Society of American Gastrointestinal and Endoscopic Surgeons Annual Meeting 1–4 April 2020, Cleveland: V201.2020.
28. de Zeeuw S, Ahmed Ali U, van der Kolk MB, van Laarhoven KC. Ileal pouch anal anastomosis with close rectal dissection using automated vessel sealers for ulcerative colitis: a promising alternative. Dig Surg. 2011;28(5–6):345–51.
29. Kaminski JP, Zaghiyan K, Fleshner P. Transanal mucosectomy revisited. Dis Colon Rectum. 2016;59(10):998–9.
30. Salum M, Wexner SD, Nogueras JJ, et al. Does sodium hyaluronate- and carboxymethylcellulose-based bioresorbable membrane (Seprafilm) decrease operative time for loop ileostomy closure? Tech Coloproctol. 2006;10(3):187–90; discussion 190-181.
31. Chough I, Zaghiyan K, Ovsepyan G, Fleshner P. Practice changes in postoperative feeding after elective colorectal surgery: from prospective randomized study to everyday practice. Am Surg. 2018;84(10):1675–8.
32. Lau C, Phillips E, Bresee C, Fleshner P. Early use of low residue diet is superior to clear liquid diet after elective colorectal surgery: a randomized controlled trial. Ann Surg. 2014;260(4):641–7; discussion 647–649.
33. Daskivich TJ, Houman J, Lopez M, et al. Association of wearable activity monitors with assessment of daily ambulation and length of stay among patients undergoing major surgery. JAMA Netw Open. 2019;2(2):e187673.
34. Patel DN, Felder SI, Luu M, Daskivich TJ, Zaghiyan KN, Fleshner P. Early urinary catheter removal following pelvic colorectal surgery: a prospective, randomized, noninferiority trial. Dis Colon Rectum. 2018;61(10):1180–6.
35. Karjalainen EK, Renkonen-Sinisalo L, Mustonen HK, Farkkila M, Lepisto AH. Restorative proctocolectomy in ulcerative colitis: effect of preoperative immunomodulatory therapy on postoperative complications and pouch failure. Scand J Surg. 2021;110(1):51–58.
36. Hainsworth PJ, Bartolo DC. Selective omission of loop ileostomy in restorative proctocolectomy. Int J Color Dis. 1998;13(3):119–23.
37. Widmar M, Munger JA, Mui A, et al. Diverted versus undiverted restorative proctocolectomy for chronic ulcerative colitis: an analysis of long-term outcomes after pouch leak short title: outcomes after pouch leak. Int J Color Dis. 2019;34(4):691–7.
38. Lavryk OA, Hull TL, Duraes LC, et al. Outcomes of ileal pouch-anal anastomosis without primary diverting loop ileostomy if postoperative sepsis develops. Tech Coloproctol. 2018;22(1):37–44.
39. Markel TA, Lou DC, Pfefferkorn M, et al. Steroids and poor nutrition are associated with infectious wound complications in children undergoing first stage procedures for ulcerative colitis. Surgery. 2008;144(4):540–5; discussion 545–547.
40. Okita Y, Araki T, Okugawa Y, et al. The prognostic nutritional index for postoperative infectious complication in patients with ulcerative colitis undergoing proctectomy with ileal pouch-anal anastomosis following subtotal colectomy. J Anus Rectum Colon. 2019;3(2):91–7.
41. Selvaggi F, Pellino G, Canonico S, Sciaudone G. Effect of preoperative biologic drugs on complications and function after restorative proctocolectomy with primary ileal pouch formation: systematic review and meta-analysis. Inflamm Bowel Dis. 2015;21(1):79–92.
42. Ferrante M, D'Hoore A, Vermeire S, et al. Corticosteroids but not infliximab increase short-term postoperative infectious complications in patients with ulcerative colitis. Inflamm Bowel Dis. 2009;15(7):1062–70.
43. Ferrante M, de Buck van Overstraeten A, Schils N, et al. Perioperative use of vedolizumab is not associated with postoperative infectious complications in patients with ulcerative colitis undergoing colectomy. J Crohns Colitis. 2017;11(11):1353–61.
44. Zittan E, Milgrom R, Ma GW, et al. Preoperative anti-tumor necrosis factor therapy in patients with ulcerative colitis is not associated with an increased risk of infectious and noninfectious complications after ileal pouch-anal anastomosis. Inflamm Bowel Dis. 2016;22(10):2442–7.
45. Cohen BL, Fleshner P, Kane SV, Herfarth HH, Palekar N, Farraye FA, JAL, Katz J, Cohen RD, Gerich ME, Cross RK, PDH, Tinsley A, Glover SC, Siegel CA, Bohl JL, HI, Raymond S, Huang R, Suarez-Farinas M, Sands BE. 415a – Anti-tumor necrosis factor therapy is not associated with post-operative infection: results from prospective Cohort of ulcerative colitis and Crohn's disease patients undergoing surgery to identify risk factors for postoperative infection I (Puccini). Gastroenterology. 2019;156:S-80.
46. Novello M, Stocchi L, Holubar S, et al. Surgical outcomes of patients treated with ustekinumab vs. vedolizumab in inflammatory bowel disease: a matched case analysis. Int J Color Dis. 2019;34(3):451–7.
47. Lightner AL, McKenna NP, Alsughayer A, et al. Biologics and 30-day postoperative complications after abdominal operations for Crohn's disease: are there differences in the safety profiles? Dis Colon Rectum. 2019;62(11):1352–62.
48. Poh KS, Qureshi S, Hong YK, et al. Multivariate prediction of intraoperative abandonment of ileal pouch anal anastomosis. Dis Colon Rectum. 2020;63(5):639–45.
49. McKenna NP, Mathis KL, Khasawneh MA, et al. Obese patients undergoing ileal pouch-anal anastomosis: short-and long-term surgical outcomes. Inflamm Bowel Dis. 2017;23(12):2142–6.
50. Sahami S, Bartels SA, D'Hoore A, et al. A multicentre evaluation of risk factors for anastomotic leakage after restorative proctocolectomy with ileal pouch-anal anastomosis for inflammatory bowel disease. J Crohns Colitis. 2016;10(7):773–8.
51. Swenson BR, Hollenbeak CS, Poritz LS, Koltun WA. Modified two-stage ileal pouch-anal anastomosis: equivalent outcomes with less resource utilization. Dis Colon Rectum. 2005;48(2):256–61.
52. Zittan E, Wong-Chong N, Ma GW, McLeod RS, Silverberg MS, Cohen Z. Modified two-stage ileal pouch-anal anastomosis results in lower rate of anastomotic leak compared with traditional two-stage surgery for ulcerative colitis. J Crohns Colitis. 2016;10(7):766–72.
53. Utsunomiya J, Iwama T, Imajo M, et al. Total colectomy, mucosal proctectomy, and ileoanal anastomosis. Dis Colon Rectum. 1980;23(7):459–66.
54. Lovegrove RE, Heriot AG, Constantinides V, et al. Meta-analysis of short-term and long-term outcomes of J, W and S ileal reservoirs for restorative proctocolectomy. Color Dis. 2007;9(4):310–20.
55. Simillis C, Afxentiou T, Pellino G, et al. A systematic review and meta-analysis comparing adverse events and functional outcomes of different pouch designs after restorative proctocolectomy. Color Dis. 2018;20(8):664–75.
56. Larson DW, Cima RR, Dozois EJ, et al. Safety, feasibility, and short-term outcomes of laparoscopic ileal-pouch-anal anastomosis: a single institutional case-matched experience. Ann Surg. 2006;243(5):667–70; discussion 670-662.
57. Reilly WT, Pemberton JH, Wolff BG, et al. Randomized prospective trial comparing ileal pouch-anal anastomosis performed by excising the anal mucosa to ileal pouch-anal anastomosis performed by preserving the anal mucosa. Ann Surg. 1997;225(6):666–76; discussion 676-667.
58. Hallgren TA, Fasth SB, Oresland TO, Hulten LA. Ileal pouch anal function after endoanal mucosectomy and handsewn ileoanal anastomosis compared with stapled anastomosis without mucosectomy. Eur J Surg. 1995;161(12):915–21.

59. Schluender SJ, Mei L, Yang H, Fleshner PR. Can a meta-analysis answer the question: is mucosectomy and handsewn or double-stapled anastomosis better in ileal pouch-anal anastomosis? Am Surg. 2006;72(10):912–6.
60. Kirat HT, Remzi FH, Kiran RP, Fazio VW. Comparison of outcomes after hand-sewn versus stapled ileal pouch-anal anastomosis in 3,109 patients. Surgery. 2009;146(4):723–9; discussion 729–730.
61. Kariv R, Remzi FH, Lian L, et al. Preoperative colorectal neoplasia increases risk for pouch neoplasia in patients with restorative proctocolectomy. Gastroenterology. 2010;139(3):806–12, 812. e801–802.
62. Lightner AL, Pemberton JH, Dozois EJ, et al. The surgical management of inflammatory bowel disease. Curr Probl Surg. 2017;54(4):172–250.
63. Lee S, Ahn B. The relationship between the number of intersections of staple lines and anastomotic leakage after the use of a double stapling technique in laparoscopic colorectal surgery. Surg Laparosc Endosc Percutan Tech. 2017;27(4):273–81.
64. de Buck van Overstraeten A, Mark-Christensen A, Wasmann KA, et al. Transanal versus transabdominal minimally invasive (completion) proctectomy with ileal pouch-anal anastomosis in ulcerative colitis: a comparative study. Ann Surg. 2017;266(5):878–83.
65. Zaghiyan K, Warusavitarne J, Spinelli A, Chandrasinghe P, Di Candido F, Fleshner P. Technical variations and feasibility of transanal ileal pouch-anal anastomosis for ulcerative colitis and inflammatory bowel disease unclassified across continents. Tech Coloproctol. 2018;22(11):867–73.
66. Chandrasinghe P, Carvello M, Wasmann K, et al. Transanal ileal pouch-anal anastomosis for ulcerative colitis has comparable long-term functional outcomes to transabdominal approach: a multicentre comparative study. J Crohns Colitis. 2020;14(6):726–33.
67. Andersson P, Norblad R, Soderholm JD, Myrelid P. Ileorectal anastomosis in comparison with ileal pouch anal anastomosis in reconstructive surgery for ulcerative colitis – a single institution experience. J Crohns Colitis. 2014;8(7):582–9.
68. Borjesson L, Lundstam U, Oresland T, Brevinge H, Hulten L. The place for colectomy and ileorectal anastomosis: a valid surgical option for ulcerative colitis? Tech Coloproctol. 2006;10(3):237–41; discussion 241.
69. Pastore RL, Wolff BG, Hodge D. Total abdominal colectomy and ileorectal anastomosis for inflammatory bowel disease. Dis Colon Rectum. 1997;40(12):1455–64.
70. Leijonmarck CE, Lofberg R, Ost A, Hellers G. Long-term results of ileorectal anastomosis in ulcerative colitis in Stockholm County. Dis Colon Rectum. 1990;33(3):195–200.
71. Uzzan M, Kirchgesner J, Oubaya N, et al. Risk of rectal neoplasia after colectomy and ileorectal anastomosis for ulcerative colitis. J Crohns Colitis. 2017;11(8):930–5.
72. Uzzan M, Cosnes J, Amiot A, et al. Long-term follow-up after Ileorectal anastomosis for ulcerative colitis: a GETAID/GETAID Chirurgie multicenter retrospective cohort of 343 patients. Ann Surg. 2017;266(6):1029–34.
73. Grundfest SF, Fazio V, Weiss RA, et al. The risk of cancer following colectomy and ileorectal anastomosis for extensive mucosal ulcerative colitis. Ann Surg. 1981;193(1):9–14.
74. Derikx L, Nissen LHC, Smits LJT, Shen B, Hoentjen F. Risk of neoplasia after colectomy in patients with inflammatory bowel disease: a systematic review and meta-analysis. Clin Gastroenterol Hepatol. 2016;14(6):798–806.e720.
75. Kock NG, Darle N, Hultén L, Kewenter J, Myrvold H, Philipson B. Ileostomy. Curr Probl Surg. 1977;14(8):1–52.
76. Litle VR, Barbour S, Schrock TR, Welton ML. The continent ileostomy: long-term durability and patient satisfaction. J Gastrointest Surg. 1999;3(6):625–32.
77. Lepistö AH, Järvinen HJ. Durability of Kock continent ileostomy. Dis Colon Rectum. 2003;46(7):925–8.
78. Fazio VW, Church JM. Complications and function of the continent ileostomy at the Cleveland Clinic. World J Surg. 1988;12(2):148–54.
79. Beck DE. Clinical aspects of continent ileostomies. Clin Colon Rectal Surg. 2004;17:57–63.
80. Nessar G, Fazio VW, Tekkis P, et al. Long-term outcome and quality of life after continent ileostomy. Dis Colon Rectum. 2006;49(3):336–44.
81. Mullen P, Behrens D, Chalmers T, et al. Barnett continent intestinal reservoir. Multicenter experience with an alternative to the Brooke ileostomy. Dis Colon Rectum. 1995;38(6):573–82.