Avoidance and Management of Stomal Complications

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Abstract

The construction of an intestinal stoma is fraught with complications and should not be considered a trivial undertaking. Serious complications requiring immediate reoperations can occur, as can minor problems that will subject the patient to daily and nightly distress. Intestinal stomas undoubtedly will dramatically change lifestyles; patients will experience physiologic and psychologic detriment with stoma-related problems, however minor they may seem. Common complications include poor stoma siting, high output, skin irritation, ischemia, retraction, parastomal hernia (PH), and prolapse. Surgeons should be cognizant of these complications before, during, and after stoma creation, and adequate measures should be taken to avoid them. In this review, the authors highlight these often seen problems and discuss management and prevention strategies.

Keywords
- stomal complications
- ileostomy complications
- colostomy complications
- enterostomal therapy
- wound ostomy continence

Objectives: Upon completion of this article, the reader should be able to understand and identify preventive and treatment strategies as they relate to common complications of intestinal stoma construction.

The creation of an abdominal stoma is a common procedure performed by surgeons as part of the treatment for both benign and malignant conditions. Stoma formation can be permanent or temporary, and elective or part of emergent operations. The most common abdominal stomas are the ileostomy and colostomy. Often this part of the surgery is performed at the conclusion of a complex and challenging operation. The rate of complications following stoma creation is not insignificant, and care must be taken to adhere to sound surgical technique during this part of the operation. Complications associated with stomas can be minor, requiring only local care and enterostomal therapy (ET)—or can be devastating, leading to multiple reoperations and significant morbidity.[1–3]

Often overlooked is the psychological weight of the stoma on patient body image and quality of life (QOL). There are conflicting results in determining whether an ileostomy or colostomy has more impact on the QOL on the patient;[4,5] however, the mere presence of any stoma has a sizable impact on patient lifestyle.[6] The stoma becomes a significant part of a patient's daily life and concern. Ostimates may be forced to change wardrobes, invest in costly supplies, and endure a sense of social embarrassment from unpleasant noise and odor, whether real or simply perceived. When complications occur and accumulate, however minor, the degree of social restrictions on a patient leads to severe detriment to QOL and even social isolation.[4] Given that 40 to 50% of "temporary" abdominal stomas ultimately remain permanent and unreversed, it is imperative to remain vigilant of potential pitfalls during the creation and care of the stoma.[6,7]

Overview

Much has been written regarding the frequency of stomal complications and the risk factors leading to their occurrence. In general, postoperative stomal complications are a relatively frequent source of morbidity. Early complications are considered those that present within 30 days of surgery; late complications occur after 30 days. Some common complications of stoma include poor siting, parastomal hernia (PH), prolapse, retraction, ischemia/necrosis, peristomal dermatologic problems, mucocutaneous separation, and pyoderma gangrenosum. Each will be discussed separately in further detail.

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Earlier studies have shown complication rates vary between 6 and 59%.[8–14] The wide range of complications related to stoma surgery may be related to the lack of consensus regarding what exactly defines a stomal complication. Indeed, the most common source of patient dissatisfaction and reason for ET nursing intervention is peristomal skin problems, a complication not always recognized in the surgical literature. These problems, often seen by wound ostomy continence (WOC) nurses, are not always brought to the attention of the surgeon, and may remain underreported. More recent studies have shown complication rates remain widely distributed, ranging from 10 to 82%.[1,15–22] One must be aware that even with new advances in surgery and technology, stoma-related problems still occur with consistent frequency. In this review, we will discuss these challenging issues and identify potential preventive measures.

Risk Factors

Many risk factors that predispose a patient to develop complications have been proposed, including patient-, operation-, and disease-specific issues. Commonly reported patient-specific parameters include age, gender, body mass index (BMI), nutritional status, American Society of Anesthesiologists (ASA) status, and corticosteroid use. The operation-specific risk factors that have been studied include emergency versus elective surgery. The location and type of stoma have also been compared, as well as the disease processes that necessitated creation of the stoma. It may seem intuitive that a malnourished, elderly patient with multiple medical comorbidities undergoing emergency operation for gross intestinal perforation may have a high likelihood of stomal complications; however, the literature is not always consistent in support of this scenario.[1,15–18,20–22] In one of the largest series in the recent literature with long-term follow-up, Nastro et al reported a major complication rate of 46.4%; when minor peristomal skin problems are included, the rate increases to 56%.[16] Minor peristomal skin problems were often coexistent with major complications (33.9%). Musculoskeletal comorbidities (rheumatoid/osteoarthritis), immobility, poor ASA status and surgery for cancer were found to be independent risk factors. Obesity also contributed to poor outcomes. Respiratory comorbidities, smoking, diabetes, and malignancy were associated with the highest risk for postoperative stomal complications.[16]

Prospective studies addressing stomal complications that occur in the early (< 30 days) postoperative period demonstrate a relatively high incidence, ranging from 27.1 to 82%.[15,18,20,21] Arumugam et al reported on 97 patients, with over 50% of the patients experiencing one or more complications. The presence of obesity, diabetes, and emergency surgery presented independent risks for complications.[18] Parmar et al noted a complication rate of 27.1% among 192 patients.[21] Interestingly, colostomies had a greater rate of early complications when compared with ileostomies (31.7 vs. 18.3%) in this study. In one of the largest studies focused on early stoma problems, Cottam et al reported on a prospective study of 3,970 cases in 93 hospitals, noting a 34% complication rate. Early complications were more likely to occur in loop ileostomies (38.2%), while end colostomies had lowest rates (29.7%; $p < 0.001$). Suboptimal stoma creation, with a height of less than 10 mm was also associated with a higher rate of complications. Procedures performed for emergencies were also a significant risk factor. High BMI did not have any effect on outcome.[20]

Despite advances in surgical care and postoperative management, little has changed regarding the incidence of stomal complications. Although data vary and are often conflicting in the identification of risk factors, it would seem prudent to optimize possible patient-related factors through weight loss regiments, smoking cessation, correction of malnutrition, and maximal medical treatment of comorbidities.

Preoperative Siting/Poor Siting

A poorly sited stoma usually does not manifest its true degree of morbidity on patients until they are discharged and attempt to resume some level of daily activity. When stomas are placed in unfavorable locations, ill fit, leakage of effluent and gas, skin irritation, trauma, and poor visualization of the stoma can result. All can lead to elements of frustration and psychological distress, poor body image, and difficulty with postoperative adjustment.[4,19,23–26] Economically, increased use of stomal products to achieve a reasonable functional status can impose a sizable financial burden.

Choosing a proper site can be performed preoperatively in elective cases. Even in urgent cases while the patient is being prepared for surgery, the involvement of a WOC nurse is not unreasonable. This not only improves proper site selection, but also serves to introduce the patient to education and resources early.[27] To ensure proper appliance seal, the site should be away from bony prominences, proposed incisions, previous scars, and skin creases. Also, a flat area of at least 2 inches of surrounding healthy skin is ideal. As a general guide, this corresponds to a location approximately one-third the distance measured from the umbilicus toward the anterior superior iliac spine (ASIS). Poorly sited stomas often are located too low on the abdominal wall.[2,28]

The stoma should be brought through the rectus abdominis muscle. Although there are instances in which partial transection of the muscle is needed, every effort should be made to use a muscle-splitting technique. Generally, the rectus muscle can be identified by having the patient perform a head or leg raise in a supine position. In obese patients, another technique is to follow the nipple line downward to approximate the lateral edge of the rectus muscle.[29] To identify potential pouching difficulties, the patient should be examined while standing, sitting, and supine. Changing positions reveals problematic areas of skin creases and potential areas where stomas can be obscured due to excess body fat. One should also consider patient disabilities that ultimately may dictate the position in which the patient must spend most of his or her time, which in turn will often determine the best position to site the stoma.

Obesity and body habitus remain challenging factors in proper siting. Although the umbilicus and ASIS are useful landmarks, they may not be appropriate in the obese patient.

Stomas placed near a large pannus or prominent skin folds will lead to management problems. Given that the obese patient often has large shifts of subcutaneous tissue and positionally dependent exaggeration of skin crease, multiple potential stoma sites should be identified. Stomas placed too low or in skin creases will make it impossible for the obese patient to see and care for the stoma. Patients may resort to the use of a handheld mirror; but one-handed stoma care is highly cumbersome; furthermore, it is an avoidable scenario. In obese patients, prevention calls for the stoma to be sited further cephalad to the typical location, as the adipose tissue layer above the umbilicus is predictably thinner, thus allowing adequate visualization and access. In women, one must also consider pendulous breast tissue obscuring the stoma and interfering with management.[30]

After the proper siting has been performed, protecting the mark from unintentional erasure can be done by application of a clear watertight barrier. Once adequate anesthesia is achieved, the mark can be further enhanced by scratching the skin with a needle tip immediately before skin scrubbing and preparation.

Patient Education

The evaluation of the patient in consultation with a WOC nurse can significantly benefit the patient. Robertson et al have shown that in the early postoperative phase, skin irritation, leakage, and foul smell are the primary issues faced by patients.[19] To exacerbate the problem, these common issues are not always brought to the attention of the surgeon, and patients suffer without proper guidance or access to readily available resources.

Ideally, education, marking, and discussion of expectations should be performed preoperatively, as the involvement of skilled WOC nursing has been shown to be beneficial.[27,30–32] The increasing use of minimally invasive techniques and adoption of enhanced recovery after surgery (ERAS) strategies have reduced the length of stay postoperatively. Opportunities for WOC nursing interaction, learning pouching techniques, and problem-solving guidance can be missed with early discharge.[33] Thus, maximizing the time period before surgery for patient education and preparation becomes more crucial. An intensive education protocol with additional WOC nursing visits beyond the conventional methods improves patient independence and ability to cope with stoma problems.[34] Patients who receive intensive preoperative training are more likely to be proficient with their stomas and less likely to need WOC nursing interventions due to unplanned events.[34]

Millan et al have shown that even in patients undergoing urgent operations, preoperative evaluation by WOC nursing is possible and beneficial.[35] Clearly, in truly emergent operations, preoperative WOC nursing education is difficult. Surgeons should familiarize themselves with proper preoperative siting techniques and take a moment to consider how they will manage less than ideal situations. Even in cases of minimal preoperative patient education, certainly the involvement of WOC nursing postoperatively improves the QOL of ostimates and should not be neglected. Continued involvement of a skilled WOC nurse can prevent progression of relatively minor common problems to more severe conditions.[36]

Dehydration/Electrolyte Abnormalities

Very little is written about high output from stomas. In a recent meta-analysis, the authors identified only four studies that included high output as a complication.[37]

Generally, the incidence ranges from 0.8 to 16.7%.[15,38–43] Ileostomies can be expected to begin function between 1 and 3 days postoperatively. Bowel edema is often still present and impairment of fluid absorption across the mucosal surface can lead to high volume output. It is not uncommon to observe volumes reaching 1,000 mL/day; severe cases may exceed 2,000 mL/day. Postoperative adaptation of the bowel takes several days to weeks, with a subsequent decrease in the output to 400 to 800 mL/day. Not surprisingly, ileostomies are more prone to high output and patients are at risk for dehydration and electrolyte abnormalities. Hypokalemia, hypomagnesemia, and hypocalcemia are common findings and renal impairment is a reported complication.[22,43] Patients are at particular risk during the third to eighth postoperative day, at which point they commonly have already been discharged to home.

Before leaving inpatient care, patients should be made aware of the warning signs of persistent volumes above 1,000 mL/day. Surgeons must also note that patients may not specifically complain of high stoma output; rather they report secondary effects such as frequent emptying of stoma bags (more than six times per day), leakage, nausea, dizziness, malaise, or fatigue. Preventing progressive dehydration and possible readmission begins with clear instructions of oral rehydration. Hypotonic fluids (e.g., water, fruit juices, soft drinks, tea, and coffee) are low in sodium and their excessive consumption will lead to efflux of sodium into the bowel lumen and result in hyponatremia. Instead, glucose-electrolyte balanced solutions should be used. Commercially available sports drinks have been advocated for this purpose.[2] Foods high in fat and sugar content can also increase ostomy output; patients should be instructed to reduce their consumption. Fiber supplementation should be started; patients should be instructed to aim for 20 to 30 g/day of fiber intake. One must be mindful that fiber will thicken the consistency and viscosity of the effluent, but will not change the water content. Thicker effluent can help prevent leakage and skin irritation, but patients must be informed of the risk of dehydration if output remains high. Additional pharmacologic treatments include antidiarrheal agents, such as loperamide (2–4 mg three to four times daily) and diphenoxylate (2.5–5 mg three times daily). Further options include codeine phosphate, camphorated tincture of opium, and deodorized tincture of opium. These opioid agents have a potential for abuse, and should be used judiciously and reserved for intractable cases.[44]

Peristomal Skin Complications

Peristomal skin complications are frequently experienced by patients with an ostomy, with reported incidences ranging

from 18 to 55%.[45] There is a broad range of presentation, from mild skin irritation to ulceration and concomitant infection. These complications can often be easily prevented with proper stoma construction and care.

Patients with difficult to fit stomas are at highest risk for developing skin complications.[18] This is most frequently encountered in patients with other stoma complications including poor siting, prolapse, retraction, and PH. Obese patients are particularly at risk for skin complications due to difficulty in fitting stoma appliances around body folds. Attention to technical detail is crucial as these complications are more commonly seen in poorly constructed and poorly located stomas. Lack of access to WOC nursing places patients at the greatest risk for developing peristomal skin complications.[46] Without WOC nursing, minor issues with stoma fitting can lead to hospitalization and more expensive treatment.[47]

Mechanical, chemical, allergic, and infectious causes have been identified. Most mechanical injuries occur from improper fitting or changing of an ostomy appliance. Frequent appliance changes lead to mechanical stripping of the surrounding epidermis. Painful denuded areas of skin develop, typically in the distribution in contact with adhesives. Patients need to be assessed for their proficiency in appliance removal, and underlying causes for frequent appliance changes should be investigated. Applying a skin sealant to the damaged area can assist healing and prevent further skin stripping. Pressure injuries occur from tightly fitting ostomy belts or use of convex flanges. Ulcers can form, at times full thickness, at pressure points. Movement of such devices against the skin also causes shear injury. Topical wound care products can be used to treat the damaged peristomal skin. Ideally, the offending device (ostomy belt or convex flange) should be discontinued; however, the patient may require these devices to obtain an adequate seal.[48] Chemical injuries occur from exposure of the peristomal skin to the intestinal effluent. Often the skin will appear reddened and moist. The extent of the injury will depend on the effluent, with small bowel content being the most caustic, as well as the duration of exposure. Irritant contact dermatitis is the most common peristomal skin complication.[49] Although attention to proper fit occurs during the inpatient setting, patients need to be refitted postoperatively as stomal swelling decreases. This must be performed throughout the lifetime of the stoma to account for changes in the abdominal wall.[50] Preventing progression is critical because the dermatitis can lead to worsening leakage, further irritation and pain, and an ongoing vicious circle. It is not uncommon for patients and inexperienced caregivers to create progressively larger wafer openings in an attempt to alleviate the skin irritation. This practice only worsens the lesion as the skin is persistently exposed to chemical injury. Such practices should be quickly recognized and promptly discouraged. Eroded peristomal skin can be treated with a hydrocolloid powder before placing the stoma appliance. Routine stoma care and a well-fitting stoma appliance that covers the injured skin will allow the peristomal skin to heal. Peristomal skin with repeated exposure to effluent may develop pseudo-verrucous lesions. These appear as thickened epidermis with papules in the region of chronic exposure. Treatment for this is similar to irritant contact dermatitis (appliance refitting and local skin care), and the pouch should be fitted to cover the lesions.[50] An allergic contact dermatitis can occur in patients sensitive to the stoma appliance adhesive or any powders, barrier, or fillers. Like irritant contact dermatitis, patients will have erythematous skin with vesicles. The two entities can be distinguished based on the pattern of distribution. Allergic dermatitis will occur where the adhesive or offending agent contacts the skin while irritant dermatitis will occur at the site of effluent leakage. Removal of the irritating agent will allow the skin to heal. A patch test of possible irritants may be helpful. Topical corticosteroids or antihistamines may help the peristomal skin recover.

The warm, moist, and dark environment of the peristomal skin places it at high risk for infection.[48] Cutaneous candidiasis is the most common peristomal skin infection.[51] Cutaneous candidiasis presents as shiny and reddened skin with pustules. An immunocompromised state or recent antibiotic use places the patient at higher risk.[48] Most often, however, the infection can simply be attributed to moist peristomal skin. Cost-effective treatment includes over-the-counter antifungal creams, with allylamines reserved for patients that fail the initial treatment.[52] Powders to dry the peristomal skin before placing the stoma appliance should be used. Peristomal folliculitis can also occur due trauma to hair follicles from stoma adhesive removal or shaving the peristomal skin. *Staphylococcus aureus* is the most common bacteria seen in peristomal folliculitis. The reddened skin with pustules can be difficult to distinguish from candidiasis and frequently these patients are first treated for candidiasis.[48] Cleansing with antibacterial soap and applying an antibacterial powder treats the folliculitis.

Ischemia/Necrosis

Vascular compromise to the newly created stoma may be localized to the superficial aspect of the stoma or can extend deeper below the level of the fascia. Partial or superficial necrosis is more common, with an incidence of 2 to 20%. More serious complete/deep necrosis can occur in 0.37 to 3% of cases.[1,10,15,16,20,21] Prevention of vascular compromise rests in the balance between mobilizing a segment of bowel that reaches the skin adequately and maintaining an adequate vascular supply in the process. Assessment for possible ischemia and prevention of the devastating consequences of ischemia should take place well before leaving the operating room. Any question of compromised viability of the stoma must be addressed and revised at the initial operation. Holding to a notion that the stoma will "get better" is ill advised and often leads to clearly avoidable complications.

Excessive trimming of the epiploic fat and the mesentery should be avoided. In general, an end ileostomy will maintain adequate blood supply with dissection of the mesentery for up to 5 cm from the distal end.[53] Collateral flow is maintained through the submucosa of the terminal ileum. Colonic arterial flow is maintained through the marginal artery; at least a

1 cm portion of the colonic mesentery adjacent to the bowel wall should be preserved to maintain patency of the marginal artery. Confirmation of pulsatile flow by digital palpation of the preserved colonic mesentery is recommended and generally ensures viability of the colostomy.

Even with adequate mobilization and a viable-appearing bowel segment, a stoma may appear "dusky" as it is passed though the abdominal trephination due to venous congestion. As peristomal edema recedes postoperatively, the venous congestion often improves. One must note, however, that the bowel may be edematous and congested as a result of an excessively small and constricting abdominal wall trephination. If such mechanical forces remain unchecked, the venous congestion leads to impaired arterial inflow and can result in ischemia, and in severe cases, stomal necrosis. If venous outflow obstruction is suspected intraoperatively, options include carefully enlarging the trephination, judicious trimming of excess mesenteric fat to reduce bulk, or both.

The obese patient, with a thicker subcutaneous adipose layer will require relatively more dissection of the mesentery and sacrifice of blood supply to bring up an end stoma. Because the upper quadrants of the abdomen often have a less prominent adipose layer, placing the stoma higher on the abdomen presents a technical advantage in the obese patient. In cases where this is not feasible, the pseudo-loop (loop–end) configuration can often achieve adequate length without compromise of the mesentery.[53]

Bowel with compromised blood supply, as evidenced by dark, purple, or grayish mucosa, is quite evident once the bowel is opened and the stoma is being matured. However, this stage of the operation is often performed at the very conclusion of the case. If possible, preparing the segment of bowel for the proposed stoma should be done early in the operation. This allows any demarcation to present itself well in advance and become clearly visible on the serosal surface. Gently rubbing the handle of a scalpel along the serosal surface can be used to check capillary flow. Also, pricking the serosa with a needle and confirming bleeding is a further option.[54]

In the postoperative period, it is common to see edema and some venous congestion does occur. Distinguishing between congestion and ischemia can be performed by a variety of techniques. Using a flashlight to directly transilluminate the stoma can be performed quickly and easily. Touching the flashlight onto a viable stoma will make it illuminate to a healthy red hue. Even in a congested stoma, if viable, transillumination will occur. Ischemia, if identified, must be fully evaluated and its extent must be assessed. Superficial ischemia of only several millimeters, and confined to the portion above the skin level, may lead to mucocutaneous separation or abscess. Such problems can be treated locally. However, even relatively minor ischemic changes in the stoma may well result in future poor stomal function and pouching difficulties with significant patient dissatisfaction.

More extensive ischemia can be visualized through the use of a phlebotomy test tube. The well-lubricated glass tube is gently inserted into the stoma, and a penlight is used for illumination. Failure of transillumination and necrosis below the fascial level requires urgent laparotomy and revision. When the degree of ischemia or necrosis extends to the subcutaneous level but remains above the fascia, one can expect stomal stenosis to eventually result. The patient may recover without the need for urgent or emergent reoperation, but stomal revision will likely be required at a later time. Another diagnostic alternative includes direct visualization with a pediatric rigid proctoscope or a flexible endoscope. Using a needle to scratch the mucosa to assess for bleeding is a further option to distinguish ischemia from congestion.

Retraction

The overall incidence of stomal retraction ranges from 1.4 to 9%,[10,11,15,16,20] and may affect both ileostomies and colostomies.[55,56] Although most studies have identified retraction as a common early complication, it can also develop in the late postoperative period.[10] Recent prospective studies show that retraction, in comparison to other complications, is one of the most commonly encountered (32.2–40.1%).[20,21] The retracted stoma discharges effluent at the skin level and causes peristomal irritation and is more prone to leakage. Acute retraction in a freshly created stoma can result in dehiscence of the mucocutaneous junction and intraperitoneal contamination. Functionally, a retracted loop stoma is problematic, as its ability to fully divert the fecal stream is compromised.

Retraction is caused by excess tension placed upon the matured segment of bowel, which is typically the result of inadequate mobilization. As such, attempts at local revision may not succeed because the underlying cause of the tension cannot be fully addressed through a peristomal incision. Laparotomy is usually needed to gain more length and to revise the stoma in a tension-free manner.

Several preventive measures can be taken at the initial operation. For left-sided colostomies, simply dividing the sigmoidal vessels may not be sufficient. The stoma will be tethered by the inferior mesenteric artery (IMA) pedicle. Ligating the IMA proximal to the left colic artery takeoff and dividing the inferior mesenteric vein (IMV) will provide significant length. Using a segment of bowel that is edematous or inflamed is also discouraged because the associated mesentery will lack pliability and is often foreshortened. Other useful measures include the complete dissection of the colon from its lateral peritoneal attachments, mobilization of the splenic flexure, and scoring the medial aspect of the mesocolon and creating "relaxing incisions."[53]

Parastomal Hernia

Parastomal hernia (PH) is a type of incisional hernia that forms in relation to the creation of an abdominal stoma. They are uncommon in the early postoperative period (0–3%),[19,21,56] but the incidence of PH increases with time, ultimately ranging from 14.1 to 40%.[12,16,17,19] Recent studies have suggested that stoma location and type do not necessarily influence the tendency to develop PH.[22,37,57] Risk factors that lead to the development of a parastomal hernia

are similar to that of other abdominal wall hernias. Nastro et al noted respiratory comorbidities, diabetes, surgery for malignancy, and end colostomy as significant risk factors for PH development.[16]

Surgical options for correcting a PH are local primary repair, relocation, and repair with mesh. Local primary repair does not require a laparotomy and dissection can be minimal. The fascial defect around the stoma is plicated, and its technical ease is appealing. The results, however, are disappointing, with recurrence rates ranging from 46 to 100%[58–64], limiting its clinical applicability. Ideally, it should only have a role in those patients where a larger complex surgical repair is considered high risk or in cases where mesh repair is strongly undesirable.

Relocation of the stoma can be performed through a formal laparotomy or by way of a local peristomal incision. The rate of recurrence at the relocated site remains problematic, ranging from 24 to 40%.[60–62,64] In fact, the recurrence rate at the new site should be expected to be at least as high as that after the initial stoma creation. A second repair with relocation is associated with even a higher expected chance of recurrence (71%).[60] Relocating the stoma to the same side of the abdominal wall further increases the likelihood of a recurrence (80–86%).[59,62] Overall, the data are limited in comparing direct repair to relocation. In the short term, it seems that relocation offers a better outcome.[64] However, with longer postoperative follow-up, the rerecurrence rates appear to be disappointingly high, regardless of whether direct repair or relocation was perfromed.[60,62]

The success of mesh repair for other types of incisional hernias has naturally attracted attention to its use for PH. Various techniques and modifications have been described, including the placement of the mesh in an inlay, overlay, sublay/retromuscular, and intraperitoneal position. A detailed discussion of the numerous techniques of repair is beyond the scope of this article. However, a review of the literature indicates that the recurrence rates for PH with mesh repair ranges from 6.9 to 17.8%, which compares favorably to both direct repair and relocation.[65]

Given the challenges of managing a PH and the disappointing surgical treatment options, much interest has risen in the prevention of hernia formation at the index operation. Technical and operative factors that have been suggested include limiting the size of the trephination, directing the bowel through the rectus abdominis, and creating an extraperitoneal course.[2,3,12,66]

No clear consensus exists regarding the ideal location of trephination through the abdominal wall musculature. Studies have suggested that the course through the rectus abdominis is favorable.[67] Others have found no correlation of the position of the stoma in relation to the rectus abdominis, and the rates of PH.[12,68] Although not clearly protective against PH, a stoma positioned through the rectus abdominis is advocated due to any lack of disadvantage and belief in superior appliance fit.[2,57]

The size of the trephination is also a matter of some debate. As a general guideline, an aperture of two finger breadths is an acceptable size. Martin and Foster suggested the trephine will expand with time and application of tangential intra-abdominal forces. Their recommendations were more precise: 2 cm for ileostomies and 1.5 cm for colostomies.[69] Several investigators have used mechanical devices to assure accurate and reproducible aperture sizes[70–72]; however, whether such devices are truly superior to conventional methods is not proven. It is best to avoid dogmatic adherence to strict sizes, but rather to use a guided approach in which the smallest aperture is fashioned to a size that allows passage of the bowel without vascular compromise.

Goligher initially described the extraperitoneal stoma in 1958, and remained a strong proponent of the technique.[73] Early findings indicated a decreased incidence of hernia formation through the use of the extraperitoneal course.[74] Recent reports have supported these findings and have demonstrated a statistically significant reduction in hernia rates.[12,75,76] However, prospective randomized studies are still lacking, and the role of the extraperitoneal stoma as a preventive measure remains unclear.

Due to the high rate of PH formation postoperatively, it is not surprising that the use of mesh as a prophylactic measure has been advocated by some. Prevention of PH using mesh at the initial operation was first described in 1986.[77] Since this early study, many advances in hernia repair, namely the development of large-pore lightweight synthetic and biologic meshes, have been made. One of the primary concerns of mesh repair in PH is the insertion of a foreign body into a potentially contaminated field. Mesh infection rates in the setting of PH repair range from 0 to 13%.[78–83] Steele et al in a large study regarding mesh infection in PH repairs, reported on 58 patients. Even with bowel in direct contact with mesh and exposed to a clean contaminated field, the wound infection, fistula, and mesh erosion rates remained low at 3%, 3%, and 2%, respectively. The authors concluded that the utilization of mesh for PH repair is safe in a clean contaminated field.[80] In another prospective trial, 25 patients undergoing elective colorectal surgery had creation of a permanent colostomy with concomitant placement of synthetic mesh. The authors estimated the procedure added ~10 to 15 minutes to the surgery total time. Follow-up was 12 months with two PH. Mesh erosion through skin without infection or abscess occurred in two patients; these were treated locally without explantation.[84] In a multicenter prospective study, 20 patients underwent abdominoperineal excision and colostomy with mesh reinforcement. With a median follow-up of 24 months, the PH rate was 5% and no infectious complications occurred.[85] Figel et al have reported on the feasibility and safety of biologic mesh for prophylaxis as well.[86] Recent meta-analyses have shown favorable results in support of using mesh in a prophylactic manner.[87,88] Data from randomized studies, however, remain sparse. Serra-Aracil et al conducted a trial of prophylactic implantation of lightweight, large-pore partially biodegradable mesh and a control group with no mesh. The implantation was estimated to add no more than 20 minutes to the total operative time. Mesh implantation was associated with a statistically significant reduction of PH occurrences (14.8 vs. 40.7%; $p = 0.033$).[89] In another prospective randomized study, 27 patients were

randomized to either sublay mesh implantation with colostomy or a conventional colostomy creation only. At 12-month follow-up, the clinical trial arm demonstrated no PH, while the control arm demonstrated eight hernias ($p = 0.003$).[90] A 5-year follow-up of the original study continues to support the effectiveness of the use of prophylactic mesh.[91] Although important issues still remain, such as the choice of the mesh type and the technique of placement, these randomized studies suggest the safety and effectiveness of the use of prophylactic mesh in reducing the risk of PH formation. Furthermore, the surgical techniques have been well described in the literature, are relatively easily incorporated into the primary operation (adding 10–20 minutes to operative time), and appear to be well tolerated by patients. Cost-effectiveness of prevention has also been put forth as a potential advantage.[86]

Stomal Prolapse

The incidence of stomal prolapse is variable, and ranges from 2 to 22%. Prolapse is often a late complication, and can be seen in both loop and end stomas. However, the loop configuration is more commonly associated.[1,10,18] Loop ileostomies prolapse at a rate of ~2%, while loop colostomies have higher rates, ranging from 16 to 19%. More commonly, it is the distal limb of the loop stoma that is subject to prolapse. Elevation in abdominal pressures (i.e., straining) and redundancy of bowel segments are proposed causes.[92] Direct fixation of the bowel at the fascial level as a preventive measure has been suggested.[92] However, fixation of the bowel or mesentery remains controversial. Although some authors have found this maneuver to be useful, others have reported it has no bearing on the subsequent occurrence of prolapse.[11,12]

The defect in the abdominal wall in creating a loop colostomy is usually large in comparison to an ileostomy. Law et al, in comparing their experience with both loop colostomies and ileostomies, found no statistical difference in the rates of prolapse. They attributed their relatively low prolapse rate, particularly from colostomies, as a function of keeping the trephination small. Although no exact measurements are reported, the fascial defects of the loop colostomies were kept similar in size as those made for loop ileostomies.[40] Often the distal limb of the loop transverse colostomy is the problematic site. Given the redundancy of the transverse colon, choosing the proximal transverse colon for a loop stoma leaves a relatively long length of colon at risk for prolapse. If there are no anatomic barriers or contraindications, using the distal transverse colon is acceptable, and may prevent prolapse because the length of the distal limb is shorter and is fixed at the splenic flexure.[2]

The end-loop colostomy as described by Prasad is also a viable option.[93] The bowel is divided, and the end of the distal bowel segment is sutured directly adjacent to the proximal end stoma. This allows for a fascial opening that is relatively smaller than that needed for a more conventional loop stoma.

Once it presents as a problem, stomal prolapse can be treated with a combination of local conservative measures and surgical revision. Prolapse of a stoma, although dramatic and disconcerting to the patient, is rarely a surgical emergency. Often, the function of the ostomy is preserved. Reduction of the prolapsed stoma can be achieved with gentle manual pressure. In instances where bowel edema and engorgement are present, topical application of table sugar or hyaluronidase injection can be used for osmotic therapy and reduction of edema. Larger and specially fitting stomal appliances can be used to maintain an acceptable seal and function. Surgical correction of stomal prolapse can often be performed through a local peristomal incision. Several authors have described techniques using stapling devices to perform excision and correction of the prolapsed limb with excellent results.[94–97]

Mucocutaneous Separation

The incidence of mucocutaneous separation ranges widely from 3.96 to 25.3%.[10,15,20,21] Occurrence is usually in the early postoperative period and can be attributed to an improperly matured stoma or excessive traction. Care must be taken to suture full-thickness stoma to the skin to prevent separation of the suture line. Also, recent advances in damage-control surgery have led to new techniques in the treatment of the open abdomen. Specifically, negative pressure devices and dynamic wound closure systems allow reapproximation of the midline wounds and fascia. Both systems use a combination of sponges, dressings, elastic retention sutures, and negative pressure. Reports suggest bowel segments are subject to traction forces causing tension at the stomal–cutaneous junction. Various modifications through the placement of grooves or cutouts have been suggested as prevention.[98,99] Treatment of mucocutaneous separation is by packing separated area with a filling paste or powder and covering the separated area with the stoma appliance.

Peristomal Pyoderma Gangrenosum

Pyoderma gangrenosum (PG) is an ulcerating skin disorder that is associated with inflammatory bowel disease, arthritis, multiple myeloma, and malignancy. Approximately 2 to 30% with PG also have inflammatory bowel disease.[100–104] The skin lesions of PG start as small pustules and progress to large superficial ulcers with necrotic edges and bases. These ulcers can be exceptionally painful and at times require hospitalization for management. PG lesions most commonly occur on the lower extremities, but can occur anywhere on the body, including the peristomal region.

The incidence of peristomal PG has been reported as 0.6% of patients with stomas and 3.8% in patients with Crohn disease and stomas; however, the true incidence is unknown with only a limited number of cases in the literature.[105,106] Risk factors for development include perianal Crohn disease, active inflammatory bowel disease, female gender, presence of autoimmune disorders, localized peristomal trauma, and high BMI.[107,108]

Patients are frequently initially treated with topical steroids or antibiotics. This is often unsuccessful because these products interfere with stoma appliance adherence. High-dose steroids may be used as a systemic therapy with an

acceptable response rate, but this may require up to 3 months of treatment.[109] Clinical trials of infliximab for PG have shown only a 21% complete response rate and 31% no response rate.[110] Surgical intervention may benefit ulcer healing. Removing actively diseased bowel has been shown to decrease average healing time from 12.4 to 1.8 months.[111] Relocating the stoma site has also been proposed as a potential treatment, but PG will likely recur at the new stoma site.[105,111,112] Closure of the stoma has been reported to lead to healing of ulcers in active PG.[113] Patients that are acceptable candidates should consider stoma closure. Otherwise, peristomal PG can be managed with systemic steroids and removal of actively inflamed bowel.

Technical Complications

Purely technical errors, such as creating a stoma with an unintended segment of bowel or maturing the wrong limb, are rare events. Such preventable complications can be avoided by careful attention to orientation and proper visualization. Placing a seromuscular stitch or a serosal mark with sterile ink to indicate the proximal limb is a simple maneuver to virtually eliminate any confusion. When creating a trephine stoma, limited exposure is a major drawback. One should clearly identify the proper segment of bowel by typical anatomic characteristics, such as the appendices epiploicae or the greater omental attachments, before proceeding with maturation. Insufflation of air with a bulb syringe or proctoscope through the anus can distinguish the sigmoid colon from other segments of bowel; it also properly orients the surgeon to the proximal and distal limbs. A flexible endoscope can also be used for insufflations, and the light of the sigmoidoscope serves as an additional guide to identifying the distal limb.[114] Hellinger et al described a novel technique of gasless laparoscopy to achieve proper orientation during a trephine stoma creation without the use of pneumoperitoneum.[115]

Summary

Creation of an intestinal stoma is a common procedure in surgical practice. The potential for serious complications requiring reoperation or persistent daily patient distress long after the initial operation should not be underestimated. Many complications can be avoided through adherence to meticulous technique, sound surgical principles, and attention to thorough preoperative preparation. Also, patient education and early involvement of skilled WOC nursing play key roles in the management of common stoma-related problems and prevention of their progression.

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