# Intestinal Ostomies

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## Introduction

Ostomy is derived from the Latin word "stoma" which means "mouth" [1]. Ostomy is an anastomosis between a part of the gastrointestinal system and anterior abdominal wall. The first ileostomy operation was done in 1879 by Baum to treat a patient with obstructive pathology in the right colon. Stomy is a worldwide medical and social problem. In the USA, 100000 new stomies are being constructed annually. Stomas are often constructed as ileostomy or colostomy [2].

## Stoma Planning and Placement

Patient and family should be educated before elective ostomy operation. American Society of Colon and Rectal Surgeons (ASCRS) guidelines recommend that preoperative and postoperative training be performed by professional figures such as stoma nurses [3]. Patients with stoma are concerned about social acceptance, sexuality, and economic burden. To eliminate these concerns, preoperative training, counseling, and ostomy site selection should be performed with a stomatherapy nurse, if possible. Proper stoma site selection, emotional support, and patient education increase postoperative quality of life and reduce length of stay in hospital. Since the preoperative period for patient education is limited, it should be an effective education that is handled with a multidisciplinary approach, planned by expert

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educators, repeated and reinforced with written brochures, CDs, or other multimedia tools [4].

Preoperative planning of the stoma site promotes self-care in both elective and emergency surgeries, reduces stoma-related complications, and improves postoperative quality of life. ASCRS, AUA (American Association of Urology), and WOCN (Association of Wound, Ostomy and Continence Nurses) strongly recommend preoperative marking of the stoma site in both enteral and urologic stoma patients. In emergency cases, especially during out of working hours, where an enterostomal therapy nurse cannot be reached, stoma site can be selected, and patient counseling can be given by an experienced surgeon. When selecting the stoma site, factors such as abdominal wall contours, belt zone, and bone protrusions in both sitting and standing position should be considered. The patient should be able to see the stoma easily [5].

## Ileostomy

### Ileostomy Indications

In general, temporary or permanent ileostomy is required to protect a distal anastomosis, to bypass a distal obstruction, or to divert the feces in patients with perianal, perineal, or pelvic sepsis (Table 19.1).

## Physiology of Ileostomy

The amount of outflow in an ileostomy depends on its distance from the ileum. The more proximal the ostomy is, the lesser the intestinal surface available for water and electrolytes absorption. The output on the first day of ileostomy is usually watery and bile-colored. The output thickens after oral intake has been started. The output is usually soft in consistency. Conditions such as type of food and fluid intake,

**Table 19.1** Ileostomy indications

| Diverting loop ileostomy | End ileostomy |
|---|---|
| Protection of low rectal/anorectal anastomosis | Total abdominal colectomy in patients with ulcerative colitis that is resistant to medical treatment |
| Resolve distal obstruction (malignity, diverticulitis, radiation stricture) | Familial adenomatous poliposis coli with distal rectal cancer/hereditary nonpoliposis coli |
| Fournier gangrene/perianal necrotizing fasciitis | Total proctocolectomy for Crohn's proctocolitis |
| Perianal Crohn's sepsis | |
| Rectal trauma/sphincter injury | |
| Rectovaginal/rectourethral/rectovesical fistula | |
| Fulminant toxic colitis | |
| Fecal incontinens | |

medications, and active Crohn's disease may affect the consistency and amount of the output. If significant bowel resection has been performed, the output is watery and patients are prone to dehydration. In cases of short bowel syndrome, support may be requested from the intestinal rehabilitation team, and the patients may need total parenteral nutrition. Undigested foods and medicines can be encountered in the ileostomy output [6].The distally ileostomy output ranges from 500 ml to 700 ml/day. If oral intake is discontinued, the amount will be reduced. In a healthy ileostomy with normal function, a healthy, functioning ileostomy can produce up to 1000–1500 ml/day. If the output is over 1500 ml, it is considered excessive and can lead to dehydration. Reduction of oral fluid intake may help reduce ileostomy output and make it more consistent. Intake of liquid and fatty food increases the fluidity and amount of the output. Patients with ileostomy are recommended to consume a low-fiber diet because fiber absorption is reduced due to bowel edema in the first few months. Usually the ileostomy bag should be emptied daily. After proctocolectomy, small bowel passage is slowed down, possibly due to mucosal hypertrophy that develops to compensate for reduced absorption capacity. Transition time can be further delayed by drugs such as diphenoxylate-atropine (Lomotil), loperamide (Lopermid), codeine, or opium tincture, which act through intestinal mucosal opioid receptors to relax smooth muscles in the intestinal wall. This increases the intestinal retention time of nutrients, allowing more water to be absorbed. Nutritional status is largely unaffected if the distal ileum is intact [7]. If the terminal ileum is resected more than 1–2 meters, fat, fat-soluble vitamins and bile acids cannot be absorbed. As a result, macrocytic pernicious anemia due to vitamin B12 deficiency may develop. These patients should be given intramuscular vitamin B12 supplementation. Inability to absorb bile salts can also cause susceptibility to gallstones. Cholestyramine may be useful in such cases. Urinary stones may also occur due to chronic dehydration and acidic urine. This can be solved by sufficient fluid intake and adding 4 g of sodium bicarbonate to the diet to make the urine alkaline [8].

## End Ileostomy

When creating an end ileostomy, the vascularity of the ileum should be good and can be brought out of the abdominal wall without tension. The Brooke technique still remains the procedure of choice for many patients. The opening in the peritoneum and fascia should be wide enough to allow the intestine to pass freely; otherwise it may lead to necrosis by reducing blood flow to the intestine and obstructing the intestinal lumen [9]. The stoma opening should be created in the previously marked skin area before the abdominal incision is closed. The abdominal wall fascia and skin are held with a clamp at the same level to prevent the bowel from bending when passing through the abdominal wall. The surgeon gently pulls the clamps medially. A compress is placed in the abdomen under the area where the ileostomy will be opened and the abdominal wall is tented. A piece of skin is excised from the marked ileostomy area. Subcutaneous adipose tissue should not be removed too much because it provides support for ileostomy. The first assistant retracts the skin

and subcutaneous fat tissue with right-angle retractors, while the surgeon reaches the fascia with the help of electrocautery. He then makes a longitudinal incision in the fascia. When he reaches to the lower rectus muscle, the muscle fibers are separated by the help of scissors or Kelly clamp, paying attention to the inferior epigastric vessels. The first assistant places the right-angle retractors between the muscle fibers, and the peritoneum is exposed. Peritoneum is opened with the help of electrocautery. A Kelly or Babcock clamp is passed through the opening in the skin into the abdomen. If the opening is considered to be small, it can be cut further through the abdomen with the help of electrocautery. The intestinal mesentery should be rechecked to ensure adequate blood supply. A Babcock clamp is then passed through the skin opening; the ileum is grasped and pulled toward the skin surface. Gently pushing the ileum from inside the abdomen facilitates the procedure. At this stage it is important to control the direction of the ileum mesentery. The ileum mesentery adjacent to the abdominal wall is then sutured to the parietal peritoneum to prevent volvulus around the ileostomy. In order to create an appropriate ileostomy, the ileum should protrude 4–5 cm above the skin level on the abdominal wall. The orientation of ileostomy and blood supply should be checked again before the abdomen is closed. The compress placed in the abdomen is removed. During maturation of ileostomy, a full-thickness suture is passed through the end of the intestine at 3, 6, 9, and 12 o'clock position, followed by a seromuscular suture through the 3 cm proximal and finally through the subcuticular layer. The sutures are gently pulled and the intestine is everted and the sutures are ligated. Additional sutures can be placed between the initially placed ones through the full-thickness intestine and subcuticular region. It is important that the sutures do not pass through the skin. This can lead to the formation of mucosal islands adjacent to ostomy, which leads to wetness and peristomal skin irritation [10]. Seromuscular sutures, which pass close to the skin level to facilitate ostomy eversion, may not be performed because of the concern that patients with Crohn's disease may be susceptible for fistula formation between ileostomy and skin. Sometimes it may be difficult to perform end ileostomy in obese patients due to abdominal wall thickness. In such cases, it may be convenient to create a loop end ileostomy. This technique, which was first described by Unti et al., allows an ostomy to be performed by reducing overstretch and preventing incision of the small intestinal mesentery [11].

## Loop Ileostomy

Loop ileostomy is most commonly performed to maintain a distal anastomosis. Loop colostomy was used to protect left-sided anastomoses for a long time. Data obtained over time revealed the superiority of loop ileostomy in terms of parastomal hernia, device problems, skin problems, and complications during ostomy reversal. Loop ileostomy is performed 12–15 cm proximal to ileocecal valve. When ileostomy is performed for the defunctioning of an ileal pouch anal anastomosis, it is often performed more proximally to avoid tension in the anastomosis [9]. After selecting the appropriate loop of small intestine, a small window is formed on the

mesenteric edge through which the penrose drain passes. The proximal and distal ends of the loop are marked. It is taken out through the ostomy area opened on the abdominal wall. After closure of the abdominal incision, ileostomy is created and matured [10]. Between the afferent and efferent loops, 80% of the efferent bowel loop is opened slightly above the skin level by electrocautery, leaving an intact area in the posterior wall. The distal part of the ostomy is fixed to the subcuticular region of the skin, usually with three absorbable sutures. Three full-thickness absorbable sutures are passed through the end of the proximal leg, followed by seromuscular suture through the 3 cm proximal and finally through the subcuticular layer of the skin. The proximal leg is everted and the sutures are tied. In the areas between these sutures, a few more sutures can be inserted through the full-thickness intestine and through the subcuticular area of the skin. Transparent bags are useful to monitor ostomy in the early postoperative period. If the support rod is used, it can be removed 3–5 days later [11, 12].

## Minimally Invasive Ileostomy

A minimally invasive method can be used to create a diverting stoma. It might be more convenient in some patients. Access to the peritoneal cavity can be gained with a Veress needle or using the Hasson technique. After producing pneumoperitoneum, the right lower quadrant is located. The ileum is usually mobile. However, in case of adhesion, it can be released by sharp dissection from the right lower abdomen and pelvic side walls. The determined small bowel loop is held with the help of Babcock grasper. In the area designated for ileostomy, the abdominal wall skin, fascia, and peritoneum are cut open as described previously. The small intestine is taken out. The pneumoperitoneum is then restored to confirm the orientation of the small intestine. Then, pneumoperitoneum is terminated and ostomy is matured [13]. Laparoscopic stoma creation seems to be a viable and safe procedure. The rate of conversion from laparoscopy to open technique ranges from 0% to 15.8%, and adhesions are the most common cause. The rate of intraoperative complications (excluding adhesions) during laparoscopic approach ranges from 0% to 3.1%. The rate of postoperative complications within 30 days after laparoscopic stoma formation ranges from 4.2% to 17.5%. However, all of the comparative series discussed in this study report a significantly lower postoperative morbidity rate in the laparoscopic group than in the open-surgery group. The 30-day mortality rate in the laparoscopic group ranged from 0% to 4.8%. For this result, the laparoscopic group was at a lower risk than the open-surgery group. Another advantage of the laparoscopic approach is that there is a significantly shorter postoperative hospital stay compared to the open approach [14]. Laparoscopic diverting ileostomy can result in various problems, such as the correct orientation of the intestines. Measures can be taken to minimize these technical errors. When creating a laparoscopic stoma, attention must be paid to the bowel (for loop ileostomy) or entanglement of the mesentery (for end ostomy). Some procedures, such as marking the proximal or distal ends and laparoscopic visualization of the intestinal cycle after passing through the fascia,

help the surgeon to verify the correct orientation of the intestines and should always be done. However, obstructive complications occur in approximately 5% of laparoscopically created stomas. It is important to recognize this ileostomy complication early because emergency surgery can reduce postoperative morbidity [14, 15].

Single incision laparoscopic surgery (SILS) has many applications in colorectal surgery. It can also be used to create loop ileostomy. After the skin is elliptically removed in the previously marked ileostomy area, the fascia is cut lengthwise, the fibers of the rectus muscle are separated, and the peritoneum is cut lengthwise to insert the SILS port. After pneumoperitoneum is gained, abdominal cavity is penetrated. Additional trocars are placed and the bowel segment that is suitable for ostomy is determined. After orientation of the bowel is done, Babcock grasper catches the bowel loop and is taken out with the SILS port. Then ileostomy is matured [16].

## Ghost Ileostomy

Ghost ileostomy is a pre-stage ileostomy that can be performed to prevent stoma formation in patients at risk of colorectal anastomosis leakage. In both open and laparoscopic surgeries, a window is created in the ileum mesentery with a vascular loop through it. The vascular loop passed through this opening is taken out through a small incision in the right flank. The strap is secured to the skin or gauze on the skin. If anastomotic leakage develops in the postoperative period, ghost ileostomy can easily be converted to loop ileostomy under local anesthesia at the bedside or in the operating theater. The need for relaparotomy or relaparoscopy under general anesthesia is avoided. If no complications occur, the bowel can be repositioned in the abdominal cavity. Ghost ileostomy seems to be a useful technique which does not increase surgical complication risks, and reduces potential risks associated with relaparotomy in patients with anastomosis leakage. However, only six reports have described ghost ileostomy technique and clinical practice in the literature [17]. There is no clear indication of clinical conditions in which ghost ileostomy should be converted to loop ileostomy. Furthermore, it is not clear whether the diagnosis of anastomotic leak should be clinical or radiological. There is no evidence about timing of conversion of ghost ileostomy in the event of an anastomosis leakage. Furthermore, there is no evidence that it is sufficient for surgical resolution. In conclusion, further research is needed to assess the clinical utility of ghost ileostomy. Therefore, ghost ileostomy should not be recommended as a routine technique to avoid loop ileostomy [18, 19].

## Continent Ileostomy

Continent ileostomy was described by Nils Kock in 1967. It is a low pressure ileal pouch constructed by using the terminal ileal loop for the storage of intestinal contents. An “Intussusception valve” is at the pouch outlet. Thus, involuntary leakage

from ileostomy is prevented. Patients intubate their pouch 3–4 times a day to empty it. A sponge is enough to cover the ostomy. There is no need for bags [20]. Indications for continent ileostomy are shown in Table 19.2.

Although the majority of patients with conventional ileostomy live unaffected, some do have problems such as hernia, fistula, prolapse, retraction, and leakage. In cases where stoma revision or re-construction fail and intestinal continuity is not possible, patients may be candidates for continent ileostomy. An ileal pouch anal anastomosis (IPAA) may not be possible if the small intestine is not long enough to reach the pelvic floor or if anal sphincter function is insufficient. Patients with rectal cancer and ulcerative colitis may need sphincter resection or pelvic radiation. In these cases, patients who want to avoid conventional ileostomy may be candidates for continent ileostomy. When a pelvic pouch surgery fails, there are three options: end ileostomy, redo-IPAA, and continent ileostomy. There are two attractive aspects to converting an IPAA into a continent ileostomy. The first is the "continuity," and the second is that the intestine used to make the original pelvic pouch can be saved in many cases [21].

Table 19.3 shows contraindications of continent ileostomy

Since the reservoir needs to be emptied by intubation, there should be no physical or mental disability in these patients. There is always the possibility of reoperation in patients with continent ileostomy. Therefore, in patients with familial polyposis and sporadic or family history of desmoid disease, continent ileostomy may not be an appropriate option, since surgery can stimulate desmoid growth. Obesity is a relative contraindication. Excessive fatty mesentery increases the risk of slipping of the valve. Approximately 50–70 cm of intestine is used to perform continent ileostomy. If the pelvic pouch fails, the reservoir must be removed. This leads to bowel loss. Continent ileostomy is not recommended in patients with limited small bowel length due to the risk of short bowel syndrome. Patients who are recommended continent ileostomy should be informed about all complications, including possible risk of reoperation due to pouch dysfunction. Whether this surgery can be recommended in patients with Crohn's disease is controversial. There are high complication rates in the results from large series. To date, there is insufficient evidence to recommend a continent reservoir ileostomy in Crohn's patients. There are two components of continent ileostomy: a reservoir and an outlet

**Table 19.2** Indications for continent ileostomy

| |
|---|
| Dysfunction of conventional ileostomy |
| Failed pelvic pouch |
| Patients unsuitable for pelvic pouch |
| Patient preference |

**Table 19.3** Contraindications of continent ileostomy

| |
|---|
| Patients with mental or physical problems |
| Desmoid disease |
| Obesity |
| Limited length of small intestine |
| Patients who do not consent for the complications |
| Crohn's disease |

valve. With the variation of these components, three types of continent ileostomies can be performed: three-armed S-pouch, Barnett's continent ileal reservoir, and T-pouch [20].

Early complications of continent ileostomy include leakage from suture lines, necrosis in the intussuscepted valve, and bleeding from suture lines. Minor bleeding can be managed by irrigation with saline or epinephrine in saline solution or endoscopic fulguration. Major bleeding, valve necrosis, or perforation require surgical repair. Late complications include valve slippage, prolapse, fistulas, volvulus, perforation, hernia, valve stenosis, or pouchitis [22].

Valve slippage usually occurs in the first 3 months postoperatively. It is rare after 12 months. Valve slippage symptoms are gas or stool incontinence or difficulty in intubation of the sac. Major valve slippage usually requires surgical repair. When a valve cannot be intubated, but the bag remains continent, the patient has a functional full bowel obstruction and needs urgent medical attention. With a pediatric rigid or flexible endoscope, the pouch can be entered under direct vision through the stoma. Functional obstruction can be temporarily relieved by aspirating gas and intestinal contents. Longer drainage can be achieved by placing a catheter over a guide wire inserted through the endoscope channel. The patient should be evaluated for further treatment after this temporary drainage. If this is patient's first dysfunction attack, after 7–14 days of drainage, the intestinal edema is expected to decrease, and the problem can be resolved. At the end of this period, intubation can be tried again. If intubation difficulties continue, the drainage tube should be reinstalled. It should remain in place until the valve is repaired surgically. Valve prolapse occurs when too large of a defect is created to reveal the efferent loop. This problem can be solved by narrowing the opening in fascia [23].

Fistulas can form at the bottom of the valve and allow fecal flow to bypass the valve, causing incontinence. In these cases, the patient notices incontinence but does not have difficulty in intubation, as in the case of valve slippage. Fistulas can occur at any time after surgery. Valve fistulas are caused by technical problems of the valve structure (such as suturing through the walls of the valve and very tight ligation, improper use of staples, excessive electrocautery causing scarring of the intestine, or erosion of prosthetic material) or Crohn's disease. Fistulas can also form between the pouch and the abdominal wall. They usually cause parastomal abscesses, then they drain and mature as an enterocutaneous fistula. Fistulas that develop from the bottom of the valve cause intestinal contents to bypass the valve and incontinence. Abscesses require drainage, and antibiotics can prove to be helpful. Fistulas may respond to drainage, medical treatment, fibrin glue, occlusion, or surgical correction [20].

Pouch dislocation and volvulus are caused by insufficient fixation of the reservoir to the abdominal wall. Volvulus can lead to necrosis of the entire pouch. Catheter perforation might occur, but it is a very rare complication that usually requires surgical repair. Stenosis at skin level may prevent the insertion of the tube. Performing the first construction with very small skin incision, intestinal ischemia, infection, wound healing abnormalities, stoma retraction, or repeated trauma can cause stenosis. It can be repaired by skin level revision or z-plasty repair [22].

The incidence of mucosal inflammation in the pouch (pouchitis) ranges from 10% to 30% in various studies. It becomes manifested by an increase in ileostomy output. The content might be watery, stinking, and sometimes bloody. Patients may also develop abdominal pain, distension, fever, and nausea. The complication is considered secondary to the overgrowth of bacteria and is usually successfully treated with antibiotics (metronidazole or ciprofloxacin) or probiotics and continuous catheter drainage to avoid stasis [24]. The summary of the complications is shown in Table 19.4.

Lepisto et al. reviewed 96 patients who underwent continent ileostomy between 1972 and 2000. They found the cumulative success rate as 71%. The most common cause of pouch excision was nipple valve dysfunction. The success rate of continent ileostomies was significantly lower than ileoanal pouch anastomoses [25].

## Colostomy

### Indications of Colostomy

Indications for colostomy are shown in Table 19.5. As with ileostomy, colostomy can be constructed as end, loop, and end-loop. End colostomy is typically performed in cases where a restorative procedure is not possible, as in patients with distal rectum tumors that require abdominoperineal resection. It is often preferred in elderly patients who are unable to tolerate coloanal anastomosis or potential complications. Sometimes, because of poor sphincter functions, coloanal anastomosis is not

**Table 19.4** Complications of continent ileostomy

| Komplikasyon | İnsidans (%) |
|---|---|
| Pouchitis | 10–30 |
| Nipple valve slippage | 3–25 |
| Fistula | 0–10 |
| Stomal stricture | 10 |
| Nipple prolapse | 4–6 |
| Stomal necrosis | 1–2 |
| Complications that require surgical correction | 15–25 |

**Table 19.5** Indications of colostomy

| Diverting loop colostomy | End or end-loop colostomy |
|---|---|
| Low rectal/coloanal anastomosis | Abdominoperineal resection |
| To relieve distal obstruction | Low anterior rectum resection in patients not suitable for coloanal anastomosis |
| Rectal trauma/sphincter injury | Hartmann procedure |
| Fecal incontinence | Fecal incontinence |
| Radiation proctocolitis | Radiation proctocolitis |
| Complex rectovaginal, rectourethral, rectovesical fistula | |
| Perineal necrotizing fasciitis | |
| Fournier gangrene | |

performed after lower anterior resection in very old female patients who have given many births and an end colostomy may be preferred. In emergency cases, end colostomy can be used. Patients with Hinchey 4 diverticulitis (fecal peritonitis) require the Hartmann procedure, which includes resection of the diseased segment of the sigmoid colon and left colon colostomy. In this case, primary colorectal anastomosis is considered unsafe due to fecal contamination. In patients with fecal incontinence, end colostomy may be considered if sphincter reconstruction or neosphincter/sacral nerve stimulation surgery has failed. In rare cases, patients with radiation proctitis, whose non-surgical management is unsuccessful, may require end colostomy [26].

Loop colostomy is used to protect the rectal anastomosis or to divert the fecal flow from distal obstruction, pelvic sepsis, or rectum/sphincter injury. Most of the surgeons prefer loop ileostomy to protect the lower rectal anastomosis because loop colostomy is associated with increased rates of stoma complications and incisional hernia compared to ileostomy. In addition, there is a risk of injury to the marginal arteries that provide the blood supply to the colonic conduit used for colorectal anastomosis during loop colostomy. When staged resection is preferred, loop colostomy can be used to bypass a distal obstructive tumor in patients with an intact ileocecal valve [27].

Rarely, in hemodynamically unstable patients under vasopressor support who have fecal peritonitis, proximal loop colostomy can be performed without resection of the diseased colon following peritoneal lavage. Such an option should always be kept in mind. In cases of pelvic or perineal sepsis, such as Fournier gangrene or perineal necrotizing fasciitis, loop colostomy can be used to divert the stool flow. In patients with complex rectal fistula (rectovaginal, rectovesical, rectourethral) requiring complex surgical repair, stool diversion may be necessary to provide optimal chance of recovery [28].

## Colostomy Physiology

Water from the small intestine is absorbed by the colon. Thus, in left-sided colostomies, the content is semi-solid, and once daily discharge is sufficient. The content is slightly more fluid in transverse loop colostomies. However, it is still of the right consistency, and it may be sufficient to empty it once a day. In more proximal colostomies, the amount of remaining colon to absorb water will decrease, so the content will be more fluid. Right-sided colostomies are rare. The biggest problem experienced by patients with right colostomy is that very foul-smelling content is present due to the effect of colonic bacteria [28].

## End Colostomy

End colostomies are usually performed in the left lower quadrant. Before the operation, the placement should be marked by the enterostomal therapy nurse. Colon loop to be ostomized should be sufficiently mobilized to prevent tension. Splenic

flexor may need to be removed. In addition, the colon loops that will be ostomized must have sufficient blood flow. Then the stoma region is prepared. Fascia and subcutaneous are pulled medially with clamps. To prevent injury to the intestines, a compress is placed in the abdomen under the area to be opened. The skin is excised in the previously marked area. The area is opened with retractors. Fascia is divided longitudinally by electrocautery. The rectus muscles are separated by scissors or the Kelly clamp, paying attention to the inferior epigastric vessels. The peritoneum is reached by retracting the muscle with retractors. Then the peritoneum is cut longitudinally. When you enter the abdomen, the previously placed compresses become visible. The stoma opening should be wide enough to allow 2 finger access. Sometimes a larger opening may be required in obese patients or in patients with proximally enlarged colon segment due to large bowel obstruction. Then, a Babcock clamp is inserted through the opening, and the cut end of the colon is grasped and taken out from the opening. Meanwhile, the colon can be pushed gently through the abdomen by hand. One must be very gentle at these stages; otherwise the colon may be damaged. Again, care should be taken against the possibility of that the colon might be twisted. For a functioning colostomy, there should be a well-perfused colon segment 2–3 cm above the skin level. The compress placed in the abdomen is removed. After the midline abdominal wound is closed, the stoma is matured with 3/0 absorbable sutures [29]. Although most colostomies are at the same level as the skin, 1–2 cm protrusion above the skin may have its advantages;

- It facilitates the placement of the ostomy device.
- Sometimes, a skin level colostomy may retract in patients who gain weight.

## Loop Colostomy

Loop colostomy is usually performed as sigmoid loop colostomy (in the left quadrant of the abdomen) or transverse loop colostomy (in the upper abdomen). Loop colostomies can be performed by open technique or laparoscopically. Sometimes, in weak patients, a trephine loop colostomy (opening an ostomy from the left fossa without laparotomy) can be performed [30]. When performing a trephine loop colostomy in the lower left quadrant, an elliptical skin portion is removed from the pre-determined stoma region. Access to the peritoneal cavity is performed as mentioned previously. Sigmoid colon is located and taken out. Support bar can be used. Then, an incision close to the skin level is made with the help of electrocautery on the distal side of the colon segment. The distal part is sutured with 3/0 absorbable sutures. The proximal part is matured by slightly everting the edges. If placed, the stick can be removed after 4–5 days. When planning a Trephine transverse loop colostomy, it will be useful to determine the position of the transverse colon before surgery. While the patient is lying on his back, a coin is placed on the anterior abdominal wall in the upper quadrant area of the abdomen and the surrounding area is marked. Then a direct graph can be taken. With this strategy, appropriate incision

site planning can be made. In weak patients, it is easier to pull the colon up. The omentum is carefully cut and relocated into the abdomen before the stoma is matured [30].

In open surgery, it is necessary to pay attention to the stoma direction and ensure that it is transmitted to the anterior abdominal wall without tension. For correct orientation, the proximal or distal end of the stoma can be marked with a suture. To create a tension-free stoma, the colon must be mobilized. Told fascia is cut and colon mesentery is released from retroperitoneum. It is necessary to recognize and protect the left ureter and gonadal vessels. For sigmoid loop colostomy, mobilization of splenic flexor is generally not required. However, it should be done when necessary. If sufficient length cannot be acquired despite these strategies, it may be necessary to ligate and cut the inferior mesenteric artery and vein. If this is not enough, the release of peritoneal attachments at the base of the colon mesentery provides extra length. As explained earlier, a 2-finger-width opening is created in the anterior abdominal wall. Then the abdomen is closed and the ostomy is matured. Transparent devices should be used in order to easily observe the complications that may develop in the ostomy in the early postoperative period. When the colostomy starts to function, the patient can receive an appropriate diet. Loop-end colostomy can be created by following the steps described in loop-end ileostomy [31, 32].

## Minimally Invasive Colostomy

A loop colostomy can be created laparoscopically. Careful patient selection is of utter importance. Most patients have history of more than one complex abdominal surgery. Care should be taken when deciding minimally invasive surgery in such patients. Access to the peritoneal cavity can be done with the Hasson technique or the Veress needle technique that allows pneumoperitoneum creation [33]. Following the camera trocar entrance, two 5 mm trocars are inserted to move the intestines. If transverse loop colostomy is to be performed, the omentum is separated from the colon and a stoma is created from the proximal part of the transverse colon. Minimal mobilization is usually sufficient for this type of stoma. Electrothermal coagulation devices can be used when necessary to separate the omentum from the colon and mobilize the colon. To create the stoma opening, intra-abdominal gases are discharged before a skin disc is removed from the anterior abdominal wall. Thus, the stoma can be positioned more easily. Toldt fascia is cut with electrothermal coagulation devices or cautery while creating a sigmoid loop colostomy. The colon is released from retroperitoneal attachments. After sufficient mobilization is achieved, the colon segment is held with an atraumatic holder. Intra-abdominal gas is evacuated and stoma opening is created. To facilitate the identification of the colon from the stoma opening, the tool holding the colon is gently manipulated. The colon is then held with a Babcock grasper, the laparoscopic device is released, and the colon is pulled through the stoma opening. The pneumoperitoneum is then re-established to check the accuracy of the colon orientation. If a sigmoid end colostomy is desired, the colon can be intracorporeally split or the colon can be split in the anterior

abdominal wall using the Endo GIA stapler. The distal segment of the colon is relocated back to the abdominal cavity. The proximal end is ripened in the form of a stoma [34].

### Turnbull Blowhole Colostomy

It was first described by Dr. Rupert Turnbull in 1953 for the management of patients with toxic colitis who are at high risk of contamination and mortality, where resection is considered contraindicated. The abdominal cavity is entered through the lower midline incision. Bowel segment is prepared. A loop ileostomy is created from the area marked in the right lower abdomen. Subsequently, an incision is made on the anterior abdominal wall in the area corresponding to the dilated colon segment in the left upper quadrant. Overly inflamed colon should be manipulated with extreme care. After the fascia and peritoneum are opened and the colon is identified, the serosal surface of the colon is sutured to the fascia circumferentially with absorbable sutures. Then the colon is cut lengthwise and sewn to the skin with absorbable sutures. Even though rarely performed, this technique may be valuable in patients who cannot tolerate resection [35].

## Ostomy Closure

### Timing of Ostomy Closure

The early closure of loop ostomy, which is defined as the closure within 2 weeks after index surgery, is considered to be feasible and reliable in patients who have an uneventful recovery and no evidence of anastomosis leakage [5].

The timing of stoma closure remains controversial. There are at least four randomized controlled trials and two meta-analyses in the last 10 years comparing conventional timing (within 8–12 weeks after index surgery) with early timing (within 4 weeks after index surgery) [36–41]. Most of the data is from patients with loop ileostomy who had rectum surgery due to cancer. All studies agree that there is no significant difference between different closure time groups with regard to anastomosis leaks. Anastomosis leakage was not observed in any of the patients who participated in the study after the research with a water soluble contrast enema. In a randomized controlled study, early ileostomy closure (on the eighth postoperative day) resulted in less bowel obstruction, a lower rate of medical complications, and a shorter hospital stay, while a lower rate of wound complications (12 weeks after Index surgery) was observed compared to a late-closure ileostomy [36]. In the Easy study, the lower complication rate was observed at the 12-month follow-up in the group that was closed prematurely after the index surgery (8–13 days after the index surgery) [37]. A small number of patients were analyzed in another randomized controlled trial [38]. He found that early ileostomy closure (sixth day after index surgery) gave better results in terms of ease of closure of the abdominal wall and

closure of ileostomy in terms of operation time and stoma care costs. No major complications (Grade III/IV) were observed in either group. (Grade III: Requiring surgical, endoscopic, or radiological intervention. Grade IV: Life-threatening complication (including central nervous system complications) requiring intermediate care/intensive care unit management.) Duration of hospital stay was similar between groups. In the fourth randomized controlled trial, data of a heterogeneous group of patients undergoing ostomy surgery were recorded (ileostomy or colostomy in elective or emergency situations). Early ostomy closure (14–28 days after index surgery) resulted in a better quality of life and lower cost [39]. The results of two meta-analyses were not different from previous randomized controlled trials. Farag et al. compared four randomized controlled trials in 2017. They did not find any difference in terms of anastomosis leakage, postoperative complications, length of hospital stay, and operation time [40]. Menahem et al. compared six studies in 2018, four of which were randomized controlled trials. While the traditional ostomy closure arm showed less infection in the stoma region, fewer stoma-related complications and small bowel obstruction were reported in the early closure arm (within 14 days after index surgery) [41].

As with the Hartmann procedure, the timing of closure of a temporary end colostomy remains a controversial issue. Few data are available on the subject in the literature. As with the Hartmann procedure, the underlying cause must be completely resolved to close a temporary end colostomy. It may take 3–6 months or even more for the patient's state of health to return to baseline, inflammation, and amelioration of the adhesions. Therefore, closure of Hartmann should be done at least 3 months after the index surgery [5].

In a study by Keck et al., patients who were closed early (before 15 weeks) and late (after 15 weeks) were compared in terms of morbidity and mortality, length of hospital stay, and operative difficulty [42]. There was no difference between the two groups in terms of morbidity, mortality, and anastomosis leakage. However, the length of hospital stay was longer in the early closure group, and the operative difficulty was higher. Other authors propose to wait at least 6 months to allow the adhesion intensity to decrease and pelvic inflammation to resolve [43, 44].

## Technical Aspects

In loop ileostomy closure operation, anastomosis can be done with staples or by hand sewing. Stapler technique seems better in terms of decreasing the rate of small bowel obstruction in the early postoperative period and shortening the operation period, without any difference in the anastomosis leak rates compared to hand sewing [5].

Many studies have been conducted to examine the data of patients who underwent loop ileostomy after rectal surgery for rectal cancer [45–48]. In all randomized controlled trials, shorter operative time has been reported on the stapler group. In one of the randomized controlled trials, despite the heterogeneity in index surgery requiring temporary ileostomy, lower small bowel obstruction was found in the

stapler arm. The anastomosis leak rate was higher in the hand-sewn group (2/70 vs. 0/71), but it was not statistically significant ($p$ = 0.2447) [48]. Shelygin et al. reported that overall morbidity rate was lower in the stapler group in 2010 but did not analyze the anastomosis leak rate [46]. In all meta-analyses, there is a consensus that the small bowel obstruction is reduced in the stapler technique. In three of these studies (except for the study of Madani et al.), it was also reported that the operative time in the stapler arm was significantly lower. There was no difference in terms of anastomosis leak [49–52].

Laparoscopic closure of the Hartmann colostomy appears to be a safe and feasible technique but should be performed by experienced laparoscopic surgeons due to the reported high rate of conversion to open technique [5].

As new minimally invasive techniques develop, they are increasingly applied to colorectal procedures, including Hartman procedure, and successful results are reported in small series [53, 54]. In two meta-analyses, laparoscopic and open Hartmann were compared. Siddiqui et al. compared eight studies in 2010 that reported an advantage in terms of lower complication rates and shortened length of hospital stay in the laparoscopic group [54]. More recently, in 2015, after analyzing 13 studies, Celentano et al. reported that there was no significant difference between laparoscopic and open approaches [53].

## Ostomy-Related Complications

The incidence of stomal complications ranges from 21% to 70%. Stomal complications can occur at any time but are most common in the first 5 years. The complications occurring in the very early period are mostly due to technical errors. Complications within the first postoperative month are generally associated with the wrong selection of the ostomy site. The complications occurring in the late period are usually related to permanent stoma cases. In general, end ostomies have lower complication rates than loop ostomies. Generally, the most frequently reported ostomy-related complication is peristomal skin lesions due to leakage. Other common complications are retraction, stomal necrosis, stomal stenosis, prolapse, bleeding, and dehydration due to high ostomy output and parastomal hernia. Rarely seen complications are small and large bowel obstruction, peristomal abscess, and fistula formation. Following closure of the stoma, wound infection, delayed healing, and hernia formation may also develop in the stoma area [55].

Whenever possible, patient education and preparation for life with stoma should be started in the preoperative period. Both participating in stoma support groups and counseling by the enterostomal therapy nurse can reduce complication rates and improve long-term outcomes and psychosocial adaptation. Regardless of the indication and type of stoma, preoperative marking of the stoma site by the enterostomal therapy nurse or an experienced surgeon has been shown to reduce the incidence of postoperative complications. There is a general consensus that most common stoma-related complications are associated with inappropriate stoma site selection. Improper stoma site selection leads to problems such as poor patient compliance,

leakage, skin irritation, trauma, difficulty in seeing the stoma, and psychological distress. This might prevent postoperative adaptation and cause further problems in stoma care. In urgent cases, the selection of inappropriate stoma site is more common. Other universal risk factors associated with stoma complications can be listed as lack of experience of the surgeon, stoma height less than 10 mm, obesity, smoking, inflammatory bowel disease, and diabetes [56].

## Peristomal Skin Complications

It is common in poorly constructed stomas. To prevent these complications, the ostomy end should protrude 2–3 cm from the skin. Thus, the intestinal contents will empty into the bag without touching the skin. In a retracted stoma, the alkaline small intestine content can irritate the skin. Using convex devices and belts may help to solve the problem [55, 56].

Mucosal implantation may sometimes develop due to the suturing of the ileal mucosa to the skin (Fig. 19.1). This may cause the ostomy edge to be constantly wet, making it difficult for the device to adhere. As a result, the ileal content will irritate the skin. Similarly, in obese patients, ileostomies formed below the umbilicus or at the abdominal folds are more likely to have skin problems. It is important that the stoma adapter is applied by the enterostomal therapy nurse and the patient must be educated by the team. The small intestine contents accumulated in the bag should be

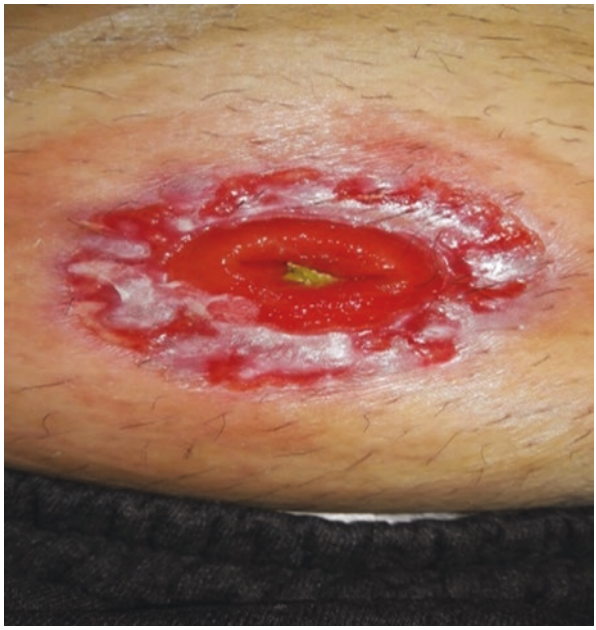

**Fig. 19.1** Mucosal implantation

emptied at regular intervals to prevent irritation to the skin. Patients with physical and mental problems and advanced age may have trouble wearing and emptying their bags. In such cases, education of family members is important [55–60].

Peristomal fungal infections are common. It manifests as peristomal erythema with satellite lesions around it (Fig. 19.2). It should be treated with topical antifungal agents. It is covered with a stoma paste and left to dry, and then ostomy device is applied.

Contact dermatitis typically occurs in the area where the stoma device baseplate touches the skin (Fig. 19.3). It is usually caused by an allergic reaction to the baseplate of the ostomy device. Using a different product may fix the problem. Topical steroid use may be beneficial [57].

Peristomal ulceration may be associated with pyoderma gangrenosum in individuals with inflammatory bowel disease (Fig. 19.4). In this type of patients, choosing a disease-free bowel segment while forming a stoma is important to prevent this complication. It can be seen in any time period after the stoma construction. Ulcers are usually full thickness and painful. Other pathologies must be ruled out to make the definitive diagnosis. Punch biopsies should be taken from the edge of the ulcer. Culture should also be taken to exclude infectious agents. These lesions can be treated with topical, oral, or intralesional steroids depending on the degree of ulceration [58]. In order for the stoma device to be placed, the ulcer area must be kept dry. Applying hydrocolloid-coated stoma or antibiotic powder can help resolve the problem. Drying foams can be used in moist ulcers. Topical tacrolimus solutions

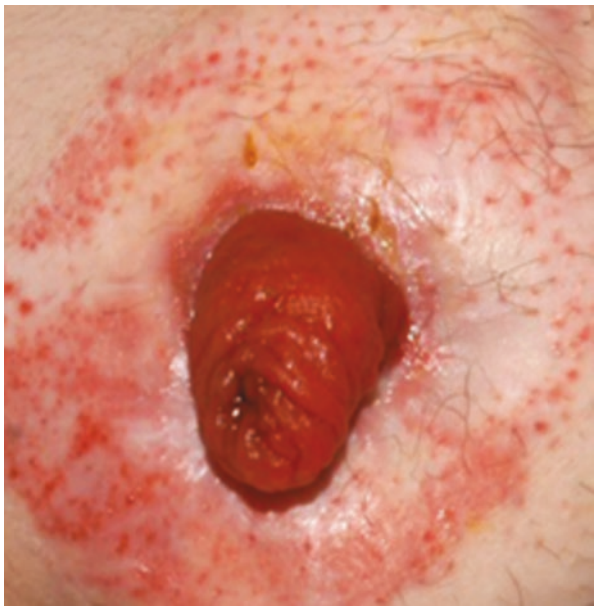

**Fig. 19.2** Peristomal fungal infection

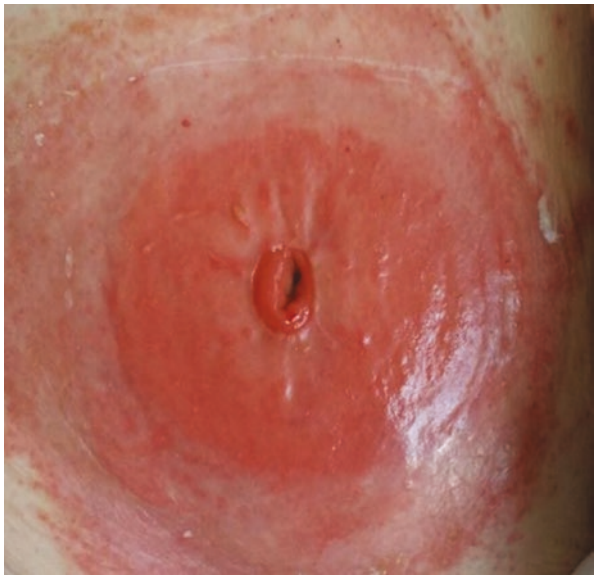

**Fig. 19.3** Contact dermatitis

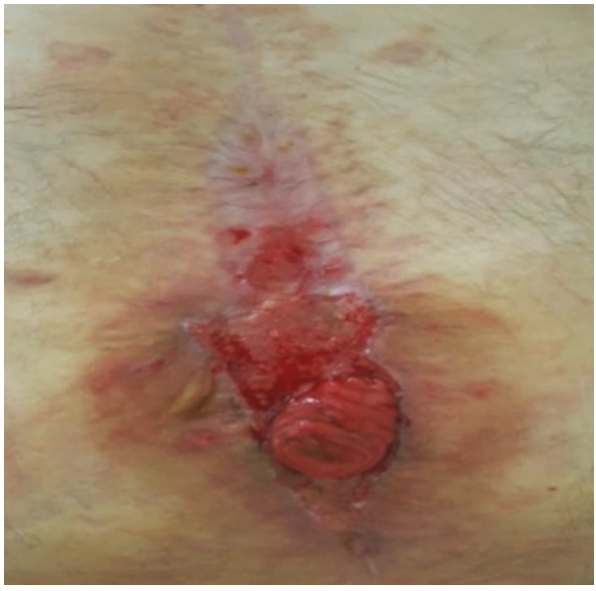

**Fig. 19.4** Peristomal ulceration

can be used in resistant cases. In more severe cases, cyclosporine, infliximab, or other immunobiological agents can be used in the treatment of the underlying disease. In severe cases, the ostomy area may need to be changed. However, in some cases, pyoderma gangrenosum may also relapse in that new ostomy site. The best treatment of pyoderma gangrenosum is to close the stoma if possible [59].

## Mucocutaneous Separation

Mucocutaneous separation is the separation of the ostomy from the peristomal skin around it (Fig. 19.5). Its incidence ranges widely from 3.96% to 25.3% in the early postoperative period. It is usually a technical complication due to over-tension. Conditions that disrupt wound healing, such as excessive cautery use on the skin or intestinal mucosa, immunosuppression or diabetes, and peristomal infection may also be a factor [58]. The management strategy should be determined depending on the size of the separation. Small separations can be covered with absorbent fillers such as skin barrier powder or an ostomy device wafer. Early diagnosis and aggressive wound care are very important. In case of larger or separations involving whole circumference of the stoma, revision may be required to prevent long-term complications such as retraction or stenosis. Due to anatomical bowel factors or some clinical situations such as a morbid obesity, a suboptimal ostomy may be inevitable. As long as the stoma is alive above the fascia level, definitive management of stoma complications should be decided according to clinical stability and delayed as much as possible [60].

## Stomal Necrosis

It has been reported that it occurs in up to 13% of stomata in the early postoperative period (Fig. 19.6). Risk factors include urgent operation, inadequate mobilization of the intestine, excessive mesenteric resection resulting in insufficient arterial blood supply or insufficient venous drainage, and a small opening in the fascia or skin, inflammatory bowel diseases (especially Crohn's disease). Obesity is an independent risk factor for stomal necrosis. Obese patients are seven times more likely to develop stomal necrosis than non-obese patients. Since there is blood support to both afferent and efferent legs, loop ostomies are less prone to necrosis than end ostomies [61]. Ischemia evaluation should be done in the operating room before the

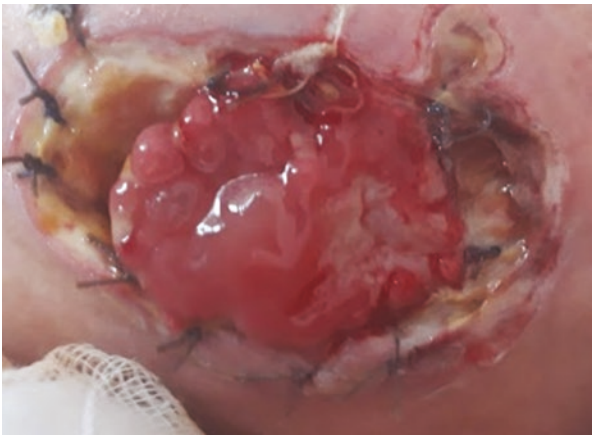

**Fig. 19.5** Mucocutaneous separation

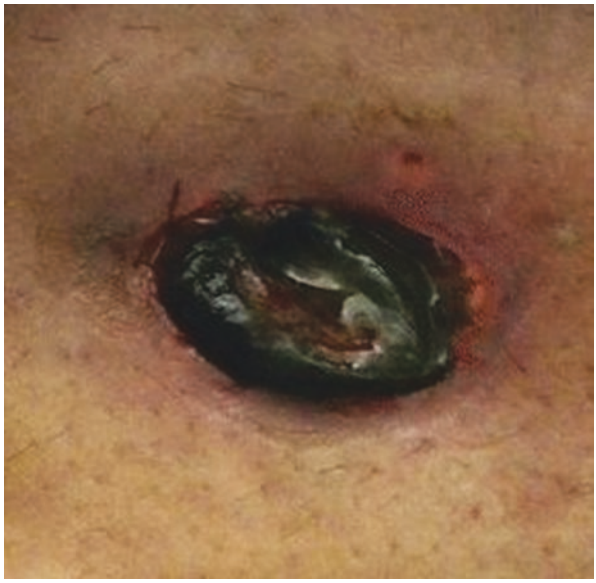

**Fig. 19.6** Stomal necrosis

patient leaves the operating room. If in doubt, the stoma should be revised in the first surgery. It may be useful to prepare the intestine segment that is to be used for stoma at the beginning of the operation to save time. Although all rules are followed, stomas may sometimes appear dusky in the early postoperative period. It is necessary to distinguish whether this appearance is due to arterial insufficiency or venous obstruction which develops due to edema in the postoperative period and improves as the edema decreases. A pediatric endoscope or an anoscope can be used to determine the extent of necrosis. Alternatively the mucosa can be examined under light by inserting a test tube into the stoma. If necrosis extends below the fascia level in the abdominal wall, a revision is required immediately. If necrosis is limited in the intestine above the abdominal wall fascia, the patient can be followed. If necrosis progresses, the stoma should be revised. Crusts can be removed with gentle debridement. However, it may result in complications such as stomal retraction and stenosis in the long term [62, 63].

## Stomal Stenosis

Frequency of clinically significant stoma stenosis is between 2% and 15%, and it is most commonly seen in end colostomies (Fig. 19.7). Stenosis, which develops immediately after the operation, usually occurs secondary to the size of the small trephine or bowel edema [64]. It can be decompressed with rubber catheters. The balloon of the catheter should not be inflated due to the risk of perforation. Late stenosis can be caused by various causes such as weak surgical technique that leads to ischemia, peristomal abscess, recurrent disease (Crohn's disease), or malignancy.

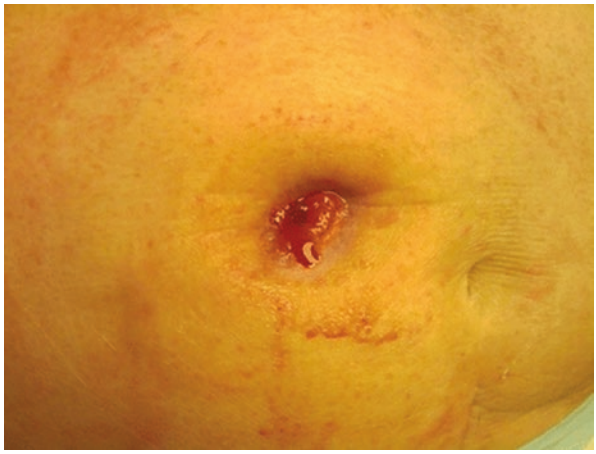

**Fig. 19.7** Stomal stenosis

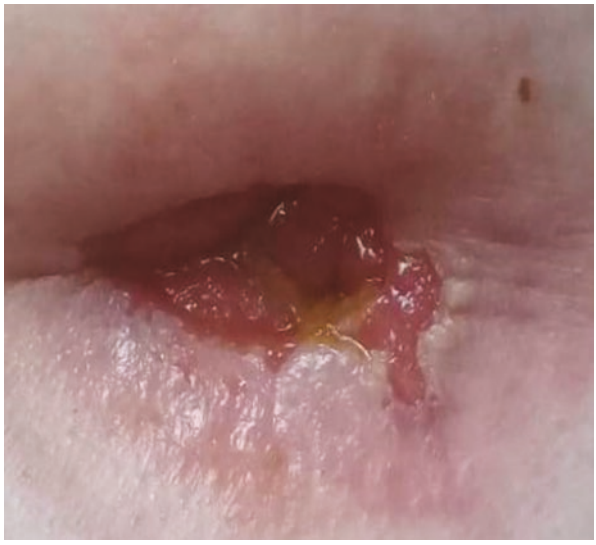

**Fig. 19.8** Stomal retraction

Early mucocutaneous detachment and retraction often result in stomal stenosis because of secondary wound healing and contracture. Mild stenoses can often be managed with serial gentle dilatations and dietary changes (such as avoiding insoluble fiber). In more severe stenoses that are associated with inflammatory bowel disease or ischemia, revision is required to create a new tension-free stoma [65].

## Stomal Retraction

It is generally defined as a stoma that is 0.5 cm below the skin surface within 6 weeks after stoma creation (Fig. 19.8). It occurs in 14% of new stomas in the early postoperative period. Retraction is generally associated with complications such as

leakage and peristomal skin irritation, mucocutaneous separation, and peristomal abscess [65]. The most common cause is tension in the stoma. It usually develops secondary to inadequate mobilization of splenic flexure in descending colostomies and inadequate mobilization of colon in sigmoid colostomies. Risk factors include obesity-related thick abdominal wall, postoperative weight gain, Crohn's disease, malnutrition, immunosuppression, shortness of intestinal mesentery, and initial stoma height below 10 mm. This complication can be prevented by taking into account the technical details during the creation of ostomy such as adequate mesentery mobilization and the creation of an appropriately sized facial opening, allowing an ostomy height more than 10 mm. During the creation of loop ostomy, most surgeons use a stoma support bar to reduce the risk of retraction [66]. However, the use of support rods during loop ostomy does not decrease the incidence of stoma retraction; on the contrary it increases the complication rates such as necrosis, infection, and dermatitis. In the multicentered randomized controlled study of Zindel et al., which included 78 patients, no difference was observed in the retraction rates, while higher stomal necrosis rates were observed in the group using the rod for loop ileostomy. Retracted stomata with a robust mucocutaneous junction can be managed with convex stoma devices. Additional stomal products such as belts and fasteners can also be used. Despite these measures, surgical revision should be considered if leakage and hygiene problems persist or if there is concomitant stenosis [67].

## Stomal Bleeding

The incidence of stomal bleeding is unknown. It can be seen early or late postoperative period or during stoma formation. It usually occurs due to the abrasion of an unsuitable, tightly seated ostomy device. This type of bleeding can be stopped by applying direct pressure, by mucosal cauterization, or by suturing the identified vein. Peristomal varicose veins are seen in patients with portal hypertension of any reason and may cause stomal bleeding. While bleeding can initially be managed by direct pressure and suturing, medical treatments or attempts to reduce portal pressure, such as transjugular intrahepatic portosystemic shunts, are required to reduce the risk of recurrent bleeding. In cases of emergency severe variceal bleeding, disruption of stoma and re-anastomosis may provide a temporary solution [61, 68].

## High Output Enterostomy

Dehydration resulting from high ostomy outflow is the most common reason for readmission in the early postoperative period. The incidence of readmission due to dehydration reaches 17%. It is more common in patients with ileal pouch restorative proctectomy, as stoma is made from the ileum that is more proximal [69, 70]. Dehydration related re-hospitalizations are associated with longer and recurrent re-hospitalizations thereafter. Re-hospitalizations have also been associated with acute kidney injury that might develop into severe chronic kidney disease.

In ileostomies, postoperative 3–8 days are the most risky days for dehydration. Attention should be paid to fluid balance and fluid replacement, as patients are frequently discharged from the hospital during this period. They should take electrolyte balanced drinks containing glucose to prevent hyponatremia. Increases in serum aldosterone levels in the long term, defined as ileostomy adaptation, help reduce the effects of water and salt deficit. Before discharge from the hospital, especially patients with ileostomy require diet training that emphasizes water and salt balance and smaller and more frequent meal consumption. In addition, they must demonstrate proficiency in evacuating their devices, changing them, and recording the output [69]. According to ERAS (enhanced recovery after surgery) protocols, most of the patients are discharged without ileostomies fully adapted to water and salt absorption. Enhanced recovery after surgery (ERAS) protocols are multimodal perioperative maintenance pathways designed to achieve early recovery after surgical procedures by maintaining preoperative organ function and reducing the profound stress response following surgery. The key elements of ERAS protocols include preoperative counseling, optimization of nutrition, standardized analgesic and anesthetic regimens, and early mobilization.

They need to be trained to understand and monitor signs and symptoms of dehydration and to take action to minimize the effects of dehydration when necessary. Despite these trainings, high rate of re-admission is observed in patients with recent ileostomy. When treatment is required for high ileostomy output, patients are instructed to avoid foods with high fat and simple sugar content and take 20–30 g of fiber a day. Although fiber will thicken the ileostomy output and reduce symptoms such as leakage and skin irritation, it has little effect on the total amount of water in the stool. If the output remains high, pharmacological treatment is required. Loperamide and diphenoxylate are often used as primary agents. Other options include octreotide, codeine phosphate, and opium tincture [70].

## Stomal Prolapse

Prolapse, which can be seen in any type of stoma, is protrusion of a segment of full-thickness bowel from stoma resembling a telescope (Fig. 19.9). It is a late complication. It is more common in colostomies, especially in transverse loop colostomies. Its incidence ranges from 7% to 26%. In loop stomas, efferent (distal) leg prolapse most commonly. Risk factors for prolapse are advanced age, obesity, abdominal wall laxity, large facial defects, bowel obstruction during the creation of stoma, redundant and mobile bowel proximal to stoma, and factors increasing the intra-abdominal pressure such as ascites, chronic cough, and constipation. Studies have shown that mesenteric or fascial fixation does not decrease the incidence of prolapse [64]. Prolapse may cause problems with device attachment in mild forms, causing leakage and psychological distress. Acute prolapse can be manually reduced after mild bedside reduction, cold compress, and osmotic agent application (such as granulated sugar). Belt or girdle-style stoma products can be used to prevent recurrent prolapse. When performing manual reduction, one should start from the end of

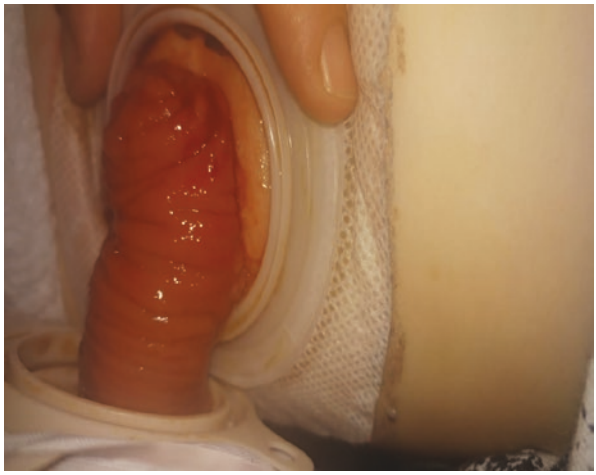

**Fig. 19.9** Stomal prolapse

the intestine and gently continue invagination. More severe or chronic complicated prolapse is associated with severe mucosal irritation and bleeding due to carcinoma or strangulation. In such cases, surgical intervention is required. Fortunately, this is rare. The stoma can be constructed in the same place as prolapsed intestine, or in a different area [65].

## Parastomal Hernia

It is a kind of incisional hernia which develops due to abdominal wall defect in the stoma region (Fig. 19.10). The frequency of clinically important hernias can be as high as 39%. It is most common in end colostomies. It usually occurs in the late period. The risk factors are similar to stomal prolapse; obesity, abdominal wall laxity or collagen disorders, steroid use, postoperative wound infections, large facial defects, and conditions that increase intra-abdominal pressure such as chronic cough, ascites, or constipation. It is often asymptomatic. Symptoms such as skin irritation, abdominal pain, and bowel obstruction due to difficulties in applying the stoma device may also be seen. Due to its appearance, stoma device can cause psychological problems, and this can decrease the quality of life. Obstruction or strangulation requires urgent operation. There are many studies investigating the techniques that can be used to reduce the occurrence of parastomal hernia. The size of the stoma radius has been widely discussed. The European Hernia Society Guidelines suggest that the size of the facial opening should be as small as possible without sacrificing stoma perfusion [71]. There is a general consensus among surgeons that the stoma opening should be 2 finger-width (2–3 cm). The stoma region should not be used to remove specimens. It has been shown that the use of the stoma opening for specimen removal increases the risk of parastomal hernia. In a study in 2017, Li et al. evaluated 738 patients retrospectively. The stoma region was used for specimen removal in 139 patients, whereas in 599 patients stoma was not used. In

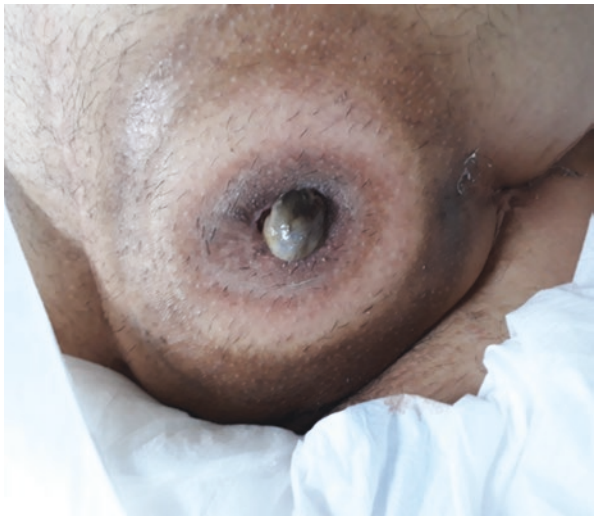

**Fig. 19.10**
Parastomal hernia

patients in which the specimen was removed through the stoma region, the parastomal hernia was significantly higher (4.2–10.1%, $p < 0.05$) [72]. The stoma can be constructed in the transrectal or pararectal position. Since the rectus muscle fibers are preserved, it has been proposed that the lateral pararectal location may reduce the risk of parastomal hernia. In a Cochrane review, there was no difference between the two techniques. However, this result may be related to the poor quality of the studies (lack of standardization in the surgical procedure, lack of definition, and detection method of the parastomal hernia) [73]. The PARASTOM study, a single-center randomized study, did not demonstrate the superiority of one technique over the other in terms of preventing parastomal hernia; 60 patients who underwent elective transient loop ileostomy were randomized, and no significant difference was found between the groups in terms of parastomal hernia incidence (18.5% in the lateral pararectal group and 13.8% in the transrectal group ($p = 0.725$) [74]. It was found that extraperitoneal tunneling, which is an alternative technique for stoma creation described by Goligher in 1958, is associated with lower incidence of parastomal hernia, especially in patients undergoing laparoscopic abdominoperineal resection and end colostomy. Prospective studies are needed to better define which patient subgroup will benefit most from this technique, given the increase in the duration of operation and the risk of postoperative complications associated with the use of the method [75].

When symptomatic parastomal hernia requires repair, mesh use is associated with lower recurrence rates than primary fascia repair. Based on this information, surgeons tried using a prophylactic patch during the first stoma formation to reduce the incidence of parastomal hernia. The results of numerous small studies support the use of prophylactic patches to reduce the incidence of parastomal hernias. Mesh can be placed as onlay, inlay, or sublay between the anterior abdominal wall layers by open approach or laparoscopy, and results are similar in terms of efficacy and

hernia prevention. There is a general consensus on the use of synthetic non-absorbable patches. In only one study, the STOMAMESH study, no difference was found in the rate of parastomal hernia between prophylactic patch procedures and no patch procedures [76]. A new meta-analysis of 11 RCTs involving 907 patients evaluated the cost-effectiveness of patch use for the prevention of parastomal hernia. The study found that there was no significant increase in operating time and significant cost savings was achieved in synthetic patch group [77].

SMART (Stapled Mesh stomA Reinforcement Technique) and modified SMART techniques are alternatively proposed techniques to reduce parastomal hernia rates. The former was first described in 2011 using a circular staple gun and biological mesh to strengthen the stoma trephine. The latter is a modification of the original technique using the standard polypropylene mesh fixed with a circular punch in its retro-muscular position [78, 79]. The use of a stomaplasty ring called KORING has been proposed for the prevention of parastomal hernia and has promising results in prospective, multicenter, observational experiments [80]. However, more research is needed for these alternative approaches, and no definitive recommendations as of today can be made. Routine use of the biological mesh for the prevention of parastomal hernia is not recommended.

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