Enterocutaneous Fistula Management in Trauma

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Introduction

Despite years of experience, we have not solved the dilemma of ECF development, but we continue to attempt to minimize the risks to our patients. Open abdomens especially, translate into a race to closure in order to prevent fistula formation. Fistulas, whether enteroatmospheric (EAF) or enterocutaneous (ECF), continue to challenge trauma surgeons worldwide.

Despite the decline in damage control laparotomies and the subsequent "open abdomen," fistulas remain a constant threat separating rapid recovery from protracted convalescence. The dreaded complication of ECF fistulas after trauma have an incidence up to 25% and are associated with significant morbidity and mortality, prolonged ICU and hospital stay with substantial financial burdens, all while requiring complex, methodical decision-making skills from multidisciplinary care team [1].

Search Strategy

The management of fistulas has dramatically changed over the decades and the search was limited to after the year 2000. A PubMed search was performed with the keywords: Enterocutaneous Fistula (ECF), Enteroatmospheric fistula (EAF), Trauma, Damage control laparotomy, nutritional support for enterocutaneous fistula, and endoscopic management of enterocutaneous fistula. There is a low number of high evidence papers due to the nature of the topic being retrospective and more

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Table 7.1 PICO

P (Patients)	I (Intervention)	C (Comparator)	O (Outcomes)
Trauma patients with enterocutaneous fistula development	Nonoperative optimization and management followed by surgical repair	Nonoperative management without definitive repair	Mortality, morbidity, recurrence of fistula, primary fascial closure, wound care options, and nutritional outcomes

experienced-based management, therefore case studies were also included in our search strategy for management of enterocutaneous fistulas (Table 7.1).

Results

According to the AAST Prospect Open Abdomen Registry, having a large bowel resection, large volume resuscitation, and increased number of re-explorations increases the likelihood of developing enterocutaneous fistula, enteroatmospheric fistula, and intraabdominal sepsis [1]. The majority of patients with ECF have one or more hollow viscus injuries that are more likely colonic in nature. Dubose et al. demonstrated that the technical method of repair, stapled versus hand-sewn anastomoses, and ostomy creation versus anastomosis at the initial operation, was not an independent predictor of fistula development. However, the performance of a damage control surgery with pancreaticoduodenal injuries was a significant predictor of ECF [2]. Ultimately the longer the abdomen remains open, the greater the risk of ECF, and primary fascial closure is the primary goal. No matter the method of closure, all abdominal closures performed in a delayed fashion carry the risk of fistula formation. Therefore, the more rapidly a closure can occur, the less the risk [1, 3].

Fistulas: Patience, Do Not Panic

After recognizing a patient has an ECF, the essential next steps include addressing the metabolic and infectious issues. Control of the output is paramount and critical to avoid sepsis. Defining the anatomical location will guide the long-term strategies such as nutrition and wound care. This period takes time, patience, and focus. Common pitfalls include attempts at repair, failure to adequately address nutrition, and failure to control output.

Martinez et al. reviewed in their institution all postoperative patients with fistulas following operations during a 10-year period to identify factors related to spontaneous closure, need for operative treatment, and mortality. A total of 174 patients were treated. Postoperative enterocutaneous fistula closure was achieved in 151 patients (86%), being spontaneous in 65 (37%) and surgical in 86 (49%). Factors that significantly precluded spontaneous closure were jejunal site, multiple fistulas, sepsis, high output, and hydroelectrolytic deficit at diagnosis or referral. The authors concluded that controlling for volume loss, metabolic disturbances and sepsis is

instrumental in acutely decreasing further morbidity and mortality associated with ECF and EAF [4]. Ideally, percutaneous drainage, antibiotics, and wound care will suffice, however, reoperation for effective drainage may be necessary. Empiric antibiotics are recommended but limited to 4 to 7 days unless unable to obtain source control to limit antibiotic resistance [5]. Aggressive resuscitation cc for cc with appropriate replacement fluids may be necessary to meet physiologic parameters of resuscitation due to significant volume shifts. If surgical intervention is required for control of sepsis, the operation should be limited to wide effective drainage only. Although frequently tempting, definitive management must be deferred due high risk of fistula recurrence in the emergent setting [6].

Understanding the anatomic makeup of the fistula provides a road map for further management and potential operative planning down the line. The location of the fistula affects the volume of effluent as well as the specific composition and viscosity, which can drastically change the patients' metabolic, electrolyte, and nutritional responses [7]. Using a combination of cross-sectional imaging and fistulograms to define the anatomy, it will be evident of the source of the fistula, the nature of the tract, presence or absence of bowel continuity, distal bowel obstructions, and abscess cavities associated with the fistula [6]. Favorable fistula anatomy that is more consistently shown to close spontaneously entails those of esophageal, duodenal stump, pancreaticobiliary, and jejunal origins with small defects less than 1 cm and long tracts greater than 2 cm [6]. Fischer et al. in reviewing 10 years of experience of ECF formation after trauma laparotomy, identified that patients with open abdomens were more likely to develop fistulas from the small bowel in comparison to those whose abdomens were closed, and 37% of fistulas occurring with open abdomens closed spontaneously versus 45% of the fistulas that occurred in a closed abdomen, likely from unfavorable anatomy of short tracts, mucosal eversion, and large abdominal wall defects seen in the open abdomen group [8]. Early recognition of the location and patient history provides valuable information for the likelihood of future operative interventions and challenges that may arise, specifically with output and wound care needs.

The external loss of fluids through fistulas dictates a high versus low output fistula. Greater than or less than 500 mL per day is the cutoff for defining high output versus low output fistulas. Quantifying the output helps understand the potential electrolyte abnormalities and malnutrition that will develop within these patients. As such, low output fistulas are three times as likely to spontaneously close and mortality rates significantly increase with higher output fistulas [6]. For high output fistulas, efforts should focus on utilizing antimotility and antisecretory agents to help control output, ease wound care, and potentially allow for enteral nutrition [5]. When all fails, somatostatin or its' analog, Octreotide may have a role. While Octreotide has been shown to decrease output, it has not been shown to affect the rate of closure and currently, there is no evidence supporting the use of octreotide in ECF after trauma. An individualized plan for each patient and the use of octreotide should exist given the detrimental effects of high output fistulas [6, 9].

Long-term success of enterocutaneous fistula management depends largely on local wound care and channeling output away from skin. This phase focuses on

skin protection while containing and accurately measuring the effluent while preventing further wound complications [7]. Utilizing the assistance of collection bags, skin barriers, drains, enteric tubes, wet to dry dressings, negative pressure wound vacuums, and pouching systems are essential. Creativity is key and the best solution frequently requires "out of the box" thinking to isolate the fistula and control its drainage. Ostomy supplies, large pouching devices, catheters within fistula to direct output in combination with wet to dry dressings are all options to channel drainage. None is without complication, however, Skin breakdown, hypersensitivity of the skin due to adhesives, and frequent leaks remain the greatest challenge when it comes to ostomy appliances and dressings. Negative pressure therapy can assist in the management and healing of fistulas and surrounding wounds. It can also be beneficial in directing and controlling fistula output. Vacuum sponges can be quite effective at isolating the fistula and directing the output away from the remaining wound. This is especially valuable when the fistula is high output and low viscosity. Returns on value diminish the more distal the fistula as viscosity of the output can quickly clog the sponge. As with all adjuncts, negative pressure devices can have complications. They have been associated with further erosion of bowel loops and with additional fistula formation [10]. Each plan must be individualized and frequently requires trial and error. The most valuable and successful approaches involve a multidisciplinary approach that involves not only the surgeon, but invested nursing, wound care specialists, pharmacists, and nutrition expertise.

Nutrition support for patients with fistulas focuses on maintaining metabolic normalcy and promoting spontaneous closure, while optimizing for long-term operative interventions. Patients with newly identified ECFs suffer from significant metabolic and physiological stress leading quickly to acute malnutrition [5]. Total parenteral nutrition (TPN) should be initiated in early management of ECF. This allows for bowel rest to decrease output so as to improve initial wound care. Once this is achieved, however, we agree with others and advocate for early enteral nutrition [5]. Ultimately, the location of the fistula and associated fluid and calorie losses will dictate the route of nutrition. Enteral nutrition is always preferred as it is believed to maintain GI mucosal integrity and reduce bacterial translocation, thus offering a protective effect [11]. It has been shown that even with only 20% of required calories given enterally there is preserved mucosal integrity, immunologic and hormonal function, as well as hepatic protein synthesis [7]. Parenteral nutrition, on the other hand, has revolutionized the long-term management and mortality in patients unable to tolerate enteral nutrition. TPN remains highly impactful for circumstances such as intestinal discontinuity, short gut syndrome, inability to obtain enteral access, intolerance, increased ECF outputs with uncontrolled skin breakdown or fluid and electrolyte imbalances [2, 7]. High output fistulas will ultimately require 1.5 to 2 times the normal caloric intake due to ongoing losses, twice the normal vitamin supplementation, 5–10 times the vitamin C requirement as well as zinc, copper, folic acid, and B12 [7]. In all patients with fistulas, trending nutritional parameters of weight, prealbumin, albumin, transferrin, and C-reactive protein are essential to achieve an anabolic state, which

is essential for corrective operative planning. Of all nutritional values, albumin levels have been correlated to surgical morbidity and mortality thus stressing the importance of sound nutritional foundation.

Fistulas in the Open Abdomen

The concept of damage Control Surgery was a paradigm shift that decreased mortality by recognizing and prioritizing the associated metabolic disturbances associated with trauma. It calls for the abbreviation of surgery to correct only active bleeding and spillage while simultaneously addressing ongoing metabolic disturbances, hypothermia, and coagulopathy. This is frequently achieved by low crystalloid, high colloid resuscitations and delaying definitive operations, and large cavity closure. Unfortunately, with all good intentions come unintended consequences. As we leave abdomens open, the risk of fistula increases, thus putting the surgeon and patient on a clock to definitive closure. These patients have a fivefold increase in ECF development compared with patients whose abdomen is not closed at the initial laparotomy. Those closed after postoperative day 5 were associated with a fourfold increase in anastomotic leak rates [3, 12]. Additionally, patients who received large initial resuscitations have been shown to have higher rates of fistula development [1, 12]. Open abdomen patients are also highly catabolic and thus become malnourished early; this too elevates the fistula risk. However, many fistulas can be prevented by using a protective non-adherent covering of the hollow viscus, avoiding over resuscitation, avoiding serosal injury, and most importantly, prompt fascial closure, and early (starting within four days) enteral nutrition [2].

If a fistula develops, 4 core principles are paramount:

1. Prevent sepsis
2. Control effluent output
3. Prevent skin and soft tissue breakdown
4. Provide adequate nutrition

Open abdomen patients are extremely challenging. The best management is prevention by closure of the open abdomen with or without a fistula. In our practice, we employ a very aggressive "open abdomen protocol" that achieves primary abdominal closure. This eliminates style-based practice and has proven extremely successful. We do not allow abdomens to remain open and have a near 100% success rate at closure [13].

There are multiple means to reach fascial closure, each with its own risk for fistula development. The details of each, however, are beyond the scope of this chapter. We use transabdominal wall traction with tremendous success to achieve primary closure of the abdomen. Fistula rates are 12% (n = 4/32) over a 3-year-time period from 2008 to 2011 [13]. The intent is to prevent fistula formation, however, should it occur either before or during the process of abdominal closure, we continue to close the abdomen and exteriorize the drainage of the fistula. In our experience, closure over a fistula with extensive drainage frequently results in resolution of the fistula as the abdominal wall seals over it. Alternatively, if the fistula is in the

midline, we routinely exteriorize the fistula through the midline and attempt to close skin around it to channel the effluent in anticipation of appliance placement to control output.

Long-Term Maintenance

The maintenance phase continues with nutritional optimization, correcting electrolyte imbalances with fluid shifts, and local wound care. Patient comorbidities related to the ECF significantly influence the morbidity and mortality of operative interventions and adequate attention from physicians and patient dedication lead to better outcomes. In fact, medical management has been shown to decrease the need for operative interventions in 50% of patients [1].

Despite all efforts, fistulas may not spontaneously close and operative interventions will be required. Patients will routinely push to have surgery, and usually much sooner than the physician's timeline. There is no clear consensus for the ideal time for reoperation, but mortality rates and risk of re-fistulization influence the timing. Evenson et al. waited four months from index operation in comparison to Lynch et al. showed a median time of 6 months to reoperation with decreased re-fistulization after 12 weeks in comparison to early intervention between 2 and 12 weeks [6, 14]. In our experience, from the time the abdomen is closed, waiting a minimum of a year, sometimes two, to ensure the least hostile abdomen is ideal if possible. We recognize, however, there are no good scientific metrics for the best timing. In order to undergo reoperation for ECF after trauma, patients at our institution must meet specific metrics. Each patient must be at an optimal BMI (<30) to minimize mechanical forces opposing abdominal wall reconstruction. They must be exercising regularly to be maximally conditioned as there is significant deconditioning expected postoperatively. There is no smoking, tobacco, or marijuana. This is critical to reduce infection, maximize wound healing, and improve neovascularization. Prior to any intervention, patients with ECF need to be maximized nutritionally, evident by albumin, transferrin, and prealbumin levels ideally within normal ranges. Medical clearance is imperative for patients with comorbidities and for preventing other complications. Lastly, operative intervention does not mean a quick fix. Strong family support and a stable domicile ultimately lead to better outcomes [15]. Planning operative interventions is founded upon a strong doctor–patient relationship. It is a two-way street where patient compliance and "buy in" are equally, if not more important, than the physician skill set. The preoperative discussion must emphasize the need for two-directional trust, and the importance of meeting the metrics and rules outlined at the beginning of the discussion. It is a contract that must be adhered to. No operative plans should be offered unless patients buy into the global plan.

Prior to undertaking a major step of operative repair, it is imperative to outline the distinct benefits, but the very real risks associated with reconstruction. While

taking down a fistula hopefully improves quality of life, the downside includes the inability to fix the fistula and re-fistulization. This is in addition to the normal risks of bleeding, infection, and death seen with any operation. Similarly, to patient expectations, the surgeons must know their own limitations. Enterocutaneous fistulas require complex decision-making and an understanding of the operative process. Complex cases, may at times, be better managed by tertiary referral facilities who regularly manage such patients.

Surgical Management

Other than common principles of management, intraoperative techniques may vary. The overwhelming goal of preventing re-fistulization and abdominal wall closure with hernia repair requires meticulous performance. Sound surgical decision-making is of the utmost importance and depends on intraoperative findings. However, some technical tips should be considered. In a retrospective study from Lynch et al., there was a 20% overall fistula recurrence rate. This was seen at higher rates with over-sewing than with resection [14]. Similarly, in another small retrospective review, Brenner et al. showed that recurrence was more likely after stapled anastomosis than hand-sewn [16]. In our experience, ensuring adequate lysis of adhesions to the point that the bowel is not tethered and thus free for peristalsis. Ideally, a single reoperation may be desirable, but depending on the operative length of time, extent of resuscitation, resulting bowel edema, and need for a second look, staged operations may be necessary.

Recommendations Based upon the Data

Unfortunately, despite all efforts, fistulas may not close or re-fistulization occurs after operative intervention; however, novel techniques can prevent the potential need for reoperation. Most of the various techniques are discussed through case reports and case series and in general have similar methods of plugging the outflow tract but leaving the fistula in place.

Depending on the location, case reports exist for endoscopically closing the enterocutaneous fistula with an over-the-scope clip. This has demonstrated a closure rate of 86% for acute (less than 30 days old) and 33% for chronic fistulas (greater than 30 days old) [17]. Similarly, endoluminal stenting has been used to exclude the fistula and prevent output but presents challenges with migration [18]. Fibrin glue gelatin sponge, or a combination with a polyglactin plug can be injected into the fistulous tract to occlude and allow healing, but much of the experience stems from treating perianal fistulas with limited information for long-term success in ECF patients [10]. These are all possibilities for nonoperative management and should be kept within the surgeon's armamentarium.

Summary of Recommendations

- Controlling for volume loss, metabolic disturbances and sepsis are instrumental in acutely decreasing further morbidity and mortality associated with ECF and EAF (evidence quality moderate; strong recommendation).
- Continue to close the abdomen and exteriorize the drainage of the fistula. Closure over a fistula with extensive drainage frequently results in resolution of the fistula as the abdominal wall seals over the fistula (evidence quality weak; strong recommendation).

A Personal View of the Data

Enterocutaneous fistulas are complex problems requiring individualized management while adhering to the same general principles. After identifying an ECF, adequately treat any signs of sepsis and drain all fluid collections. Once stabilized, define the anatomy and optimize nutritional status that may require evolution from total parenteral nutrition to enteral nutrition, or a combination of both. Wound care can be a challenge, but many options exist with the ultimate goal of adequately directing the output while protecting the skin and preventing wound disruptions. While some will close on their own, reoperations may be necessary, but only after a significant time period to decrease associated mortality and complication profile. Each patient will dictate the best interventions and may include creative means for closure. Enterocutaneous fistulas ultimately require a multidisciplinary approach for the best outcomes and a continuous relationship between the surgeon and patient.

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