7 Enterocutaneous Fistulas

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Key Points

- The management of enterocutaneous fistulas should be performed according to SNAP (Sepsis, Nutrition, Anatomy, Procedure).
- Timing of reconstructive surgery should be at least 6 months after the last surgery.
- Patients dependent on parenteral nutrition or with metabolic issues require an abdominal reconstruction, if their risk profile is acceptable.
- Abdominal wall reconstruction is essential for successful fistula closure.

Initial Evaluation

The general principle of management of enterocutaneous fistula can be summarized in the acronym SNAP, which represents Sepsis, Nutrition, Anatomy, Procedure.

1. Sepsis
   - Remove cause and control sepsis.
   - Drain abscess cavities.
   - Wound care and skin protection.
2. Nutrition
   - Control fluid and electrolyte intake (restriction depends on fistula output).
   - Total parenteral nutrition/enteral nutrition.
3. Anatomy
   - CT: define abscess cavities.
   - Inside-to-outside contrast video radiography or MR enteroclysis (determine upstream absorption length).
   - Completion of road map as preoperative work-up (MR, colonography, fistulogram).
4. Procedure

Controlling Sepsis

Key Concept: *Initial focus should be on source control, resuscitation, and early antibiotics to reverse the septic process.*

The treatment of abdominal sepsis in the acute setting is characterized by preservation or restoration of organ function to provide adequate perfusion and oxygenation. A rapid sequence in treatment steps involves resuscitation, antimicrobial therapy, and surgery. Resuscitation comprises all measures taken to sustain adequate perfusion and oxygenation. Adequate resuscitation in the first 6 h of a septic shock improves mortality rate significantly [1]. Early administration of antibiotic therapy is of great importance. With every delay of 30 min after the diagnosis, mortality rate increases with an odds ratio of 1.021 (95 % CI 1.003–1.038) [2]. Early administration of antibiotics gives a 33 % relative risk reduction of mortality in patients with bacteremia admitted to the intensive care unit [3]. Empiric antimicrobial therapy should be aimed at expected strains, while there is no preference for one of the various available empiric antibiotic regimes [4]. When culture results and their susceptibility become available, the antibiotic regime should be reviewed once more and, if necessary, adapted. Colonization and infection with yeast and fungi is common in ICU patients, especially with *Candida* spp. [5] A meta-analysis has shown that antifungal prophylaxis is useful in reducing yeast infections in severely ill patients with either a single-drug antifungal prophylaxis (odds ratio 0.54, 95 % CI 0.39–0.75) or with selective bowel decontamination (odds ratio 0.29, 95 % CI 0.18–0.45) [6].

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To prevent one yeast infection, 20 patients have to be treated with single-drug prophylaxis, or 18 patients have to be treated with selective bowel decontamination. Furthermore, mortality rates are lower with antifungal prophylaxis with a combined odds ratio (single-drug or selective bowel decontamination regimes) of 0.23 (95 % CI 0.09–0.60) [6].

Surgery remains the cornerstone for the treatment of peritonitis where elimination of the infectious focus (source control) and prevention of an ongoing infection are key features. This can comprise not only surgical intervention, but also additional measures such as a radiological intervention or the removal of an infected catheter [7]. The underlying condition and the anatomical site causing secondary peritonitis dictate which procedure is most appropriate. Specific surgical techniques used for each condition are not discussed here, as the variety of underlying causes would call for an extensive description, which is beyond the scope of this chapter. Effort must be made to achieve complete source control in the early phase of the disease and in a single surgical procedure. Source control is of greater importance than restoration of normal function and/or anatomy [8]. Rinsing of the abdominal cavity with saline, or even antibiotics, or antiseptic agents in case of an intra-abdominal infection is a common practice in surgery. To the surprise of many, none of the intra-abdominally used solutions have any proven positive effect on the outcome of secondary peritonitis [9], whereas rinsing can damage mesothelial cells which play a key role in the immune reaction [10]. Therefore, the proverb “the solution to pollution is dilution” seems a dogma to divert from. Elimination of the infectious focus makes drain placement unnecessary and potentially harmful. Drain placement in general should be reserved for percutaneous drainage of fluid collections that develop during the postoperative course. In some cases a monitor drain can be useful, such as after primary closure of a duodenal perforation. Just as important, whenever possible, closure of the abdominal cavity (by fascial closure) is important to prevent fluid losses, fistula formation, and permanent abdominal hernia.

Despite adequate source control during the initial emergency laparotomy, a re-laparotomy may sometimes be necessary depending on the patient’s clinical course. In general, only in the setting of clinical deterioration or insufficient improvement in the first few days will a re-laparotomy be performed. This is called the “on-demand” strategy. There are several reasons to prefer the on-demand strategy above the planned re-laparotomy strategy. A meta-analysis of observational studies showed a nonsignificant lower mortality implementing the on-demand strategy (combined odds ratio 0.70, 95 % CI 0.27–1.80) [11]. In 2007 the only randomized trial comparing the on-demand and planned strategies was published (RELAP trial) [12]. For this trial, 510 patients with secondary peritonitis were registered, of which more than half were excluded because of an APACHE-II score ≤10. Two hundred and thirty-two patients were included (116 on-demand and 116 planned re-laparotomy). A nonsignificant lower mortality was found in the on-demand group compared with the planned re-laparotomy group (29 % versus 36 %, $p=0.22$). Even for the most severely ill patients with an APACHE-II score >20, this pattern was observed (Fig. 7.1). This important finding argues against the dogma that the most severely ill patient in particular benefits from the planned re-laparotomy strategy. While sounding

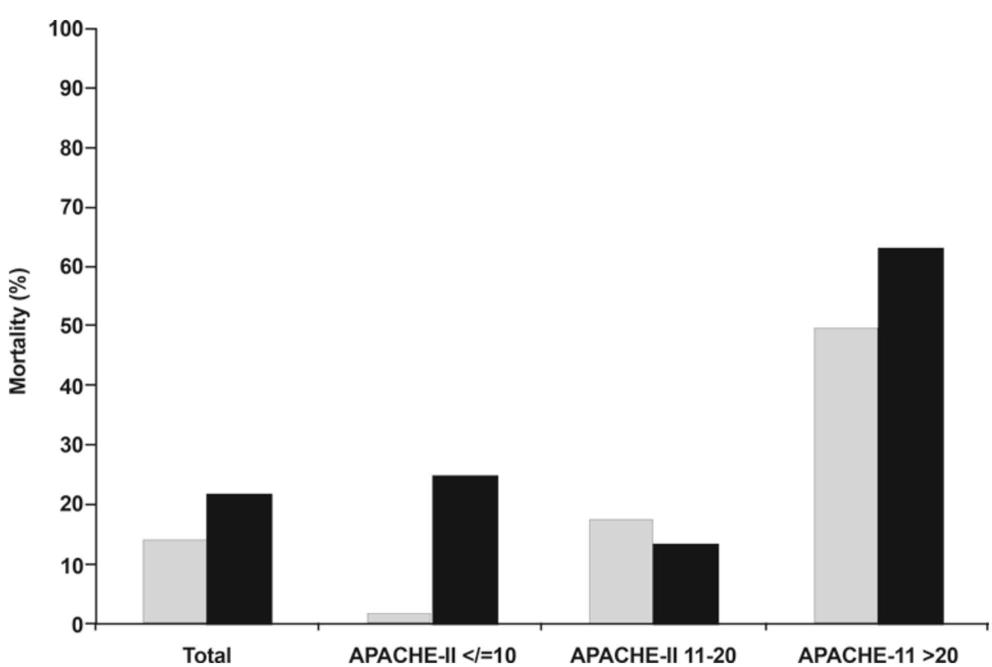

Fig. 7.1 Mortality of secondary peritonitis patients, divided based on the severity of disease expressed by the APACHE-II score. Two surgical strategies were compared per category, re-laparotomy on-demand (□) and planned re-laparotomy (■). A total of 510 patients were registered; patients with an APACHE-II score >10 were randomized in two strata (11–20 and >20) between on-demand and planned re-laparotomy strategy

oversimplified, only the patients that "need" to return to the operating room are those that should be reexplored. Additionally the on-demand strategy significantly decreases healthcare utilization, resulting in a cost reduction of USD 23,000 per patient [13]. Patients treated with the on-demand strategy are admitted shorter to the ICU and hospital. Less repeat laparotomies are performed in the on-demand group and 113 versus 233 in the planned re-laparotomy group. Furthermore, the rate of unnecessary re-laparotomies was significantly lower in the on-demand group compared with the planned re-laparotomy group (31 % versus 66 %, $p < 0.001$).

The acute phase of abdominal sepsis may at some point lead to the development of an enterocutaneous fistula or even several fistulas. Factors that contribute to this unfortunate course of disease are:

- Ongoing peritonitis, in particular when combined with multiple laparotomies within a short period of time
- A bowel anastomosis *in situ*
- Open abdomen
- Inadequate drainage of intra-abdominal abscesses or infected fluid collections
- Synthetic meshes in contaminated environment used as bridging or inlay and meshes of whatever material when positioned as an inlay

When an enterocutaneous fistula has developed, it is important to verify whether there is an ongoing intra-abdominal infection. Certainly in the case of a fistula that has a tract from intestine to abdominal wall, remaining abscesses of infected fluid collections have devastating effects. Imaging work-up in this situation should be performed by contrast-enhanced computed tomography (CT). Intravenous contrast is needed in a septic patient, even when renal function is compromised, since an inadequate diagnosis is in the end more harmful than the risk of increased renal insufficiency related to use of contrast. Use of oral contrast that can be applied via the nasogastric tube can enhance CT accuracy in specific cases, although the gain in diagnostic accuracy is limited. Therefore, paralytic ileus that frequently accompanies abdominal sepsis—hampering enteral contrast work-up—should not delay CT imaging.

Thus far, reliable CT accuracy data come from patients suspected of having secondary peritonitis after elective abdominal surgery. The positive predictive value of CT to detect an abdominal source of sepsis (ruling in) is 71 % (95 % CI 57–83 %), leaving a margin of error. However, the negative predictive value for an abdominal source of sepsis (ruling out) is 15 % (95 % CI 6–32 %) making it a reliable modality [14]. In contrast, there are no data on the accuracy of CT after an initial operation for peritonitis and none in the setting of an open abdomen. For fistulas in an open abdomen setting, without any tract, imaging of the fistula is a less pressing matter initially. Harm has been done with early aggressive attempts at closing the fistula, and spontaneous closure of open abdomen fistulas is anecdotal. It is more important to focus on sepsis control.

Overall, antibiotics are usually not indicated merely because of fistulas. Use of antibiotics after the initial event of abdominal sepsis should be reserved for ongoing or new-onset peritonitis or during (percutaneous) drainage in a septic patient, preferably based on previous culture results and resistance pattern.

Managing Patient Expectations and the Importance of "Patience"

Key Concept: *Surgeons need to avoid the temptation to rush patients back to the operating room for an attempt to close the enterocutaneous fistula. Explaining the usual extended timeline to the patient and family will be helpful to controlling emotions and managing expectations.*

Fistulas usually develop after multiple laparotomies, in an open abdomen, and days after the initial septic event. As a rule of thumb, re-laparotomy for a fistula more than 7–10 days and less than 6 months after previous laparotomy, after multiple recent re-laparotomies, or in case of an open abdomen, is not advised. This means that, in general, the moment intestinal fluid is seen coming out of the laparotomy wound (after fascial closure), a drain, an old drain opening, or the open abdomen, surgery is not an option at that time. This should be made clear to the patient, family, and other involved doctors such as intensivists. Although tempting, any additional surgery in the first phase of a fistula to treat this fistula is a futile attempt and should be avoided. Remember that "early fistula surgery is for the surgeon not for the patient; we surgeons need to be patient."

Initial fistula management comprises restoring and monitoring of fluid and electrolyte balance, adequate nutrition, and wound care. Apart from CT in case of clinical suspicion of ongoing infection, no imaging of the fistula tract is needed or desirable. The only exception to this rule is leakage or fistulas from the proximal gastrointestinal tract, such as from a surgically closed duodenal perforation or biliary leakage such as leakage from a hepaticojejunostomy or after cholecystectomy. In these cases a percutaneous transhepatic catheter (PTC) drainage is very effective, and after cholecystectomy endoscopic retrograde cholangiography (ERC) and stenting may provide source control.

Wound management should focus on skin protection, using modern wound management systems, which collect fistula fluid and at the same time allow granulation and (near) closure of the wound. Figure 7.2 shows an example of inadequate wound management in the presence of a fistula. Other ways to protect the skin are reduction of fistula production and fluid composition (see section "Rehabilitation phase").

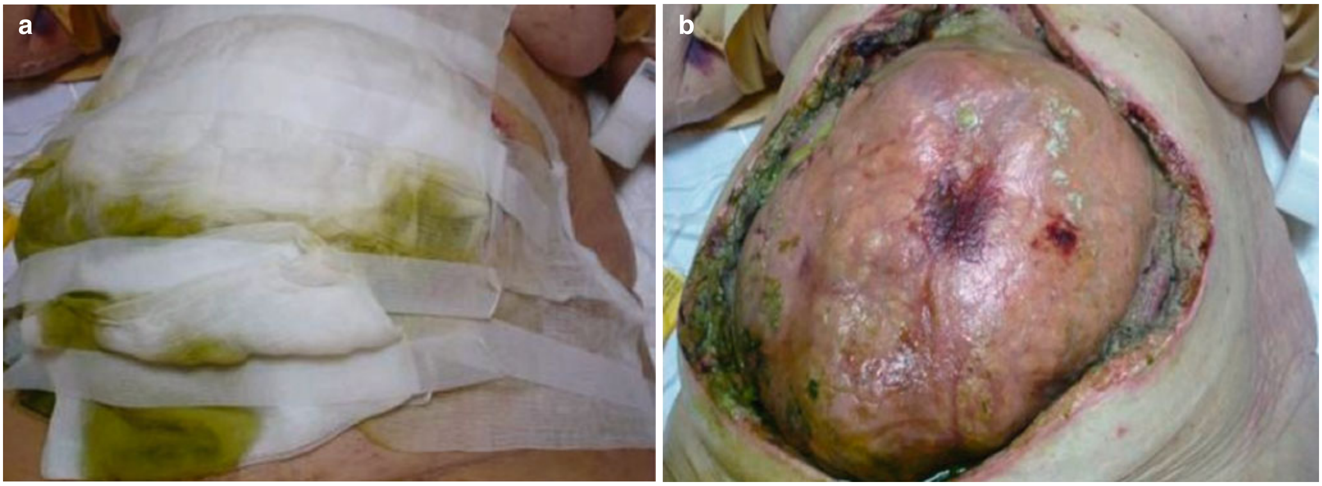

Fig. 7.2 Inadequate wound management of fistula in open abdomen

Evaluation of the Fistula

Defining the Anatomy

Key Concept: *In the phase II stabilization period*, *in absence of ongoing sepsis*, *defining the fistula anatomy can be performed with the aid of a small bowel contrast studies*, *CT*, *or preferably*, *MR enteroclysis*.

During phase I (≤2 days after its presentation) of enterocutaneous fistula management, focus is on its diagnosis and evaluation of coexisting ongoing peritonitis, as has been described in the previous paragraph. The diagnosis of a fistula can be relatively simple if evident bowel content is seen in wound or drain or open abdomen. Usually we can deduce the most likely cause of this leakage, i.e., anastomotic leakage, leakage from a primary closed duodenal perforation, leakage from an oversewn iatrogenic bowel injury, bile leakage, and open rectum stump. In most cases we can only have a fair guess toward the origin of the fistula. During phase I, this is typically all the information required to determine an action plan, as the radiological evaluation is predominantly a CT directed at the detection of a coexisting ongoing infection as an underlying cause of the fistula or as a mechanism that prohibits fistula closure. The old practice of instilling methylene blue via a gastric tube is not very informative and should be abandoned in an era of modern imaging.

During phase II, the stabilization phase (≤10–14 days), focus is on fluid, metabolic and electrolyte balance, adequate nutrition, and wound care. Percutaneous drainage of an intra-abdominal abscess may still play a role in this phase. When untreated infections or non-drained abscesses are no longer an issue, it is time to have a more exact location of the fistula. This is done by "inside-to-outside" contrast imaging and not by fistulogram ("outside-to-inside" contrast imaging). Manipulation in the fistula is not helpful for accurate localization and likely to disturb any potential for spontaneous closure. A fistulogram with water-soluble contrast no longer is considered the "gold standard" for examining a fistula. Inside-to-outside contrast imaging can comprise small bowel contrast radiography with contrast administered via a post-pyloric tube or by mouth, or MR enteroclysis, if the patient's condition allows. The advantage of MR enteroclysis is that it provides a clear image of the fistula tract as well as the surrounding tissues and any abscess cavity connected to the fistula tract. For initial imaging of a proximal fistula during phase II, contrast radiography usually suffices. In this phase (1) the length of the intestinal tract proximal to the (first) fistula and (2) the length of the fistula tract from intestine to abdominal wall/"outside world" are the primary information needed to determine whether (a) enteral feeding is of any use with respect to absorption length and (b) enteral feeding is feasible with respect to location (e.g., duodenal leak versus fistula of the ileum) and chances of spontaneous closure (e.g., long fistula tract versus fistula in open abdomen). For ICU patients these modalities can be replaced by enteral and intravenous contrast-enhanced CT, but visualization of the fistula anatomy and origin is less clear. For suspicion of a fistula of colonic origin, enteral and intravenous contrast-enhanced CT may be helpful or more feasible and sensitive in this stage than contrast radiography of the colon.

Endoscopy can also be helpful in determining the origin of the disease that caused the fistula, but it is not a particularly helpful or necessary study to reveal a fistula. Biopsy samples could be useful if inflammatory bowel disease, radiation enteritis, or malignancy is suspected. In specific cases with a very proximal, (e.g., esophageal) or very distal (e.g., rectal) origin of a fistula, endoscopy may be useful because of the possibility of endoscopic therapy. Nevertheless, endoscopy should not be considered as a first-step diagnostic tool. Examples of endoscopic fistula therapy are bridging stents in the esophagus or transrectal endoscopic drainage or local vacuum sponge treatment. For gastric and duodenal fistulas, contrast imaging is preferred over endoscopy, as endoscopic fistula therapy does not play a major role in these locations.

Nutritional Support

Key Concept: *Adequate nutritional support through both the enteral or parenteral route is paramount for both an attempt of spontaneous closure as well as preparation for operative intervention*, *if required*.

Intestinal failure due to an enterocutaneous fistula is caused by a functional short bowel syndrome. In this situation, the absolute bowel length may be adequate; however, the absorption capacity is only relevant in the intestine proximal from the fistula. The small bowel distal from the fistula is, for all practical purposes, defunctionalized. Therefore, intestinal failure typically presents as malabsorption leading to intractable diarrhea (or output), dehydration (secondary to high-output losses), malnutrition, and weight loss. Total parenteral nutrition (TPN) is the mainstay of therapy for patients with intestinal failure and in particular for those with high-output fistulas, distal obstruction, and ongoing sepsis. TPN maintains good nutritional status and control of fluid, calorie, nitrogen, and electrolyte intake. Moreover, output reduction by TPN reduces wound care problems and risk of dehydration. TPN reduces the maximal secretory capacity of the gastrointestinal tract by 30–50 %. Malnutrition is often a silent, but significant, cause of morbidity and mortality in patients with enterocutaneous fistulas. An additional great advantage of TPN is that it is independent of fistula anatomy.

While the practice of TPN for enterocutaneous fistula has been adopted widely, even for high-output fistulas, additional enteral feeding is beneficial. The primary role of nutritional support, whether enteral or parenteral, is the prevention of malnutrition. Randomized trials investigating outcomes in patients kept "nil by mouth" have not been performed. In fact, it has never been proven that fistula closure rates improve dramatically with TPN compared to enteral nutrition. The concept of "bowel rest" has been based largely on the observation of output reduction, yet output reduction has never been proven to be related to fistula closure [15].

When comparing the oral and intravenous routes, the advantages of enteral nutrition include avoidance of catheter-related complications (sepsis, thrombosis), trophic effect on bowel mucosa, support of immunological and barrier functions of the gut, reduced risk of bacterial translocation, and stimulation of bowel adaptation. Enteral nutrition should be used whenever possible, to some extent, although high-output small bowel fistulas as a rule require supplemental parenteral nutrition to prevent malnutrition and manage output.

Fistuloclysis (i.e., feeding distal to the fistula) is believed to prevent atrophy of the small intestine distal to an enterocutaneous fistula and is performed by placing a feeding catheter into the fistula opening. Some surgeons also believe that subsequent reconstructive surgery is made technically easier, though that statement has never been substantiated. Provided there is more than 75 cm of healthy small intestine available downstream for absorption distal to the fistula opening [16], fistuloclysis makes theoretical sense from a nutritional standpoint and may indeed prevent mucosal atrophy. However, in clinical practice, the enormous effort to provide this fistula feeding often does not outweigh its disadvantages, such as additional wound care difficulties, decreased mobilization of the patient, relatively limited contribution to overall nutrient demand (e.g., feeding the distal ileum has limited nutrient absorption), and unpredictable absorption of nutrients. Therefore, the practitioner must consider the reality that distal feeding does not provide adequate, predictable, and balanced nutrition, whereas TPN combined with proximal enteral feeding does.

Postoperative Nutrition

Key Concept: *Intravenous nutrition requirements continue even after definitive surgery due to problems with absorption until adaptation is complete*.

It is important to remember that after fistula surgery the downstream part of the intestine has limited function for a prolonged period of time. Although some enteral nutrition is still possible and preferable, resorption of enteral nutrients is not optimal until after the postoperative adaptation phase with intestinal mucosal restoration. Therefore, postoperative TPN is essential to ensure adequate nutrient intake without the pressure of enteral intake to fulfill this need.

Rehabilitation Phase

How to Control Fistula Output and Role of Adjunctive Medications

Key Concept: *Several classes of medications are available and often required to reduce fistula output*.

The standard regimen to reduce fistula output, if needed, is the use of high-dose antidiarrheals in a combination of loperamide, codeine, and proton pump inhibitors (PPIs). Loperamide acts in the gastrointestinal tract on both cholinergic and noncholinergic mechanisms, thereby decreasing the activity of both longitudinal and circular muscles. Codeine sulfate is an opioid analgesic with weak analgesic properties. Yet its "side effects" include an ability to decrease gastric, biliary, and pancreatic secretions; cause a reduction in motility; and are associated with an increase in tone in the gastric antrum and the duodenum. Digestion in the small intestine is delayed, and propulsive contractions are decreased. Codeine can cause a spasm of the sphincter of Oddi, thereby increasing biliary tract pressure. PPIs are lipophilic weak bases that cross the parietal cell membrane and enter the acidic parietal cell canaliculus. In this acidic environment, the PPI becomes protonated, producing the activated sulfenamide form of the drug that binds covalently with the H^+/K^+ ATPase enzyme that results in irreversible inhibition of acid secretion by the proton pump. PPIs pantoprazole, esomeprazole, and rabeprazole were more effective in increasing gastric pH and decreasing gastric volume than omeprazole [17]. It is our general practice, after a short period observing natural behavior of the fistula, to start with loperamide, a PPI, and codeine.

Cholestyramine can be added to this regimen, in particular when corrosive action of fistula output creates a wound care problem. Cholestyramine is a chloride salt of a strongly basic non-digestible anion-exchange resin used as a bile salt sequestrant. It binds to bile acids in the intestine to form an insoluble complex, which is excreted in the feces.

It should be especially noted that bulk-forming laxatives are not part of the standard regimen of medical treatment of high-output fistulas. These agents absorb water and cause a softening of stool mass. In addition, the bulk-forming laxatives cause an enlargement of the stools that stimulates propulsive movements in the GI tract and encourages the passage of intestinal contents.

Somatostatin analogues inhibit the release of gastrin, cholecystokinin, secretin, motilin, and other gastrointestinal hormones. This results in a decreased secretion of bicarbonate, water, and pancreatic enzymes into the intestine and an increased water and electrolyte absorption, thereby reducing the intestinal fluid volume. Moreover, analogues relax intestinal smooth muscle, which increases the intestinal capacity. For somatostatin and somatostatin analogues such as octreotide, there is no equivocal evidence that closure rate is improved. In a recent meta-analysis that included randomized trials comparing somatostatin or one of its analogues with control treatment, closure rates are improved by the somatostatin analogues octreotide (5 trials) and lanreotide (1 trial) (RR 1.36 (95 % CI 1.12–1.63); $I^2 = 47$ %) [18]. This effect is dominated by the results of the two largest trials comprising 192 of 307 pooled patients and including not only 114 small bowel fistulas, but as much as 101 pancreatic and gastric fistulas. The pooled effect of somatostatin is hampered by heterogeneous results ($I^2 = 84$ %). There is conflicting evidence about its capacity, on top of standard regimen, to reduce output and time to spontaneous closure. We primarily use somatostatin in the setting of high-output fistula despite adequate loperamide, PPIs, and codeine causing fluid and electrolyte disturbances and wound care problems.

Creative Ways for Wound Care

Key Concept: *Due to the nature of these wounds, often you are required to think "outside of the box" for innovative solutions to control effluent and protect the skin.*

Various solutions can be applied for wound management of high-output fistula. Wound management systems (Fig. 7.3) and negative pressure wound therapy (NPWT) systems with either foam (Fig. 7.4) or gauzes (Fig. 7.5) deliver excellent solutions. In general, wound care in patients with enterocutaneous fistula is tailor-made, and choices must be made per patient, depending on output, localization, abdominal shape, and skin folds. These include wound appliances that can be cut to shape, suction catheters, and adhesive paste dressings to build up or flatten irregularly shaped wounds. When available, often the incorporation of wound care or enterostomal therapist provides additional knowledge and experience that are invaluable to this aspect of care of ECF patients.

Dealing with Medications for Underlying Disease

Key Concept: *While fistulas in the setting of active Crohn's disease may close with immunosuppressive therapy, in general the diseased section of bowel needs to be removed.*

The presence of Crohn's disease, diverticulitis, cancer, or radiation enteritis in the segment of bowel related to the enterocutaneous fistula is a poor prognostic factor. As a rule of thumb, the fistula will never close as long as the diseased segment is in place. Most enterocutaneous fistulas in the setting of Crohn's disease are postoperative fistula due to a sealed anastomotic leak. Spontaneous fistula in Crohn's disease might close with medical therapy using anti-TNF agents. A systematic review Ford et al. indicated that the number needed to treat to obtain remission is one patient in eight for all anti-TNF agents and four for infliximab [19]. So, definite closure of the fistula is achieved only in some at the expense of expensive maintenance therapy. Surgical resection of the diseased segment is mostly required after optimization of the patient.

Fig. 7.3 Examples of tailor-made fistula wound care. (**a**) A deeper laying enterocutaneous fistula with a skin wall. (**b**) Solution for the (here shown) massive, painful skin erosion caused by fistula effluent (We thank Yvonne Lutgens, specialist nurse, Academic Medical Center (AMC), Amsterdam, for these pictures)


a
b

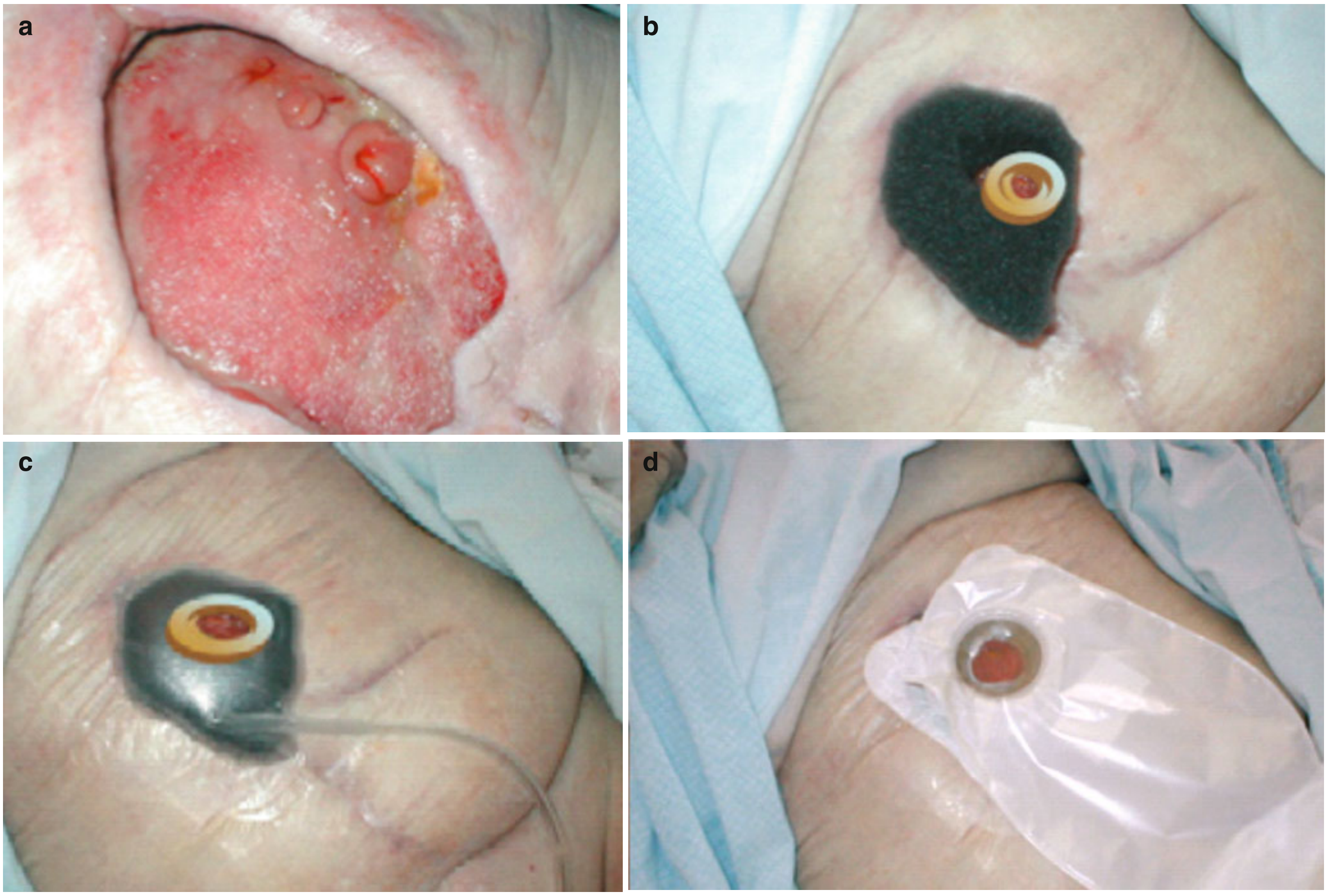

Fig. 7.4 V.A.C. ® negative pressure wound therapy to isolate the fistula. (**a**) View of granulating open abdomen with fistula. Wound care by V.A.C. ® (KCI) negative pressure wound therapy (NPWT) system to isolate the fistula. (**b**) Create a donut of petroleum gauze allowing for a clear 1 cm margin around fistula mouth. (**c**) Invert a stoma ring into a cone to sit inside donut with fistula mouth clearly visible. V.A.C.® GranuFoam™ Dressing to cover wound bed appropriately without overlapping donut. (**d**) Successful fistula isolation with stoma bag applied on top to collect secretions (We thank Chris Borsten, KCI Medical, Houten, the Netherlands, for these pictures)

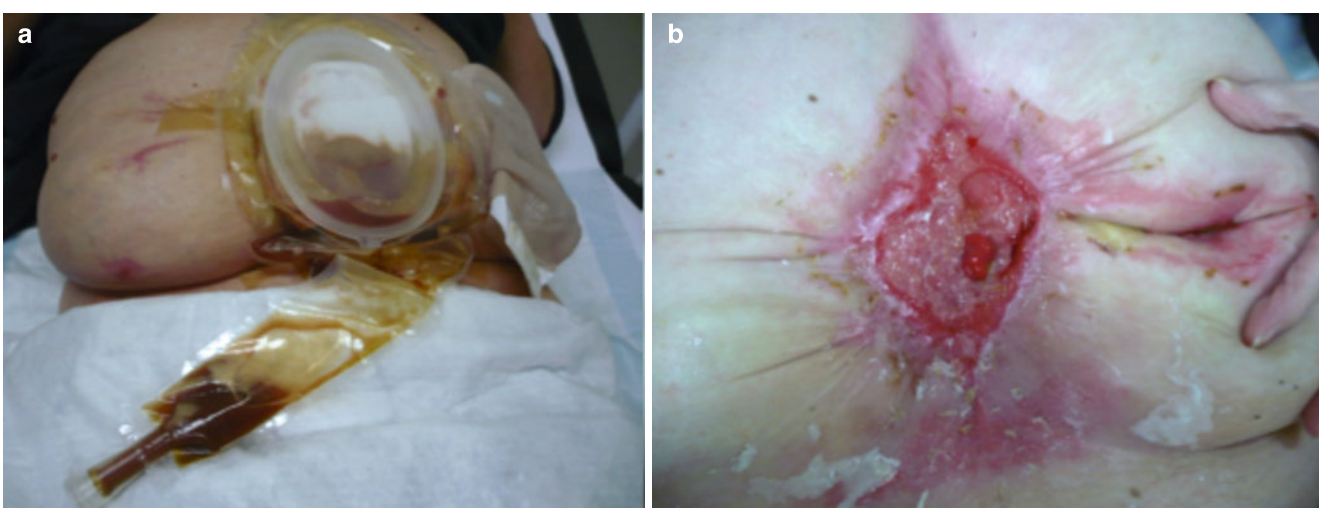

Fig. 7.5 Avance ® gauze negative pressure wound therapy to isolate the fistula. (**a**) Standard wound manager leaks in sitting position, twice a day. (**b**) View of granulating open abdomen with fistula and clear corrosive injury, on patient's left side a stoma is seen. (**c**, **d**) Wound care was changed to hydrocolloid with (Avance ®, Mölnlycke) gauze negative pressure wound therapy (NPWT) system to isolate the fistula. (**e**) On top a two-part stoma system. (**f**) 60 mmHg negative pressure on fistula environment, fistula itself is isolated from negative pressure (We thank Yvonne Lutgens, specialist nurse, Academic Medical Center (AMC), Amsterdam, for the photographs)

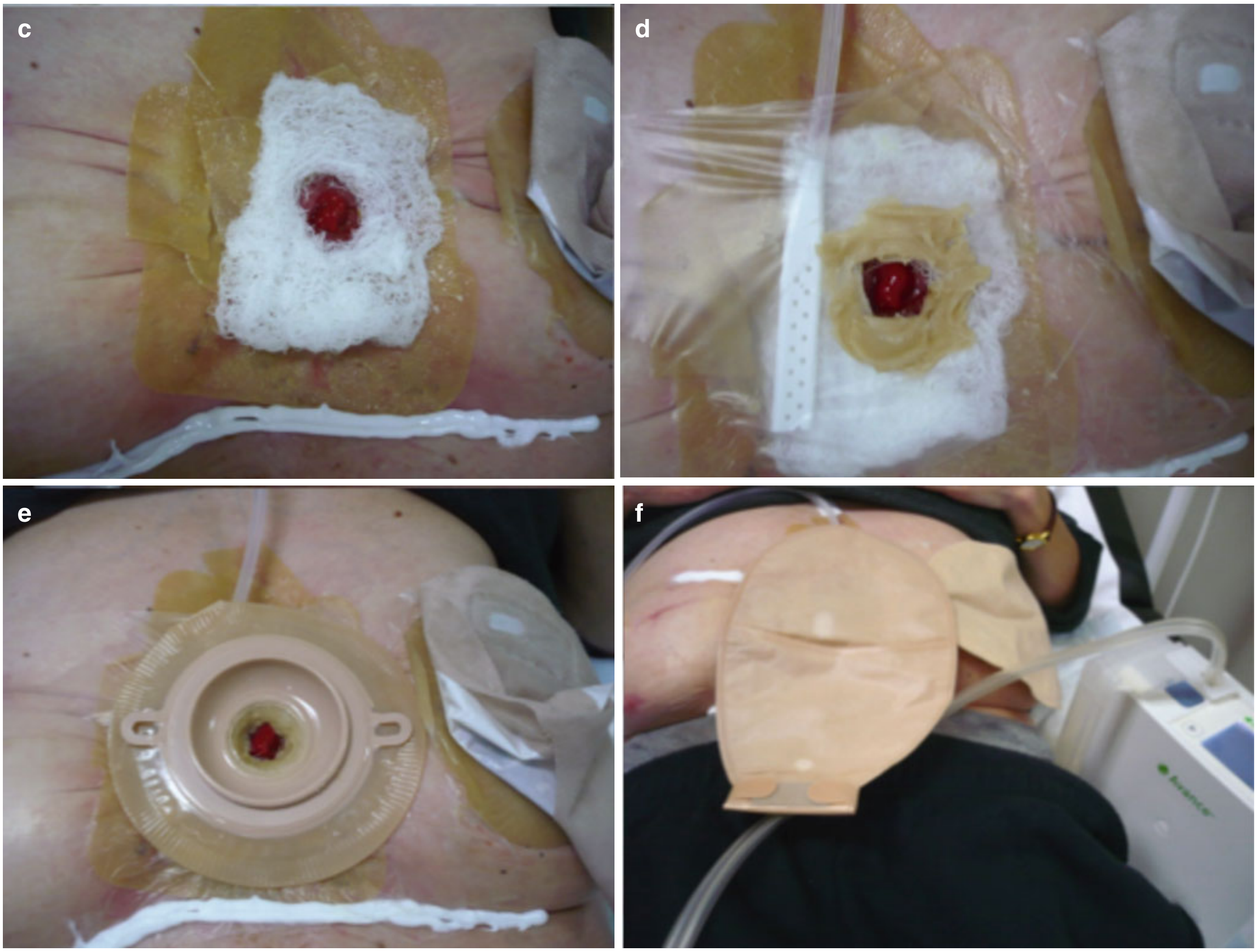

Fig. 7.5 (continued)

Surgical Evaluation

Spontaneous Closure or Not?

Key Concept: *Spontaneous closure of an ECF is widely variable, with several underlying factors that help to predict a high or low likelihood.*

Overall, a 7–70 % spontaneous closure rate is reported for ECF [15, 20, 21]. Of spontaneous closing enterocutaneous fistulas, the vast majority close within 4–12 weeks of conservative treatment [15]. In general, these fistulas are simple lateral fistulas arising from small bowel anastomotic leaks within otherwise normal bowel. Fistula closure is unlikely with foreign body, diseased bowel (radiation enteritis, malignancy, Crohn's disease), epithelialization of the fistula tract, a short fistula tract (<2 cm), distal obstruction, eversion of mucosa in the wound, sepsis, high output, malnutrition, unfavorable fistula site (stomach, duodenum, proximal jejunum, ileum), and complicated lateral fistula (from an infected segment or with surrounding infiltrate). Favorable fistula features are as follows: no underlying bowel disease, long fistula tract, no sepsis, low output, well nourished, and favorable fistula site (esophageal, duodenal stump, pancreaticobiliary, colon).

Timing of Operation

Key Concept: *Waiting at least 6 months to operate on ECF is associated with better outcomes. During this time, full optimization and planning are crucial to overall success.*

In general, the rule of thumb for timing of surgery of a recent enterocutaneous fistula is "not now!" Optimal timing of definitive surgical intervention is at least 6 months after the last laparotomy or last sign of ongoing intra-abdominal infection. Early surgery for enterocutaneous fistula is associated with more recurrent fistula [20, 22]. In addition, physical examination findings that suggest optimal timing include fistulas with mucocutaneous continuity should begin to protrude

Fig. 7.6 Protruding fistula as a sign for optimal timing of surgery

(Fig. 7.6) and the abdomen is more mobile on palpation (the London University College Hospital groups call this the "wobbliness sign"). Classically you can lift the scar tissue covering the laparostomy from the underlying (intra-abdominal) bowel. The patient must be fully optimized conditionally, medically, and nutritionally prior to reconstructive surgery.

Also prior to surgery, a complete road map of the gastrointestinal tract is very helpful for guidance in operative strategy planning and to prevent preoperative surprises or oversights of additional fistula or downstream obstructions. Although complete adhesiolysis is an essential part of successful reconstructive surgery, in some cases part of the intestinal windings cannot be entangled—in particular in the pelvic region—without a too high risk of bowel lesions. A reliable road map of the intestinal tract reduces the risk that in those areas bowel obstructions are overseen. An ideal surgical work-up consists of small bowel contrast radiography with contrast administered via a post-pyloric tube (or by mouth in case of a very proximal fistula) or MR enteroclysis (presently the preferred imaging technique), colonography (if the colon may be reconnected in the intestinal tract), and a fistulogram (if MR enteroclysis does not provide a complete small bowel road map). Frequently bowel length is found to be different from what has been reported in medical records. Key messages of the surgical work-up are summarized in Fig. 7.7.

Reviewing the Prior Operative Notes: Does It Help?

Key Concept: Review of all the original reports provides insight into not only what you may encounter, but also helps avoid pitfalls and repetition of interpretation mistakes.

KEY MESSAGES

- Bridging to surgery > 6 months
- At home not in hospital (intestinal failure team can assist)
- Start from scratch - original documentation
- Intestinal road mapping
- Further work-up, e.g. vascular

Fig. 7.7 Key messages of surgical work-up

Reviewing of important documentation in its original form is very essential not to follow the same slippery path that has led to the development of intestinal fistulas in a patient. This means that a discharge letter may be informative, but cannot be the only source of information. Apart from clarity about segments of bowel removed, also information about the position and anatomy of anastomoses is extremely important.

For example, a 52-year-old female was referred to our intestinal failure clinic to evaluate surgical options given her short bowel. She had received daily TPN for 3 years at the time of her referral. According to her medical records, she had about 140 cm of small intestine left, ending on an enterostomy, and her colon had been removed. The length of the rectosigmoid stump was not mentioned explicitly. To evaluate reconstructive options, a MR enteroclysis was performed and a colonography (Fig. 7.8). Total intestinal length on imaging was estimated to be well over 200 cm and a complete colon was in situ. After surgical restoration of intestinal continuity and an adaptation period, TPN was no longer needed.

Techniques

Preoperative Preparation

Key Concept: Planning out all aspects of surgery, from the opening incision to the need for reconstruction of the abdominal wall at closure, will aid in minimizing complications and avoid surprises.

When approaching the complex abdomen, sufficient preoperative planning is of great importance. This involves an assess-

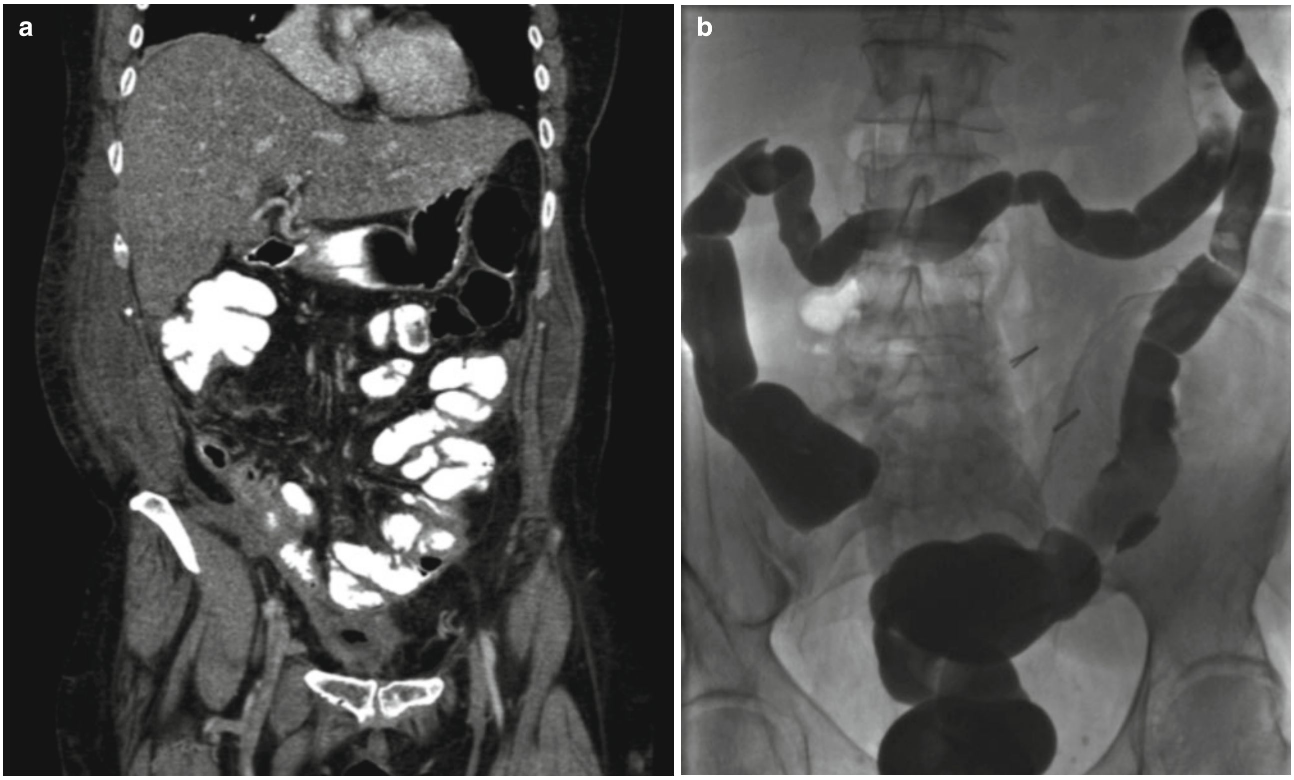

Fig. 7.8 MR entercolysis (**a**) and colonography (**b**) as part of a road map work-up of a short bowel patient, discovering much more bowel length than documented

ment of multiple different components of the surgery, including the ofttimes most important determination of where to start attempting to enter the abdomen safely. In addition, preoperative evaluation of the need of abdominal wall reconstruction helps in assessing the requirement of special meshes. Patients recovered from an abdominal disaster generally have an incisional hernia covered with either granulation tissue (plastron), a split skin, or subcutaneous fat with skin. CT or MR of the abdomen can tell you where there is a safe place to start entering the abdomen (i.e., where there is no bowel below the surface). If no safe place can be found, the abdomen can best be entered subxiphoidally in the upper midline, where most likely the liver or the stomach will be encountered first. In general, entering below the xyphoid is the best option for safe entry.

Imaging can also show you the separation of the rectal muscle indicating whether abdominal wall reconstruction is necessary. It helps to determine whether the abdominal wall can be closed using a component separation technique either with "reinforcement" with a mesh or whether the remaining defect even after extensive mobilization needs to be "bridged" by a biological mesh [23].

Surgical Approach

Key Concept: *The tool kit of technical success comprises of meticulous technique*, *adhesiolysis under visual control of separate bowel loops*, *and covering repaired or re-anastomosed bowel parts with visceral peritoneum from healthy organs* (*i.e.*, *omentum*, *small bowel*, *mesentery*). *Abdominal wall reconstruction and closure of the abdominal cavity is paramount*.

The overlying skin is incised at the predetermined place. The abdominal cavity is carefully reached by pulling up the subcutaneous edges with Kocher or Ochsner clamps. Once inside, fascial edges are clamped and the skin is incised, excising the plastron (i.e., the remains of the open abdomen composed of granulation tissue and underlying bowel and omentum) step by step by detaching it from the underlying small bowel. This must be performed under visual control, identifying bowel loops stuck underneath before cutting the skin. Avoid incising the skin on the fingertip, because sometimes it is difficult to feel the presence of a collapsed atrophic small bowel loop with the finger. The plastron is excised including the fistula openings.

If an ostomy is present, and if it is planned to close or revise, the procedure can be initiated with dissecting the ostomy free from its position on the abdomen in order to find a safe entrance via the ostomy site. Adhesions should be lysed where this can be done easily. Leave the difficult part of adhesiolysis for later. If surrounding loops are lysed, the difficult part will become easier. Try to isolate one small bowel loop at a time, and use the antimesenteric site of the bowel to stay in the right plane (no fat there). Lyse bowel loops separately and not "en masse." Most often, the small bowel loops are stuck to the skin or plastron. If it is not safe to lyse the bowel from the plastron, one can leave parts of the plastron on the bowel as long as it has no skin.

Repair serosal defects immediately after lyses of the affected loop, or mark them with a suture for later repair. Later on during the procedure, these defects might be difficult to find or one might forget altogether, leading to further fistula or sepsis. We prefer to use a flexible monofilament like a PDS 4-0. This suture is the least traumatic to the friable bowel. Vicryl sutures are traumatic and resolve rapidly. Position the stitches seromuscularly; avoid full-thickness bites oversewing seromuscular defects. A serosal defect might become a transmural defect if the sutures are full thickness. If the anatomy is unclear, a full adhesiolysis might be necessary. Otherwise it is best to avoid unnecessary high-risk adhesiolysis.

Sometimes it is easier to find the right plane of adhesiolysis by turning the bowel loop around. The plane between the loops might be easier to identify from the back. Staying in the proper plane is of great importance to avoid serosal defects and bleeding. Use a pair of scissors with a blunt tip pushing and cutting the tissue forward rather than cutting through the tissue right away.

Pay particular attention to full-thickness lesions, as these should be repaired meticulously. Two-layer closure with interrupted 4-0 Vicryl followed by a running 4-0 PDS might be necessary. These repaired lesions must be covered with undamaged organs like omentum, small bowel, or colon to separate them from other repaired defects or anastomoses and the abdominal wall incision. Never leave the sutured defects exposed to the suture midline incision or a mesh.

The fistula opening in the bowel must be excised and closed, rather than simply oversewn, in order to prevent recurrent fistula. Usually a segmental resection with anastomosis is required [24]. An anastomosis needs to be covered by visceral peritoneum, whenever possible, and should not in any case be positioned adjacent to the laparotomy wound, which increases the risk of a recurrent fistula. A good place to "hide" an anastomosis of the small intestine is close to the mesocolon or covered by omentum. Also, other intestinal loops are ideal for covering an anastomosis. Full abdominal wall closure is essential to reduce the risk of recurrent fistulas or anastomotic leakage. In other words, an open abdomen does not combine with fistula repair, ever.

Abdominal Wall Reconstruction

Key Concept: *Abdominal wall reconstruction is a regular aspect of managing ECF patients, and surgeons should be facile with or involve someone with experience and knowledge with these techniques.*

Rarely, the abdominal wall can be closed without tension. Mostly, a one- or double-sided component separation technique must be applied to bring the rectal muscles together. Before suturing the wound edges, they must be cleaned of peritoneum and fatty tissue. These structures do not support the abdominal wall reconstruction and might become necrotic, giving rise to a higher chance of infection and dehiscence. Use a flexible, slowly absorbable, monofilament polydioxanone (PDS) 0 or PDS 1 with a circle taper (CT) or tapercut needle to avoid unnecessary large holes in the fascia. When tightening the sutures, they should be pulled in the direction of their exit of the tissue. Otherwise, holes in the fascia will be torn at the site of the exit of the sutures.

In many cases, either reinforcement (Fig. 7.9) or bridging (Fig. 7.10) with a mesh is necessary. The choice of mesh depends on the level of contamination, the location of the mesh (Fig. 7.9; onlay, sublay, or intraperitoneal), and whether it is used to reinforce or to bridge. Muscle (skin) flaps are rarely necessary and require the availability of a plastic surgeon. A considerable increase in the morbidity rate of the donor site of flap repairs must be anticipated, when required. Unfortunately, evidence is lacking which techniques and meshes are best used to close the abdominal defects [23].

Onlay reinforcement can be done using Vicryl meshes (temporary) in largely contaminated conditions or by using biologicals such as Strattice™ (LifeCell, Bridgewater, NJ), Permacol™ (Covidien, Mansfield, MA), or Surgisis® Biodesign™ (Cook Medical, Bloomington, IN). If a sublay reinforcement is possible, a lightweight polypropylene mesh is the most cost-effective solution. If the abdominal wall cannot be closed, the defect is best bridged by a (intraperitoneal) biological mesh. All bridging meshes must be fixed using full-thickness transmuscular/transfascial PDS (or Prolene) sutures with a circle taper needle placed at some distance from the mesh using them as tension wires to pull the mesh flat and tight. Excellent results have been documented in the RICH study, examining the use of Strattice™ non-cross-linked biomesh in challenging abdomens, i.e., contaminated ventral hernias [25]. It is of note that only 4 % of included patients also had fistulas.

The component separation technique is always accompanied by an extensive subcutaneous wound, where fluids can readily accumulate. Large suction drains are therefore advised on both sides of the abdomen. Complication rate of abdominal reconstructions is high, up to 90 % in some reports. Thankfully, the majority of the morbidity is caused by superficial wound infection that can be readily treated. Minimal invasive and endoscopic techniques have been described to perform the component separation technique to avoid the extensive subcutaneous wound and its associated morbidity [26–28].

Dealing with a Stoma

Key Concept: *Having a plan for a new stoma or how to deal with the wound following takedown of a present one is paramount when considering reconstruction of the abdominal wall.*

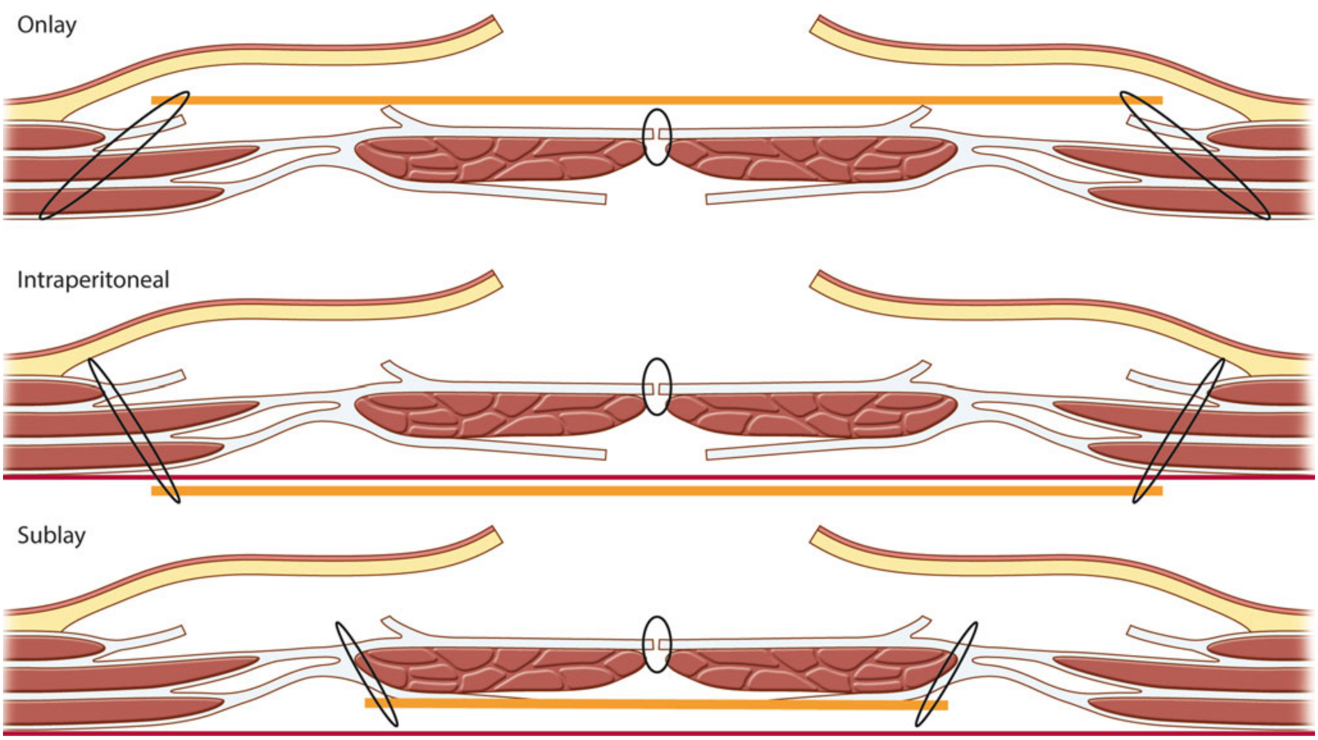

Fig. 7.9 Reinforcement with mesh after component separation technique in three different positions only, intraperitoneal and sublay. Full-thickness sutures fixate the mesh acting as tension wires

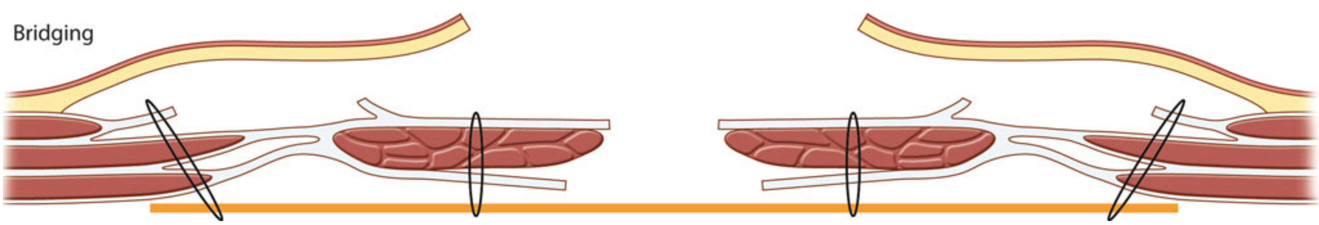

Fig. 7.10 The component separation technique has been insufficient to bring the abdominal wall together. The mesh is used to close the gap (bridging)

The objective of the abdominal reconstruction is to close all fistulas and ostomies and reconstruct the abdominal wall. Abdominal reconstruction is hindered by ostomies, although ostomies can traverse meshes if necessary. Primary surgery encompassing low anterior anastomoses or ileoanal anastomoses will mostly require a defunctioning ileostomy. In surgery for the complex abdomen, defunctioning of low anastomoses is therefore an absolute necessity.

Follow-up

Postoperative Management

Key Concept: *Having a pathway that involves plans for wound care, drain management, nutrition support, and physical therapy is crucial to minimizing complications.*

(a) *Antibiotics*: There is no evidence of any benefit of prolonged perioperative administration of antibiotics. A prophylactic schedule is advised (typically ≤24 h). Only in the case of gross contamination should a therapeutic schedule be given.

(b) *Feeding*: If given parenteral nutrition preoperatively, this should be continued until the patient is able to tolerate sufficient enteral feeding. According to the Enhanced Recovery After Surgery (ERAS) principles, the oral intake can be advanced as soon as tolerated [29]. Anticipating a higher chance of postoperative ileus due to extensive adhesiolysis, one might limit this to fluids and protein-enriched drinks in the first days after surgery. Importantly, the part of the intestine downstream from the fistula is atrophic and postoperatively has limited function for a prolonged period of time. A bridging period with TPN is frequently necessary to allow the downstream intestine to adapt.

(c) *Mobilization*: According to the ERAS principles, the patient is encouraged to start mobilizing as soon as possible, though venothromboembolic (VTE/DVT) prophylaxis is warranted.

(d) *Suction drains*: Evidence is lacking how long these drains should be in place. In general, it is our practice that they can be removed if the production is reduced to 50 mL per day or with a maximum of 5 days. When a biological mesh is used, it is advised to leave in suction drains for a longer period of time and only remove when the production is less than 30 mL per day.

Management of Postoperative Complications

Key Concept: *Having a realistic expectation regarding anticipated postoperative complication development will help to not only minimize their incidence*, *but also allow for prompt diagnosis and early treatment*.

Morbidity rates following attempts to close enterocutaneous fistula are high. Morbidity rates are reported in up to 90 % with 30-day mortalities in between 5 and 10 % [24, 30–33].

Wound Infection

There is a high chance of wound infection, in no small part due to the large subcutaneous wound surface and the extensive surgery. To treat the wound infection, the skin sutures must be removed at a small area, enabling irrigation of the subcutaneous space using catheters. Wound infection in these types of patients is not treated by removing all sutures because the skin may then become completely dehiscent, and the underlying abdominal wall reconstruction is rendered at risk.

Bleeding

Preferably, postoperative bleeding is managed conservatively. Large subcutaneous hematomas sometimes need to be evacuated surgically because of the high likelihood of infection and prolonged wound care. It is advised to approximate the skin after such drainage procedure and not to leave it wide open. Currently, adjuvant topical medications such as fibrin glue, thrombin-based gels, and powders have not proven to minimize bleeding complications.

Anastomotic Leakage and Recurrent Enterocutaneous Fistula

Key Concept: *Recurrent ECF is a possibility*, *especially with underlying risk factors*, *and surgeons should be aware of the signs of symptoms*.

If shortly after surgery to repair the fistula the patient deteriorates, imaging is imperative (preferably a CT). If imaging indicates anastomotic leakage or a small bowel perforation, it has to be decided whether and how to intervene. If the leakage is sealed, the localized collection is preferably drained percutaneously if possible. If the leakage has caused diffuse fluid collections and the patient's condition deteriorates, a re-laparotomy has to be done. Exteriorization of the small bowel perforation or dismantling of the anastomosis with stoma formation is most often warranted to control the source of sepsis. If a fistula recurs after an arbitrary period of a week, it must be treated conservatively, according to the SNAP principles (see before).

Fistula recurrence is reported in up to 25 %, but can be much lower in specialized settings of an intestinal failure surgical team. Operative correction might close the fistula in up to 84 % of the patients [24, 30–32]. Owen indicated that patients with severe chronic obstructive pulmonary disease, portal hypertension, a history of long-term steroid use, and/or a diagnosis of short bowel syndrome prior to surgery had increased risk of recurrent fistula in univariate analysis [30]. Visschers demonstrated in multivariate analysis that a preoperative albumin less than 25 g/l was associated with fistula recurrence and mortality. In addition, fistula recurrence was associated with the need of abdominal wall reconstruction [31]. Martinez concluded that independent predictors of recurrent fistula were a preoperative albumin <30 g/l and an age >55 [32]. This highlights the need for optimization across all fronts prior to initial operative re-intervention.

Who to Operate on?

The expected benefits of an operation must always be out weighed against the risks. The decision to operate depends on the (biological) age of the patient, comorbidities, the extent of the required reconstruction, and the motivation of the patient. High-risk patients with small-output fistula that can be treated with a stoma bag should not undergo an operation. Patients depending on parenteral nutrition or with metabolic issues require an abdominal reconstruction if the risk is acceptable. There is no rule of thumb which patient to operate. This decision should be made together with the patient. While factors such as a BMI of less than 20 and a totally dependent functional status are associated with a high 1-year mortality [30], it is ultimately your surgical judgment that plays the primary role for determining who should and should not get an operation.

Summary Pearls

Unfortunately, the development of enterocutaneous fistulas remains an untoward possibility for patients undergoing laparotomy. Once identified, adhering to the general principles of SNAP (Sepsis, Nutrition, Anatomy, Procedure) will help guide your management while minimizing subsequent morbidity and mortality. You should avoid the urge to re-intervene within 6 months for fistula closure and instead discuss a realistic timeline with patients and their families. Full attention should then be on the optimization of the patient's overall health (bridging to surgery with a specialized team), while planning out the surgery from preoperative complete road mapping, via initial incision to working through exactly how you will get the abdomen closed. Despite the multitude of challenges, success lies in the details of preoperative work-up and surgery itself and taking time to think completing through the various situations that will arise along the way.

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