Current role of surgery in the treatment of digestive fistulas

Ann. Ital. Chir., 2010; 81: 285-294

Luca Cozzaglio*, Eriberto Farinella**, Massimiliano Coladonato*, Francesco Sciannameo**, Leandro Gennari*, Roberto Doci*

**Department of Surgical Oncology , IRCCS Istituto Clinico Humanitas, Rozzano (Milano), Italy*
***Department of General and Emergency Surgery, S. Maria Hospital, Terni, University of Perugia, Italy*

Current role of surgery in the treatment of digestive fistulas

Surgery is the main treatment of digestive fistulas (DF) but its role has changed over the last 40 years. The aim of this review is to analyze the surgical management of DF paying attention to timing and type of surgery.
METHODS: *We performed a review considering the following electronic databases: Medline, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials, EMBASE and the reference lists of the key papers. Literature searches were carried out using the following medical subject headings: "digestive fistula"; "gastrointestinal fistula"; "enterocutaneous fistula"; "AND surgery"; "AND surgical treatment". Because the absence of randomized studies, we have considered the larger series or original techniques.*
RESULTS: *Surgical treatment of DF has two indications: to treat complications due to DF juice action such as peritonitis, abscesses, gangrene, bleeding; and when a fistula fails to heal. In this case the surgical indication is often difficult to establish, because of the risk of making an inconclusive act.*
CONCLUSIONS: *Indications to surgery, timing and choice of operation cannot often be standardized because they depend on a mixture of DF and patient characteristics. In specific cases, involvement of nutritionist and plastic surgeon is required.*

KEY WORDS: Digestive fistulas, Surgery, Therapy.

Introduction

Surgery is still the main treatment for digestive fistulas (DF) but its role has changed over the last 40 years, mainly due to improvements in medical therapies. Nowadays management of DF patients is often delivered in the Intensive Care Unit where nutritional support, antimicrobial therapy and maintenance of glycemia to less than 140-120 mg/dl are performed. Many non-surgical treatments such as skin care, percutaneous or endoscopic treatments have been proposed, but in spite of the improvement in medical care, surgery is mandatory in many situations, such as severe secondary peritonitis, and delaying it can be life threatening. The aim of this paper is to analyze the surgical management of DF with particular attention to indications, timing and type of surgery.

Methods

We overviewed available international data, without any language restrictions, using the following electronic databases: Medline (PubMed interface), Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials, EMBASE and the reference lists of the key papers.

Pervenuto in Redazione Giugno 2010. Accettato per la pubblicazione Luglio 2010.
Correspondence to: Dr. Luca Cozzaglio, Department of Surgical Oncology, IRCCS Istituto Clinico Humanitas,Via Manzoni 56, 20089 Rozzano (Milano) (e-mail: luca.cozzaglio@humanitas.it)

Literature searches were carried out using the following medical subject headings (MeSH): "digestive fistula"; "gastrointestinal fistula"; "enterocutaneous fistula"; "AND surgery"; "AND surgical treatment". Because the absence of randomized studies in literature, we have considered only the larger series or original techniques.
However, a preliminary synthetic analysis of DF pathophysiology seems opportune to justify surgical strategies.

Pathophysiology of digestive fistulas

Characteristics of Digestive fistulas

Three main classifications have been used to define a DF [1,2]: anatomical, physiological and etiological. But only when all these characteristics are considered together is it possible to completely understand the fistula. From the *anatomical* point of view, DF are classified as external, internal or complex [1,2] . External fistulas are pathological communications from any portion of the gastrointestinal (GI) tract with the skin. Internal fistulas connect the GI tract to another internal organ, and they can be further divided into two types: intestinal and extra intestinal. Intestinal internal fistulas refer to a gut-to-gut connection, and extra intestinal internal fistulas imply communication of the GI tract with another organ system such as the genitourinary system, biliary tree or respiratory tract. Internal fistulas have a lower mortality than external [3] and sometimes may not necessarily need repair. Complex fistulas contain both internal and external components. The side of the fistula has important clinical implications too. Continuity of the intestine is maintained in lateral fistulas allowing normal progression of intestinal contents, and usually closes spontaneously if not associated with any other anatomical abnormality. On the contrary in end fistula, there is a complete loss of intestinal continuity which generally requires surgery to achieve closure [4]. Other anatomical characteristics associated with non-healing fistula include: fistula tract less than 2 centimetres in length, enteral defects greater than 1 centimetre, epithelialisation of the fistulous tract, eversion of mucosa, large adjacent abscess, presence of ileus, distal obstruction, diseased adjacent bowel, multiple fistulas, and fistula arising from some GI segments such as stomach, lateral duodenal, ligament of Treitz, and ileum [2,5] (Table I). *Physiological* classification is useful in planning operative versus non-operative treatment, and daily fistula output is the most important factor. The classification based on daily fistula output shows three categories [2,6] : low (<200 ml/24 hour), moderate (200-500 ml/24 hour), and high output (>500 ml/24 hour), with a mortality rate two-three times higher in patients with high output fistulas than those whose fistulas have a low output[5,7,8]. Concerning *etiology*, most DF (75-85%) follow surgery [2] and both local and systemic factors may contribute to their development [9].

Table I - *Indications for fistula surgical repair* [2,4,5,11,50]

Fistula characteristics
Complex or multiple fistulas
End fistula (intestinal discontinuity)
Short fistula tract (<2 cm)
Enteral defect >1 cm
Eversion of mucosa
Epithelialisation of the fistulous tract
Distal occlusion
Presence of ileus
Diseased adjacent bowel
Fistula arising from stomach, lateral duodenal, ligament of Treitz, ileum
Associated abscess
Abdominal wall defect
Open abdomen
Evisceration
Fistula output >500 ml/day
Fistula arising in the first 48 hours after surgery
Chronic fistula (>4-6 weeks)
Underlying diseases
Malignancy
Inflammatory bowel disease
Radiation enteritis
Intra-abdominal foreign body
Trauma

Technical problems leading to fistula formation include: breakdown of an intestinal anastomosis due to suture-line defects, tight suture causing ischemic necrosis, inadvertent full thickness bowel injury, deserosalisation of the bowel, inadvertent injury to the mesenteric vessels, poor hemostasis resulting in a perisuture hematoma, tension of the anastomosis, distal obstruction, an intestinal loop caught in a fascial suture and an inappropriate use of drains [3]. Postsurgical DF are generally external rather than internal [3]. Fistula can occur at any time following surgery, but the critical time for healing of a GI anastomosis, is between postoperative days 5 and 7. The time elapsed to fistula appearance is an important guideline for management and prognosis. In fact early fistulas arising in the first 48 hours after surgery can be considered as technical errors and they would usually require further surgical procedures [10,11], whereas low output, well drained fistulas appearing later have a good prognosis and can generally be treated conservatively. Postoperative DF can develop after a laparostomy with open abdomen in approximately 25% of patients, with reported mortality of 36-64% [12-16]. An "enteroatmospheric fistula" occurring in the midst of an open abdomen is a major problem [17,18] because it does not close without proper surgical treatment [13,14,16,19-21].
Approximately 15-25% of all DF are unrelated to surgery. Diseases such as Crohn's disease, ulcerative colitis, colonic diverticulitis, radiation enteritis, appendicitis, ischemic bowel, pancreatitis, perforation of peptic

ulcers, malignancies, trauma and erosion of indwelling tubes can cause a DF [1,2,22-26]. In penetrating trauma with suspect or evidence of DF, urgent laparotomy is mandatory.

Characteristics of specific digestive fistulas

Gastric fistulas are postoperative in about 85% of cases, the remainder being due to irradiation, inflammation, ischemia, and malignancy [2,27-29]. Anastomotic leak after gastric resection for cancer occurs in 5-10% of cases; occasionally due to residual cancer at the suture line and in these cases are unlikely to close spontaneously [27,30]. Gastric leaks after resection for peptic ulcer disease, antireflux procedures, and bariatric surgery occur in roughly 1-3% [29,31-33]. Duodenal fistulas occur as a complication of gastric resection, duodenal resection, biliary tract procedures, pancreatic resections, right colectomy, and aortic and kidney operations in 85% of cases. The remainder are related to trauma, perforated peptic ulcers, and cancer[2,34]. Duodenal fistulas occur in 3-5% of patients undergoing gastric resection, with a mortality ranging from 13 [35] to 42% [29]. Lateral duodenal fistulas close spontaneously in only 30% to 40% of cases [2] with a mortality rate of 25%. Approximately 2-5% of all patients with duodenal trauma develop a fistula, usually occurring in conjunction with other intra-abdominal injuries [36-38]. Pancreatic fistula complicates 6-25% of elective pancreaticoduodenectomies with a mortality rate of 8-10% [39,40]. External fistulas are frequently associated with pancreatic debridement for severe necrotizing pancreatitis and they develop in 23-29% of patients undergoing pancreatic necrosectomy [41,42]. Any upper abdominal invasive procedure involving or adjacent to the pancreas, places the patient at risk for fistula development [43]. Management of pancreaticocutaneous fistulas should be non-operative, at least for the first 2-3 weeks and surgery is indicated when non-operative management fails [43]. The type of operation is dictated by the anatomy and therefore preoperative evaluation with fistulography, CT scan or ERCP is crucial. Fistulas arising from the body and tail of the pancreas are usually managed by distal pancreatectomy, while fistulas arising from the head by internal drainage procedure.
Pancreaticoduodenectomy is rarely justified for fistulas because of its high morbidity and mortality [44]. Small bowel fistulas are complications of abdominal surgery in 70-90% of cases, due to anastomotic failure or inadvertent enterotomy during another surgical procedure [45,46]. Small bowel defects greater than half of the bowel circumference should be promptly treated by surgery. The remaining small bowel fistulas are related to: Crohn's disease (5-10%), cancer (2-15%), peptic ulcer disease (3-6%), and pancreatitis (3-10%) [2]. Colorectal fistulas result primarily from surgical treatment of cancer and inflammatory diseases [2,47]. When a colonic fistula is present the need for surgical treatment depends on the presence of sepsis, the extent of local inflammation, the fistula output, and the degree of difficulty in controlling effluent. If proximal diversion is indicated an ileostomy is often preferred over colostomy.

Surgery of digestive fistulas

Although surgery is the main treatment for DF, it is characterized by a recurrence rate from 20 to 40% and a high complication rate [48,49]. Surgical treatment of DF has mainly two indications: the treatment of complications due to DF juice action and the failure of fistula healing. In the first case the surgical indication is often clear, while in the second case it is certainly more difficult to establish, and in both cases there is the risk of making an inconclusive act or worse to create a new fistula. The main DF complications requiring surgery are peritonitis, intraabdominal abscesses, gangrene, and bleeding or septic status not otherwise curable. In these cases emergency or semi-urgent surgery is generally performed, and the procedures should be limited to controlling sepsis or bleeding and performing a proximal defunctioning stoma. Surgical indications for repairing a fistula not spontaneously healed and not associated with DF complications are reported in Table I [2,4,5,11,50]. Anyway before attempting a surgical fistula repair it is mandatory to have already identified and resolved the possible focus of sepsis. The act of re-entering the abdomen in a patient with DF may be quite challenging; the surgeon may worsen the situation creating enterotomies in an attempt to gain access into the free peritoneal cavity. Some advocate a new and separate incision through virgin territory; others prefer to go through the previous incision. The first approach carries a lower risk of producing inadvertent enterotomies and is very advantageous when the patient had a previous small lateral laparotomy, but this approach is often not feasible. The operative plan should include lysis of all adhesions, drainage of all abscesses and relief of distal bowel obstruction [51]. It is safer trying to develop a plane of dissection as far from the fistula or septic focus as possible. The knowledge of fistula characteristics, underlying diseases and patient general conditions can guide the surgical timing and the chosen type of surgery. When deciding timing of surgery, many Authors recommend re-operation after 6-8 weeks, when the abdominal cavity and intestinal adhesions are accessible to relatively easier dissection and when the probability of a spontaneous fistula closure is very low [46]. In fact Reber et al [45] reported that 90% of spontaneous fistula closures occurred within 1 month, 10% within 2 months, and none after 3 months. Fazio et al. [52] described the "obliterative peritonitis" that occurs during the period from approximately 10 days to 6 weeks following laparotomy in patients with enterocutaneous fistulas associated with sepsis. Patients

who were operated within 10 days after their original surgery and those whose operations were delayed at least 6 weeks had mortality rates of 13% and 11%, respectively. In contrast, patients requiring re-laparotomy during the period between 10 days and 6 weeks after their initial surgery suffered a mortality rate of 21% [52]. Surgery of DF in an eviscerated wound is a more challenging problem. Some Authors believe that these patients should undergo immediate operative repair [10], while others obtained best results with initial medical care and late operative intervention [53].

Surgical management of DF is often difficult and the type of surgery depends mainly on the site of fistula and presence or absence of a septic focus. The different surgical procedures used in DF treatment are described as follows:

1) The *drainage* of all septic foci and infected peritoneal fluid is always the main procedure, because DF will never heal in a septic field. The pelvic region, paracolic gutters, and subphrenic spaces must be opened and debrided. Peritoneal debridement, including removal of fibrinous deposits from the parietal and visceral surface, is often performed even though some Authors demonstrated the lack of advantages and some deleterious effects [54]. Intraoperative peritoneal lavage with 0,9% NaCl warm solution reduces the degree of bacterial contamination and removes pus, blood, intestinal juice, fecal material and necrotic tissues [55]. Silastic sump drains are left to drain any suspicious areas. Some Authors also proposed postoperative continuous peritoneal lavage with the addition of antibiotics as well as low-doses of heparin in an attempt to reduce the risk of persistent or recurrent infections [56], but the clinical value of this procedure remains unclear [57]. Percutaneous drainage is a valid alternative to surgery, characterized by reduced morbidity and mortality [58], but in some cases it can be ineffi-cacious, technically not feasible or not available. Moreover surgery must be preferred when abscesses are multiple, located between the intestinal loops, with high viscosity fluid or associated with tissue necrosis.

2) The *exclusion* of an intestinal fistula is indicated in very ill patients, in presence of compromised bowel and sepsis; this procedure usually involves resection of the diseased segment followed by exteriorization of the ends [36] . In case of an intestinal exclusion protecting a distal anastomosis, a loop stoma is preferable to an end stoma, because in the first case the intestinal continuity can be restored without the need to reenter a "frozen" peritoneal cavity. In the open abdomen intestinal stomas should be placed as laterally as possible to allow maximal medial mobility of the abdominal wall during closure [59]. If the duodenum cannot be exteriorized, a duodenostomy tube is placed. Other methods of surgical exclusion of the gastroduodenal area include pyloric exclusion by stapling the stomach and creating a gastrojejunostomy; this procedure is often used in trauma patients in order to protect a damaged duodenum although the pyloric lumen may be restored within a few weeks and the fistula may still be present [36]. In the inaccessible abdomen, re-exploration frequently leads to other fistulas and the exteriorization of the digestive tract is nearly always impossible [14,60]. In order to resolve this problem Bosscha and Vroonhoven [61] presented a surgical technique for the total disconnection of the proximal digestive tract. The basic principle came from the observation that in a completely scarred and adhesive abdomen, the bursa omentalis remains virgin territory with an undisturbed anatomy and proper surgical dissection planes. Through a 6-8 centimetre median incision just below the xiphoid, the upper part of the abdomen is opened. The lesser sac (bursa omentalis) is then opened by dividing 5-10 centimetres of the gastrocolic ligament along the greater curvature of the stomach. Near the caudal edge of the pancreas the transverse mesocolon is incised just left of the aorta and the ascending duodenum and duodenojejunal flexure are identified and carefully mobilized. By transecting the ascending duodenum and closing the distal end by means of a stapler, total disconnection of the proximal digestive tract is achieved. An end-to-side duodenogastrostomy is subsequently performed and a gastrostomy tube is placed for decompression. After intervals ranging from 2 to 5.5 months, continuity of the digestive tract is restored. In the midst of an open abdomen with a fixed visceral block, exteriorization of the fistula is usually impossible because the stoma does not reach the retracted abdominal wall, and on the other hand the intubation of the fistula in an open abdomen makes the hole bigger eroding into adjacent bowel loops [62]. In these cases the "floating stoma" [63] would be an unorthodox but effective solution by realizing a physical barrier between the intestinal effluent and the peritoneum with an intravenous fluid bag sutured directly to the stoma. In presence of a laparostomy or/and obliterative adhesions precluding a safe mobilization of intestine, Delaney et al. [59] reported another technique to facilitate enterostomy. This procedure uses the skin and subcutaneous tissue adjacent to the intestine as the only abdominal wall component that the stoma will come through. Usually the mobility of the skin and subcutaneous tissues is not sufficient to easily achieve a wide margin around the stoma to hold the stoma appliance. Thus a flap of skin and subcutaneous tissue is mobilized off the retracted fascia of the rectus abdominis muscles and advanced medially to lie over the ileum performing an ileostomy fashioned through the skin and subcutaneous fat only.

3) *Resection* of the anastomotic fistula is sometimes the operation of choice, especially in small bowel fistulas; the diseased segment is resected and a new anastomosis is performed, but this technique should not be performed if the new anastomosis is in a contaminated field or if ischemia, tension or edema on the anastomosis are present [36]. Furthermore, bowel resection and anastomosis in previously irradiated tissue increase the risk of anasto-

motic failure [26]. Controversy exists regarding surgical management of left colon fistula, in particular for splenic flexure, but the general opinion is that a new anastomosis is at high risk of dehiscence. The restoration of intestinal continuity should not be combined with drainage of an abscess, because this frequently results in recurrence of the fistula. Also the patient's poor conditions, such as hemodynamic instability or severe malnutrition are relative contraindications to perform a primary anastomosis. On rare occasions of colonic fistula in obese patients or in presence of foreshortened mesentery, a primary anastomosis without proximal intestinal exclusion may be safer than trying to exteriorize what is likely to become an ischemic bowel segment under tension [62]. The emergency surgery, obesity, mesenteric ischemia, and Crohn disease lead to a stoma complication rate of up to 40% [64] and a stoma necrosis rate of up to 21% [59]. In such cases, emptying the proximal colon by means of on-table washout before performing a primary anastomosis may help to reduce the consequence of a new anastomotic leakage [65,66].

4) *Intestinal bypass*. In patients with complex fistula, high output, poor general conditions, severe lesions of skin or abdominal wall, an intestinal bypass through a laparotomy far from the affected area can be indicated [67]. End-to-side anastomosis of the intestinal segment proximal and distal to the fistula is performed, allowing alternative intestinal transit, and anastomosis is performed in the healthy intestine far from the affected area. This technique allows the re-introduction of oral feeding, control of the fistula drainage and early hospital discharge. Resection of the affected intestinal segment will be made in a second stage after 4-6 months in elective surgery, when the patient's clinical and nutritional condition will have improved. In Schirmer's experience [67] intestinal bypass has shown excellent results with almost no surgical complications despite having been performed on severely ill patients.

5) *Closure* of the fistula defect could seem the procedure of choice but often placing sutures in the fistulous opening is only a futile exercise that tends to enlarge the opening instead of reducing its size. Besides, closure of such defects may also lead to compromise the lumen, particularly for lateral duodenal fistulas.

6) *Coverage* of the fistula with well-vascularized soft tissue can be employed in particular cases of large fistulas. This manoeuvre, when possible, significantly improves the likelihood of fistula closure. The possible options include rotation or advancement of skin flaps placed over a fistula intubated with a soft rubber tube, musculofascial rotation and free flaps. Jamshidi and Schecter [16] often place fibrin glue between the fistula and the flap in an attempt to seal the fistula and allow the vascularized flap to stick to the adjacent bowel in order to achieve definitive closure. The same Authors presented a novel approach for the treatment of DF in open abdomen using human acellular dermal matrix (HADM) and cadaveric split-thickness skin graft (CSTSG). An option is the application of fibrin glue and HADM for closure of small fistulas [68,69]. Another option is meshed cadaver skin applied to the surrounding bowel preventing desiccation and contact with dressings, and protecting against the adverse effects of exposure to enteric succus emanating from the fistula. Alternatively, split-thickness skin coverage of enterocutaneous "bud" fistulas may be successful [70]. Large defects in the duodenal wall are technically difficult to repair due to the complex anatomy of duodenum and marginal blood supply shared with the pancreas, so serosal patch [71] or Roux-en-Y anastomosis [72] have been proposed. The bowel to be patched must be cleaned from fat and have an adequate blood supply; the defect can then be patched with jejunum or a defunctionalized Roux limb, taking care that the sutures are placed serosa to serosa. Agarwal and Sharma [73] reported the first clinical use of rectus abdominis musculoperitoneal (RAMP) flap for duodenal fistula repair in 8 patients, who healed within 3-5 days in all cases except one. A majority of duodenal defects are best closed by an omental patch, but in a re-do operation omentum may not be available, and in a seriously ill patient it is not advisable to perform time-consuming surgical procedures like partial gastrectomy, serosal patching, or Roux-en-Y duodeno-jejunostomy. RAMP flap for closure of duodenal defect is technically easy, and can be performed quickly also in critically ill patients.

7) *Laparostomy*. Patients with diffuse suppurative peritonitis and uncertain control of the infection source in a single laparotomy could be candidates for a laparostomy and open management of the abdomen [62]. This is the case of tertiary peritonitis, a diffuse and persistent form of peritonitis developing after a secondary peritonitis because of the presence of patient's impaired defence or an overwhelming infection. Laparostomy is in widespread use because of the increasing recognition of the association between severe abdominal infection and intraabdominal hypertension with abdominal compartment syndrome (ACS). There is a considerable body of experimental and clinical evidence supporting evidence that abdominal pressure level over 27 centimetres of water is associated with significant pathological changes in respiratory, cardiac, renal and visceral function, which may rapidly lead to ACS [74-76]. Repeated accesses to the peritoneal cavity allow to achieve debridement of nonviable tissue, peritoneal toilet and effective drainage of fistula juice. However, the laparostomy technique is associated with a series of side effects such as loss of large volumes of peritoneal fluid, abdominal fascia retraction, a catabolic status and the appearance of new "enteroatmospheric" fistulas. Within the abdomen, activation of coagulation, cytokine and other inflammatory cascades results in a copious fluid and cellular response in the first 48 hours but they continue at a slower rate while the abdomen remains open [77]. The systemic inflammatory response is likely to be severe, especially if the under-

lying pathology is severe [78]. In open abdomen patient beyond the first 10 days, any attempt to suture the fascial edges or dissect the bowel away from the posterior aspect of the anterior abdominal wall is likely to result in multiple enterotomies and fistulas [50]. A fistula may be the result of the underlying pathology, or may be the result of the open abdomen itself after ill-advised dissection, a spontaneous serosal tear at an adhesion on coughing or change of dressing. Thus, if a fistula is present after a period of 10 days in an open abdomen, a long period of supportive care is inevitable before repair of fistula and closure of the abdominal wall can be contemplated [50]. Management of a laparostomy should be limited to one or two experienced surgeons who know the wound very well; free access to the wound for all members of surgical staff increases the risk of "enteroatmospheric" fistula formation. In the attempt to decrease the rate of such complications in the 1995 Brock et al [79] introduced the vacuum pack system, a "sandwich" technique in which the visceral block is wrapped in a polyethylene sheet, then covered with a surgical towel that absorbs fluids and finally sealed on the top with a plastic adhesive draped to the skin over suction drains. As a general rule, intubation of a DF in an open abdomen is not suggested, because it fails to control drainage of fistula juice and generally results in a larger hole [62].

When a DF treated with laparostomy needs surgical repair because conservative treatments failed, the definitive resection of involved bowel must be delayed for many months. In conclusion prospectives studies analyzing the efficacy of open abdomen treatment [15] and others comparing open abdomen management with planned re-operations [80] do not demonstrate a clear definitive advantage of laparostomy technique and nowadays this approach is suggested only in very critical patients not otherwise treating.

8) *Jejunostomy* is an adjunct to surgical therapy of DF and it can be a useful tool in the medical management of proximal fistulas. Insertion of a feeding tube distal to a DF allows normal process of digestion and absorption with a low rate of morbidity. Enteral nutrition can be a good and cheap alternative to total parenteral nutrition even though data reported in literature show that less then 50% of DF patients tolerate adequate amounts of enteral nutrition [81], due to presence of ileus, sepsis, and hypoalbuminemia.

9) *Vacuum assisted closure (VAC).* The application of topical negative pressure [82] is not a strictly surgical approach but can be associated with other surgical techniques both in the direct treatment of DF or for associated abdominal wound infections. The VAC system (KCI International, San Antonio, TX) works by a continuous or intermittent aspiration of fistula effluents, protecting and promoting healing of excoriated skin and in the open abdomen exerts a continuous medial traction on the fascial edges of the wound [83]. Active removal of excess interstitial fluids from tissues may decompress small blood flow and therefore improve supply of oxygen and nutrients for tissue repair and granulation tissue formation. The VAC reduces colonisation of anaerobic bacteria, enhancing neutrophils bacteria killing. Bacterial colonisation was decreased by 1000-fold after 4 days of treatment with VAC compared with non-negative pressure treatment [84]. In one of the first papers published on this topic by Barker et al [85], the presence of an intestinal fistula was an absolute contraindication for VAC management; but nowadays, we have many papers promoting the use of the VAC system directly over the enteric fistula [86]. Castriconi et al. [87] reported that 30 out of 35 patients with DF were successfully treated by VAC with a mean recovery time of 45 days, while Medeiros [88] reported 74 patients with gastrointestinal postoperative fistulas treated by VAC where moderate/low-output fistulas had the best results: 65% closed after 5 days, 22% after 10 days and 5% after 15 days, and failure was observed in only 8% of patients. VAC therapy has gained acceptance as a reliable technique to simplify the nursing management of the open abdomen and the intestinal fistula. However, the use of VAC is not free of risk; in his paper Rao et al. [89] reported the development of abdominal complications such as new intestinal fistulas, and he identified as negative prognostic factors the presence of intestinal inflammation, meshes, sutured enterotomy or anastomoses.

The laparoscopic approach to the operative treatment of DF

In the initial reports of laparoscopic management for Crohn's and diverticular disease, the presence of a fistula was considered a contraindication for this approach [90,91]. But, with increasing experience, there have been some reports of laparoscopic resections for fistulas with the same advantages of early recovery, shorter hospital stay and decreased adhesion formation as seen with other laparoscopic intestinal procedures [92,93]. Furthermore laparoscopic adhesiolysis in a selected group of patients can provide a view of the abdominal wall and all adherent loops, which would be difficult to obtain via a traditional laparotomy. Pokala et al. [94] reported the results of 43 patients who underwent laparoscopic surgery for internal fistulas caused by Crohn's or diverticular disease. All types of fistula, including colovescical, colovaginal, and enterocolic fistulas, were managed definitively with a single-stage procedure. The Authors reported a mean operative time of 163 minutes, a mean length of hospital stay of 5.2 day, six major complications (14%) and seven minor complications (16.3%), the conversion rate was 32.6% and the most common cause of conversion was dense adhesions. Duodenal involvement by the fistulas and low colovaginal fistulas are associated with higher conversion rates. Regan and Salky [95] reported their

experience with 72 patients undergoing laparoscopic operations for DF complicating diverticular and Crohn's disease; conversion rate was 4.1%, median length of hospital stay 5.2 days, and overall complication rate 11%.

Factors predictive of DF recurrence after surgery

Lynch et al. [48] reviewed 205 patients with enterocutaneous fistulas who required acute or elective surgical management in order to define factors related to a successful surgical outcome. Multivariate analysis demonstrated that surgical repair technique was the most significant predictor of fistula recurrence, since patients with a wedge repair or fistula oversewing had a recurrence rate of 36%, compared with 16% if the DF was resected or the anastomosis revised. These results are reminiscent of a previous series without multivariate analysis in which fistula closure was obtained in 57 of 66 patients (89%) having fistula resection, compared with only 19 of 32 (59%) after direct suture closure [45]. In some cases, a fistula may be oversewn when it is not thought possible to perform a resection, for example because of the inability to adequately mobilize the bowel. In these cases consideration should be given to protecting the repair with a proximal stoma or making a bypass of that area.

Conclusions

The management of DF is both time consuming and emotionally taxing and needs daily attention by a senior surgeon, because several care options are available and often only specific experience in this field can lead to healing. In fact, indications to surgical treatment, timing and choice of operation type cannot often be standardized because they depend on a puzzle of DF and patient characteristics. Furthermore, in specific cases, the involvement of both nutritionist and plastic surgeon is indicated. Mortality and morbidity in DF patients are also influenced by the number and significance of errors in medical management. Moreover it has been demonstrated that higher mortality is linked to hospitals with low patient volume and inadequate surgical training or experience in this specific field [96]. Failure to spend a small amount of time each day with the patient results in a large expenditure of time later because of psychologic "meltdown". Psychologic support of both patient and family is essential, as these patients are often desperate, with problems concerning body image, odor, cleanliness when not focused on survival; and intrafamilial tensions are usually present.

Conflict of interest Statement

The authors declare that there are no conflict of interest.

Riassunto

La chirurgia rappresenta il principale mezzo di trattamento delle fistole dell'apparato digerente (DF) mail suo ruolo è cambiato negli ultimi 40 anni.
Lo scopo di questa revisione è quello di analizzare il trattamento chirurgico delle fistole digestive (DF) con particolare attenzione ai tempi dell'intervento ed al metodo chirurgico da adottare.
METODI: Abbiamo eseguito una revisione della letteratura prendendo in considerazione I seguenti archivi elettronici: Medline, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials, EMBASE e la bibliografia dei principali lavori analizzati. Le ricerche bibliogarfiche sono state eseguite usando le seguenti parole "chiave": "fistole digestive"; "fistola gastrointestinale"; "fistola enterocutanea"; "e chirurgia"; "e trattamento chirurgico". Per l'assenza di studi randomizzati abbiamo preso in considerazione le casistiche più numerose o le tecniche originali adottate.
RISULTATI: Il trattamento chirurgico delle DF ha due indicazioni: il trattamento delle complicazioni dovute alla azione del succo della DF, come la peritonite, gli ascessi, la gangrena i sanguinamenti; e quando una fistola non tende a guarire. In questo caso l'indicazione chirurgica è spesso difficile da definire, per il rischio di eseguire una azione inconcludente.
CONCLUSIONI: Le indicazioni al trattamento chirurgico, I tempi di intervento e la scelta della tecnica da adottare molto spesso non possono essere standardizzate perchè esse dipendono sia dal tipo di fistola che dalle caratteristiche del paziente. In casi particolari è necessaria la collaborazione con i nutrizionisti e con il chirurgo plastico.

References

1) Pickhardt PJ, Bhalla S, Balfe DM*: Acquired Gastrointestinal Fistulas: Classification, Etiologies, and Imaging Evaluation.* Radiology, 2002; 224:9-23.

2) Berry SM, Fischer JE: *Classification and pathophysiology of enterocutaneous fistulas.* Surg Clin North Am, 1996; 76:1009-18.

3)Rubelowsky J, Machiedo GW: *Reoperative versus conservative management for gastrointestinal fistulas.* Surg Clin North Am, 1991; 71:147-57.

4) Falconi M, Pederzoli P: *The relevance of gastrointestinal fistulae in clinical practice: A review.* Gut, 2001; 49:2-10.

5) Campos ACL, Meguid MM, Coelho JCU: *Factors influencing outcome in patients with gastrointestinal fistula.* Surg Clin North Am, 1996; 76:1191-198.

6) Fisher JE: *The pathophysiology of enterocutaneous fistulae.* World J Surg, 1983; 7:446-50.

7) Chamberlain RS, Kaufman HL, Danforth DN: *Enterocutaneous fistula in cancer patients: Etiology, management, outcome, and impact on further treatment.* Am Surg, 1998; 64:1204-211.

8) Levy E, Frileux P, Cugnenc PH, Honiger J, Ollivier JM, Parc R: *High-output external fistulae of the small bowel: management with continuous enteral nutrition.* Br J Surg ,1989; 76:676-79.

9) Fazio VW, Coutsoftides T, Steiger E: *Factors influencing the outcome of treatment of small bowel cutaneous fistulas.* World J Surg, 1983; 7:481-88.

10) Sitges-Serra A, Jaurrieta E, Sitges-Creus: *Management of postoperative enterocutaneous fistulas: The roles of parenteral nutrition and surgery.* Br J Surg, 1982; 69:147-50.

11) McIntyre PB, Ritchie JK, Hawley PR, Bartram CI, Lennard-Jones JE.: *Management of enterocutaneous fistulas: A review of 132 cases.* Br J Surg 1984; 71:293-96.

12) Bosscha K, Hulstaert PF, Visser MR, van Vroonhaven TJ, van der Werken C: *Open management of the abdomen and planned reoperations in severe bacterial peritonitis.* Eur J Surg, 2000; 166:44-49.

13) Mastboom WJ, Kuypers HH, Schoots FJ, Wobbes T: *Small-bowel perforation complicating the open treatment of generalized peritonitis.* Arch Surg, 1989; 124:689-92.

14) Schein M, Decker GA: *Gastrointestinal fistulas associated with large abdominal wall defects: experience with 43 patients.* Br J Surg, 1990; 77:97-100.

15) Adkins AL, Robbins J, Villalba M, Benedick P, Shanley CJ: *Open abdomen management of intra-abdominal sepsis.* Am Surg, 2004; 70:137-40.

16) Jamshidi R, Schecter WP: *Biological dressings for the management of enteric fistulas in the open abdomen.* Arch Surg 2007; 142:793-96.

17) Losanoff JE, Richman BW, Jones JW: *Intestinal fistulization in the open treatment of peritonitis.* Am J Surg, 2003; 185:394.

18) Sriussadaporn S, Sriussadaporn S, Kritayakirana K, Pak-Art R: *Operative management of small bowel fistulae associated with open abdomen.* Asian J Surg, 2006; 29:1-7.

19) Sleeman D, Sosa JL, Gonzalez A, Mc Kenney M, Puente I, Matos L et al.: *Reclosure of the open abdomen.* J Am Coll Surg, 1995; 180:200-4.

20) Dumanian GA, Llull R, Ramasastry SS, Greco RJ, Latze MT, Edington H: *Postoperative abdominal wall defects with enterocutaneous fistulae.* Am J Surg, 1996; 172:332-34.

21) Sriussadaporn S, Pak-Art R, Bunjongsat S: *Immediate closure of the open abdomen with bilateral bipedicle anterior abdominal skin flaps and subsequent retrorectus prosthetic mesh repair of the late giant ventral hernia.* J Trauma 2003; 54:1083-89.

22) Annibali R, Pietri P: *Fistulous complications of Crohn's disease.* Int Surg, 1992; 77:19-27.

23) Froines EJ, Palmer DL: *Surgical therapy for rectovaginal fistulas in ulcerative colitis.* Dis Colon Rectum, 1991; 34:925-30.

24) Vasilevsky CA, Belliveau P, Trudel JL, Stein BL, Gordon PH: *Fistulas complicating diverticulitis.* Int J Colorect Dis, 1998; 13:57-60.

25) Donner CS: *Pathophysiology and therapy of chronic radiation-induced injury to the colon.* Dig Dis, 1998; 16:253-61.

26) Meissner K: *Late radiogenic small bowel damage: Guidelines for the general surgeon.* Dig Surg 1999; 16:169-74.

27) Csendes A, Diaz JC, Burdiles P, Braghetto I, Maluenda F, Nava O et al. :*Classification and treatment of anastomotic leakage after extended total gastrectomy in gastric carcinoma.* Hepatogastroenterol, 1990; 37s2:174-77.

28) Halversen RC, Hogle HH, Richards RC: *Gastric and small bowel fistulas.* Am J Surg, 1969; 118:968-72.

29) Tarazi R, Coutsoftides T, Steiger E, Fazio VW: *Gastric and duodenal cutaneous fistulas.* World J Surg, 1983; 7:463-73.

30) Papachristou DN, Fortner JG: *Anastomotic fistula complicating total gastrectomy and esophagogastrectomy for cancer of the stomach.* Am J Surg ,1979; 138:399-402.

31) Buckwalter JA, Herbst CA Jr.: *Leaks occuring after gastric bariatric operations.* Surgery, 1988; 103:156-60.

32) Gianello P, Baulieux J, Maillet P: *Esophageal and gastric fistula after hiatal hernia surgery.* Acta Chir Belg, 1985; 85:169-78.

33) Hauters P, de Canniere L, Collard JM, Buysschaert M, Michel LA.:*Gastrodiaphragmatic fistula after trans-abdominal Nissen fundoplication.* J Clin Gastroenterol, 1990; 12:313-15.

34) Shorr RM, Greaney GC, Donovan AJ: *Injuries of the duodenum.* Am J Surg, 1987; 154:93-98.

35) Schein M, Decker GA: *Postoperative external alimentary tract fistulas.* Am J Surg 1991; 161:435-38.

36) Chung MA, Wanebo HJ: *Surgical management and treatment of gastric and duodenal fistulas.* Surg Clin North Am, 1996; 76:1137-146.

37) Cogbill TH, Moore EE, Feliciano DV, Hoyt DB, Jurkovich GJ, Morris JA et al.: *Conservative management of duodenal trauma: A multicenter perspective.* J Trauma 1990; 30:1469-475.

38) Nassoura ZE, Ivatury RR, Simon RJ, Kithir T, Stahl WM: *A prospective reappraisal of primary repair of penetrating duodenal injuries.* Am Surg, 1994; 60:35-39.

39) Cullen JJ, Sarr MG, Ilstrup DM: *Pancreatic anastomotic leak after pancreaticoduodenectomy: Incidence, significance and management.* Am J Surg, 1994; 168:295-98.

40) Fernandez-del Castillo C, Rattner DW, Warshaw AL: *Standards for pancreatic resection in the 1990s.* Arch Surg, 1995; 130:295-9.

41) Ho HS, Frey CF: *Gastrointestinal and pancreatic complications associated with severe pancreatitis.* Arch Surg, 1995; 130:817-22.

42) Tsiotos GG, Smith CDE, Sarr MG: *Incidence and management of pancreatic and enteric fistulas after surgical management of severe necrotizing pancreatitis.* Arch Surg, 1995; 130:48-52.

43) Ridgeway MG, Stabile BE: S*urgical management and treatment of pancreatic fistulas.* Surg Clin North Am, 1996; 76:1159-73.

44) Ihse I, Larsson J, Lindstrom E. *Surgical management of pure pancreatic fistulas.* Hepatogastroenterology 1994; 41:271-75.

45) Reber HA, Roberts C, Way LW, Dunphy JE: *Management of external gastrointestinal fistulas.* Ann Surg, 1978; 188:460-67.

46) Rinsema W, Gouma DJ, von Meyenfeldt MF, van der Linden CJ, Soeters PB: *Primary conservative management of external small-bowel fistulas: changing composition of fistula series?* Acta Chir Scand, 1990; 156: 457-62.

47) Lavery IC: *Colonic fistulas.* Surg Clin North Am, 1996; 76: 1183-90.

48) Lynch AC: *Clinical outcome and factors predictive or recurrence*

after enterocutaneous fistula surgery. Ann Surg, 2004; 240: 825-31.

49) Borison DI, Bloom AD, Pritchard TJ: *Treatment of enterocutaneous and colocutaneous fistulas with early surgery or Somatostatin analog.* Dis Colon Rectum, 1992; 35:635-39.

50) De Costa A: *Making a virtue of necessity: Managing the open abdomen.* ANZ J Surg, 2006; 76:356-63.

51) Rolandelli R, Roslyn JJ: *Surgical management and treatment of sepsis associated with gastrointestinal fistulas.* Surg Clin North Am, 1996; 76:1111-122.

52) Fazio VW, Coutsoftides T, Steiger E: *Factors influencing the outcome of treatment of small bowel cutaneous fistula.* World J Surg, 1983; 7:481-8.

53) Conter RL, Roof L, Roslyn JJ: *Delayed reconstructive surgery for complex enterocuateous fistula*s. Am Surg, 1988; 54:589-93.

54) Polk HC Jr, Fry DE: *Radical peritoneal debridement for established peritonitis: The results of a prospective randomized clinical trial.* Ann Surg, 1980; 192: 350-55.

55) Hau T, Ahrenholz DH, Simmons RL: *Secondary bacterial peritonitis: The biological basis of treatment.* Curr Probl Surg 1979; 16:1-65.

56) Hallerback B, Anderssom C, Englund N, Glise H, Nilhberg A, Solhaug J et al.: *A prospective randomized study of continuous peritoneal lavage postoperatively in the treatment of purulent peritonitis.* Surg Gynecol Obstet, 1986; 163:433-6.

57) Leiboff AR, Soroff HS: *The treatment of generalized peritonitis by closed postoperative peritoneal lavage: A critical review of the literature.* Arch Surg, 1987; 122:1005-10.

58) D'Harcour JB, Boverie JH, Dondelinger RF: *Percutaneous management of enterocutaneous fistulas.* Am J Roentg, 1996; 167:33-38.

59) Delaney CP, Fazio VW: *Ileostomy construction in complex reoperative surgery with associated abdominal wall defects.* Am J Surg 2000; 180: 51-2.

60) Mulholland MW, Delaney JP: *Proximal diverting jejunostomy for compromised small bowel.* Surgery, 1983; 93: 443-47.

61) Bosscha K, Vroonhoven JMV: *Novel approach to the treatment of intestinal fistula in the inaccessible abdomen: Transbursal end-to-side duodenogastrostomy.* Br J Surg, 1998; 85: 276-78.

62) Schecter WP, Ivatury RR, Rotondo MF, Hirshberg A: *Open abdomen after trauma and abdominal sepsis: A strategy for management.* J Am Coll Surg ,2006; 203: 390-96.

63) Subramaniam MJ, Liscum KR, Hirshberg A: *The floating stoma: a new technique for controlling exposed fistulae in abdominal trauma.* J Trauma, 2002; 53:386-88.

64) Leenen LPH, Kuypers JHC: *Some factors influencing the outcome of stoma surgery.* Dis Colon Rectum, 1989; 32: 500-4.

65) Dudley HA, Radcliffe AG, McGeehan D: *Intraoperative irrigation of the colon to permit primary anastomosis.* Br J Surg, 1980; 67:80-81.

66) Allen-Mersh TG: *Should primary anastomosis and on-table colonic lavage be standard treatment for left colon emergencies?* Ann R Coll Surg Engl,1993; 75:195-89.

67) Schirmer CC, Gurski RR, Gugel FL, Lazzaron AR, Brentano L, Kruel CD: *Alternative surgical treatment for complex enterocutaneous fistula.* Int Surg, 1999; 84:29-34.

68) Girard S, Sideman M, Spain DA: *A novel approach to the problem of intestinal fistulization arising in patients managed with open peritoneal cavities.* Am J Surg, 2002; 184:166-67.

69) Gibble JW, Ness PM: *Fibrin glue: The perfect operative sealant?* Transfusion, 1990; 30:741.

70) Sarfeh IJ, Jakowatz JG: *Surgical treatment of enteric "bud" fistulas in contaminated wounds: A riskless extraperitoneal method using split-thickness skin grafts.* Arch Surg, 1992; 127:1027-30.

71) Jones SA, Joergenson EJ: *Closure of duodenal wall defects.* Surgery, 1963; 53:438-42.

72) Ujiki GT, Shields TW: *Roux-en-Y operation in the management of postoperative fistula.* Arch Surg, 1981; 116:614-17.

73) Agarwal P, Sharma D: *Repair of duodenal fistula with rectus abdominis muscolo-peritoneal (RAMP) flap.* Indian J Gastroenterol, 2004; 23:143-44.

74) Burch JM, Moore EE, Moore FA, Franciose R: *The abdominal compartment syndrome.* Surg Clin North Am, 1996; 76:833-39.

75) Chang MC, Miller PR, D'Agostino R Jr, Meredith JW: *Effects of abdominal decompression on cardiopulmonary function and visceral perfusion in patients with intra-abdominal hypertension.* J Trauma, 1998; 44:440-45.

76) Faull RJ: *Peritoneal defenses against infection: Winning The battle but losing the war?* Semin Dial, 2000; 13:7-44-56.

77)Davies MG, Hagen PO: *Systemic inflammatory response syndrome.* Br J Surg, 997; 84:920-35.

78)WickelWB, Barker DE, r-Jones MA, Garrison RN: *Pooroutcome from peritonitis is caused by disease acuity and organ failure, not recurrent peritoneal infection.* Ann Surg, 1997; 225:744-56.

79) Brock WB,Cheadle WG, Mercer-Jones MA, Garrison RN: *Poor outcome from peritonis is casued by disease acuity and organ failure, not recurrent perioneal infection.* Ann Surg, 1997; 225:744-56.

80) RobledoFA,Luque-De-Leon E.Suarez R,Sanchez P,de-la-Fuente M. Vargas A, et al.: *Open vs closed management of the abdomen in the surgical treatment of severe secondary peritonitis: a randomized clinical trial.* Surgical Infections, 2007; 8:63-71.

81)Garden OJ, Dikes EH, Carter DC: *Surgical and nutritional management of postoperative duodenal fistulas.* Dig Dis Sci, 1988; 33:30-35.

82)Cro C, George KJ, Donnelly J, Irwing ST, Gardner KR: *Vacuum assisted closure system in the management of enterocutaneous fistulae.* Postgrad Med J, 2002; 78:364-6.

83) Easterlin B, Bromberg W, Linscott J: *A novel technique of vacuum assisted wound closure that functions as a delayed primary closure.* Wounds, 2007; 19:331-33.

84) Morykwas MJ, Argenta LC*: Nonsurgical modalities to enhance healing and care of soft tissue wounds.* J South Orthop Assoc, 1997; 6: 284-86.

85) Barker DE, Kaufman HJ, Smith LA, Ciraulo DL, Richart CL, Burns RP: *Vacuum pack technique of temporary abdominal closure: A 7-year experience with 112 patient*s. J Trauma, 2000; 48:201-6.

86) Alvarez AA, Maxwell GI, Rodriguez GC: *Vacuum assisted closure for cutaneous gastrointestinal fistula management.* Gynecol Oncol, 2001; 3:413-16.

87) Castriconi M, Romagnuolo G, Giuliano ME, Bartone G, Chianese F, Maglio MN, et al.: *Conservative treatment of the digestive fistulas: Personal experience*. Ann Ital Chir, 2005; 76:523-27.

88) Medeiros AC, Aires-Neto T, Marchini JS, Brandao-Neto J, Valenca DM, Egito ES: *Treatment of postoperative enterocutaneous fistulas by high-pressure vacuum with a normal diet*. Dig Surg, 2004; 21: 401-5.

89) Rao M, Burke D, Finan PJ, Sagar PM: *The use of vacuum-assisted closure of abdominal wounds: A word of caution.* Colorectal Disease, 2007; 9:266-68.

90) Kockerling F, Schneider C, Reymond MA, Scheidbach H, Scheuerlein H, Konradt J, et al.: *Laparoscopic resection of sigmoid diverticulitis: Results of a multicenter study. Laparoscopic Colorectal Surgery Study Group*. Surg Endosc 1999; 13:567-71.

91) Ludwig KA, Milsom JW, Church JM, Fazio VW: *Preliminary experience with laparoscopic intestinal surgery for Crohn's disease*. Am J Surg, 1996; 171:55-56.

92) Poulin EC, Schlachta CM, Mamazza J, Seshadri PA: *Should enteric fistulas from Crohn's disease or diverticulitis be treated laparoscopically or by open surgery? A matched cohort study*. Dis Colon Rectum, 2000; 43:626-27.

93) Watanabe M, Hasegawa H, Yamamoto S, Hibi T, Kitajima M: *Successful application of laparoscopic surgery to the treatment of Crohn's disease with fistulas.* Dis Colon Rectum, 2002; 45:1057-61.

94) Pokala N, Delaney CP, Brady KM, Senagore AJ: *Elective laparoscopic surgery for benign internal enteric fistulas. A review of 43 cases*. Surg Endosc, 2005; 19:222-25.

95) Regan JP, Salky BA: *Laparoscopic treatment of enteric fistulas*. Surg Endosc, 2004; 18:252-54.

96) Yeh TS, Jan YY, Jeng LB, Hwang TL, Wang CS, Chen SC, et al.: *Pancraticojejunal anastomic leak after pancreaticoduodenectomy-multivariate analysis of perioperative risk factors*. J Surg Res, 1997; 67:119-25.