Outcome of Reconstructive Surgery for Intestinal Fistula in the Open Abdomen

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Objective: To determine factors which influence the outcome of surgical techniques to close enterocutaneous fistulas within the open abdomen.

Summary Background Data: Enterocutaneous fistulation within an open abdominal wound is associated with considerable morbidity and mortality. The factors that influence the outcome of reconstructive surgery are unclear.

Methods: Sixty-one patients undergoing 63 operations to close enterocutaneous fistulas associated with open abdominal wounds were referred to a national center for further management. Once sepsis had been eradicated, nutritional status restored and local conditions in the abdomen judged to be suitable, fistulas were resected and the abdominal wall reconstructed by suture repair with and without component separation, or by suture repair in combination with absorbable or nonabsorbable prosthetic mesh. Patients were followed up for 16 to 84 months postoperatively.

Results: There were 3 postoperative deaths (4.8%). Major complications, including postoperative respiratory and surgical site infection occurred in 52 of 63 (82.5%) procedures. Refistulation occurred in 7 cases (11.1%) but was more common when the abdominal wall was reconstructed with prosthetic mesh (7 of 29, 24.1%) than with sutures (0 of 34, 0%). Porcine collagen mesh was associated with a particularly high rate of refistulation (5 of 12, 41.7%).

Conclusions: Simultaneous reconstruction of the intestinal tract and abdominal wall remains associated with a high complication rate, justifying the management of such patients in specialized units. Simultaneous reconstruction of the abdominal wall with prosthetic mesh is associated with a particularly high incidence of recurrent postoperative fistulation and should be avoided if possible.

(*Ann Surg* 2008;247: 440–444)

Management of severe abdominal sepsis associated with anastomotic dehiscence is frequently associated with the need for repeated laparotomy.[1] In the most severe cases, recurrent or persistent abdominal infection or the abdominal hypertension associated with marked visceral edema and massive fluid replacement may necessitate leaving the abdomen open (laparostomy).[2] Although laparostomy may facilitate the management of severe abdominal sepsis, the open abdomen is inherently fistulogenic[3,4] and many patients with a laparostomy develop fistulas within the loops of bowel covered with granulation tissue, related either to the primary cause of abdominal sepsis or to secondary bowel injury during the process of dressing the open abdominal wound.

Although reconstructive surgery can be successfully undertaken in such cases, usually after a prolonged period of nutritional support during which a neo-peritoneal cavity forms,[5] the loss and retraction of the abdominal wall tissues associated with the presence of large laparostomy defects often present as great a challenge for the surgeon as reconstruction of the gastrointestinal tract, particularly given the considerable potential for refistulation.[6] The difficulty in successfully managing this particularly complex group of patients is reflected in their relatively poor prognosis. For example, although improvements in surgical critical care and advances in diagnosis and management of sepsis and intestinal failure have been associated with an overall reduction of the mortality rate associated with postoperative gastrointestinal fistulation from over 60%[7] to between 6% and 20%,[8] the overall mortality rate for patients with gastrointestinal fistulas within the open abdomen was reported to exceed 50% a decade later, despite management in a specialized center.[9] It is unclear whether continued improvements in the management of sepsis and nutritional support, and refinements in surgical techniques for abdominal reconstructive surgery have led to improvements in the outcome of treatment for these patients. Furthermore, there are few data available concerning the relevance to outcome of differing techniques for reconstruction of the abdominal wall in these patients. The present study, from a specialized national referral center established by the UK Department of Health for the management of such cases, reports the results of management of patients with enterocutaneous fistulas associated with laparostomy. A specific objective of the present study was to address the influence of techniques used for abdominal wall closure on the outcome of surgery. The results of the present study suggest that, with careful attention to optimal sepsis control, nutritional support and the timing and technique of surgery to reconstruct the gastrointestinal tract and abdominal

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ISSN: 0003-4932/08/24703-0440

DOI: 10.1097/SLA.0b013e3181612c99

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wall, very substantial improvements in outcome for these challenging problems can now be obtained.

METHODS

Consecutive patients undergoing reconstructive gastrointestinal surgery for enterocutaneous fistula associated with laparostomy between January 1, 1999 and December 31, 2006 were identified from a prospectively maintained clinical database, and a review of case notes undertaken to determine patient demographics, primary etiology of the abdominal sepsis which led to the formation of the enterocutaneous fistula, time from development of the fistula to reconstructive surgery, nature of intestinal surgery undertaken and techniques used to reconstruct the abdominal wall.

The techniques used to reconstruct the intestinal tract in this setting have been previously reported in our unit,[5,10] and were employed in the present study. The technique of abdominal wall closure was chosen according to the surgeon's preference at the time of surgery. Techniques used to close the defect in the abdominal wall were classified either as suture repair alone, mesh repair alone, or a combination of suture/mesh repair. In all cases, the abdominal wall was dissected free, assisted by the component-separation technique if required[11] and an attempt was made to close the defect by suture alone, where it was judged possible to do so by the surgeon. Suture repair techniques included simple mass closure and double near and far[12] or continuous double loop closure.[13] Prosthetic mesh was used only when the size of the abdominal wall defect was considered too large for the abdominal wall to be safely approximated despite component separation, or there was clinical concern regarding the possibility of resulting abdominal hypertension. Intra-abdominal pressure monitoring was not routinely undertaken.

Prosthetic mesh was employed, when required, as an adjunct to suture repair of the abdominal wall. In such cases, the upper and lower parts of the abdominal wall were united by suture repair, and the diamond-shaped defect in the central abdomen, where there was insufficient native abdominal wall to allow suture repair, was reconstructed with prosthetic mesh using a mesh inlay technique. When there was insufficient abdominal wall to allow approximation of any of the native abdominal wall tissues, even after mobilization and component separation, the abdominal wall was reconstructed entirely using an implant of prosthetic mesh. All patients were nursed on the High Dependency or Intensive Care unit postoperatively until mechanical ventilation and inotropic support were not required, at which time they were transferred to the Intestinal Failure Unit or routine ward until discharge.

All patients were reviewed at 6 weeks after discharge from hospital, 6 monthly thereafter, or more frequently depending upon clinical need. Postoperative mortality and morbidity were noted, including surgical site and lower respiratory tract infection,[14,15] recurrent fistulation (defined as any leakage of bowel content from the abdominal wound at any time in the postoperative period), incisional hernia formation (defined as clinically apparent localized or generalized weakness of the abdominal wall at the wound site), duration of intensive care and hospital stay, and need for unplanned postoperative mechanical ventilation or readmission to the Intensive Care Unit in the first 30 postoperative days. Patients were followed up for a median of 29 (range 16–84) months after hospital discharge.

Statistical analysis of complication rates with respect to differences in wound closure techniques was undertaken using Fisher exact test, with $P < 0.05$ taken as the level of statistical significance. All statistical analyses were undertaken using Graphpad Prism Software for the PC (Graphpad Prism inc., San Diego, CA).

RESULTS

Between January 1, 1999 and December 31, 2006, 61 (31 male) patients, median age 50 (range 20–60) years, with laparostomies and associated enterocutaneous fistulas underwent 63 operative procedures to close the fistulas surgically and simultaneously reconstruct the abdominal wall defect. Patients were followed up for a median of 29 (range 16–84) months. In all cases, a laparostomy had been created during a series of abdominal operations undertaken for the management of recurrent abdominal infection, associated with intestinal fistulation and abdominal sepsis resulting from complications of surgery. The most common clinical condition for which the surgery which had led to postoperative fistulation was undertaken was Crohn disease (n = 17, 26.9%), though surgical treatment of a variety of other conditions also contributed to the creation of intestinal fistulas within laparostomy wounds.

In 25 cases, abdominal sepsis developed as a primary consequence of anastomotic leakage, whereas leakage from enterotomies was responsible for abdominal sepsis in 22 cases. In the remaining 16 cases, abdominal sepsis developed primarily, as a consequence of Crohn disease (4 cases), perforated diverticular disease (4 cases), necrotizing pancreatitis (2 cases), mesenteric vascular thrombosis (2 cases), accidental injury (2 cases), perforated peptic ulcer (1 case), and strangulated small intestinal adhesion obstruction (1 case).

The median (range) number of laparotomies undertaken before the establishment of a laparostomy and associated intestinal fistula was 3 (1–8) and the median (range) duration between the creation of the laparostomy and associated intestinal fistula and the corrective procedure undertaken to restore intestinal continuity and reconstruct the abdominal wall defect was 11 (6–34) months. Fistulas involved the small intestine alone in 52 (82.5%) cases, both small and large intestine in 7 (11.1%), and the colon alone in 4 (6.3%) cases. Restoration of intestinal continuity involved a median of 1 (range 1–4) intestinal anastomoses.

Suture repair alone was used to close the abdominal defect in 34 (54.0%) cases. In 17 cases (27.0%), simple mass closure was possible after mobilization of the abdominal wall. Suture repair was combined with bilateral component separation in 5 cases, whereas in 17 cases (27.0%) near and far suture was required to satisfactorily close the abdominal wall defect. In the remaining cases, a combination of suture repair and prosthetic mesh were required for closure of the abdominal wall defect. In 22 cases (34.9%), mass closure was combined with insertion of prosthetic mesh, whereas in 5

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TABLE 1. Outcome of Techniques Used to Reconstruct Abdominal Wall Defects in Patients Undergoing Simultaneous Closure of Enterocutaneous Fistulas

Closure Technique	n (%)	Median (Range) Critical Care Stay (d)	Median (Range) Total Hospital Stay (d)	Death n (%)	Unplanned ICU Readmission n (%)	Prolonged Ventilation n (%)	SSI n (%)	LRTI n (%)	Other
Suture repair	34 (54.0)	4 (2–19)	25 (8–165)	2 (5.9)	3 (8.8)	3 (8.8)	10 (29.4)	8 (23.5)	Central line infection, n = 3 MODS, n = 3 Arrhythmia, n = 2 GI bleed, n = 1 Seroma, n = 1
Suture + prosthetic mesh	27 (42.8)	4.5 (2–16)	48 (8–180)	1 (3.7)	2 (7.4)	2 (7.4)	11 (40.7)	10 (37.0)	Central line infection, n = 4 MODS, n = 2 Seroma, n = 1 Arrhythmia, n = 1 DVT, n = 1
Mesh repair	2 (3.2)	4 (4)	108.5 (34–183)	0 (0)	0 (0)	0	2 (100)	0 (0)	Acute renal, failure n = 1 Arrhythmia, n = 1

SSI indicates surgical site infection; LRTI, lower respiratory tract infection; MODS, multiple organ dysfunction syndrome; DVT, deep vein thrombosis; ICU, intensive care unit.

cases (7.9%), near and far repair was combined with insertion of prosthetic mesh. In 2 cases (3.2%) the abdominal defect was so large that it was impossible to approximate any part of the abdominal wall during abdominal closure and the abdominal wall was closed entirely with prosthetic mesh in these cases. Prosthetic mesh was thus employed in 29 cases (46.0%). In 12 cases (41.3%), denatured porcine collagen mesh (Permacol, TSL Ltd., Castleford, UK) was used, whereas Polyglactin (Vicryl, Ethicon Ltd., Livingston, UK) and Polyglactin/Polypropylene (VyPro, Ethicon Ltd., Livingston, UK) were also employed in 14 (48.3%) and 3 cases (10.3%), respectively.

Intestinal reconstructive surgery was associated with a very high incidence of postoperative complications (Table 1), with 52 of the 63 procedures (82.5%) leading to the development of 1 or more major complications, with surgical site infection (23 cases, 36.5%), respiratory infection (18 cases, 28.6%), and central line infection predominating. In 5 cases (7.9%), intestinal reconstructive surgery was associated with unplanned readmission to the intensive care unit and a need for prolonged mechanical ventilation beyond the immediate postoperative period. There were 3 deaths (4.8%) within 30 days of surgery, associated with abdominal sepsis in 2 cases and central line sepsis in 1 case. Two patients required further laparotomy within 30 days, one as a result of abdominal sepsis, and another as a result of sepsis of unknown origin, for which exploratory laparotomy (negative) was undertaken to exclude anastomotic dehiscence. There were no statistically significant differences between the incidence of surgical site or respiratory infection, or of other major postoperative complications when the outcome of techniques used for reconstruction of the abdominal wall was compared (Table 1).

The use of mesh was, however, strongly associated with postoperative intestinal fistulation and incisional hernia formation (Table 2). There were no postoperative intestinal fistulas or incisional hernias in patients where it was possible to close the abdomen without the use of prosthetic mesh, irrespective of whether the abdomen was closed using simple mass closure or near and far sutures. By contrast, the use of prosthetic mesh of any form was associated with a significantly greater incidence of postoperative enteric fistulation (24.1%, $P = 0.003$) and incisional hernia formation (62.1%, $P < 0.001$). Although porcine collagen mesh was employed in only 12 cases, this was associated with recurrent fistulation in 5 (41.7%), whereas refistulation occurred in only 2 of the remaining 51 (3.9%) cases ($P < 0.002$). When the incidence of refistulation with the use of porcine collagen mesh was compared only with those cases in which other forms of mesh were used for reconstruction of the abdominal wall (2 of 17,

TABLE 2. Fistulation and Incisional Hernia Formation in Patients Undergoing Simultaneous Abdominal Wall Reconstruction and Closure of Enterocutaneous Fistula

Closure Technique	n (%)	Fistula, n (%)	Incisional Hernia, n (%)
Suture repair alone			
Near and far suture	17	0 (0)	0 (0)
Mass closure	17	0 (0)	0 (0)
Total	34 (54)	0 (0)	0 (0)
Suture repair + prosthetic mesh			
Porcine collagen	12	5 (41.7)	5 (41.7)
Polyglactin mesh	12	2 (16.7)	11 (91.7)
VyPro mesh	3	0 (0)	0 (0)
Total	27 (42.8)	7 (25.9)	16 (59.2)
Prosthetic mesh alone			
Polyglactin	2 (3.2)	0 (0)	2 (100)
Total	63 (100)	7 (11.1)	18 (28.6)

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11.8%), the difference narrowly failed to achieve statistical significance ($P = 0.09$).

Polyglactin mesh was almost inevitably associated with postoperative incisional hernia formation (13 of 14 cases, 92.8%), whereas the use of suture repair, with or without other forms of prosthetic mesh, was associated with a significantly lower incidence of postoperative incisional hernia (5 of 49, 10.2%, $P < 0.001$). Incisional hernias developed, however, in 5 of the 12 cases in which porcine collagen mesh was used (41.7%), in all cases associated with recurrent intestinal fistulation.

DISCUSSION

Management of patients with severe intra-abdominal sepsis requires substantial investment in nursing and medical time and involves not only considerable use of critical care resource, but also repeated trips to the operating room to gain control of abdominal infection. In the present study, patients had already undergone up to 8 separate laparotomies before creation of a laparostomy. Although the open abdomen technique seems to allow effective control of abdominal infection, secondary fistulas may develop from edematous bowel loops within the wound, which become injured during the process of wound dressing, or by injudiciously applied vacuum dressings.[16] Secondary fistulation has been said to occur in up to 25% of patients during treatment with an open abdomen for abdominal sepsis, with an associated mortality of more than 40%[3] and, even in those patients who survive, the presence of multiple open bowel loops within the granulating wound creates considerable problems for definitive management of the resulting abdominal wall defect. In the present study, patients were referred having already undergone a series of laparotomies for sepsis elsewhere and it is not possible to determine the proportion of cases in which fistulation developed within the open wound as a secondary consequence of management of the open abdomen, as opposed to as the primary cause of the abdominal sepsis.

In contrast with a previous report of outcome in patients with gastrointestinal fistulas in the presence of a large abdominal defect, which was associated with a hospital mortality of 60%,[17] the results of the present study suggest that, almost 2 decades later, it is possible to achieve a substantially better outcome, with mortality rates below 5% and with refistulation in less than 12%. However, in the present series, reconstructive surgery to close the abdominal wall defect and simultaneously restore intestinal continuity was associated with a very high incidence of postoperative complications, and a particularly high incidence of surgical site and respiratory infection, when compared with previous reports of the outcome of techniques used to repair uncontaminated abdominal wall defects.[18] This difference is likely to relate, at least in part, to the added complexity of surgery and complications attributable to multiple intestinal anastomoses and contamination of the operative field with enteric contents in our patients.

The principles of undertaking reconstructive surgery in patients with multiple fistulas in open abdomen wounds have been described in detail elsewhere[10] and include ensuring complete resolution of sepsis, adequate restitution of nutritional status and allowing sufficient time for re-establishment of a neoperitoneal cavity.[5] The high incidence of major postoperative complications, in spite of adherence to these principles and careful attention to technical detail in a specialized national referral center underlines the challenge involved in managing these difficult problems and supports referral of these patients to centers with sufficient resources and experienced multidisciplinary teams for adequate treatment. Given the fact that almost 10% of patients had an unplanned postoperative admission to the intensive care unit, and the overall median length of postoperative stay for the group in a critical care environment was in excess of 8 days, availability of critical care resources is clearly essential for adequate management.

In the present series, use of any form of prosthetic mesh was associated with a significantly greater incidence of postoperative fistulation and incisional hernia formation, when compared with suture repair of the abdominal wall alone. Although these poor results are likely, in large part, to be directly attributable to the consequences of using prosthetic mesh in an already contaminated wound, the study was not randomized and it likely that other factors are at least as important. For example, it was not possible to achieve sound abdominal closure without using mesh in patients with the largest abdominal wall defects and the size and complexity of the defect, rather than the use of the mesh per se, may have been equally responsible for the higher incidence of postoperative complications. To determine whether the size of the defect and the degree of contamination, as opposed to the technique of reconstruction, was the prime source of complications would require a randomized controlled trial, which, given the relative rarity of the condition, and the heterogeneity of the patients groups, would be very difficult to undertake.

The very high incidence of postoperative complications associated with the use of porcine collagen mesh was particularly worrying, in view of recent reports suggesting that it could be used safely in highly contaminated wounds.[19] Although the difference between the results of porcine collagen mesh and other meshes narrowly failed to achieve statistical significance, possibly because of the relatively small sample size, the very poor performance of porcine collagen mesh in the present study was a surprise. Although this is, to our knowledge, the largest reported series of reconstructive surgical procedures on intestinal fistulas within the open abdomen, the relative infrequency of such complex cases, even within specialized units, and our policy of avoiding prosthetic mesh wherever possible left a relatively small cohort of patients undergoing simultaneous restoration of gastrointestinal continuity and mesh reconstruction of the abdominal wall. Although the results of the porcine collagen mesh were so poor that it would require only 20 patients in each arm of a study to confirm, with 80% power, the higher refistulation rates when collagen mesh was compared with and all other forms of mesh, at a significance level of 5%, it seems unlikely, that any single center could undertake a randomized controlled trial over a realistic time period. Most reports of safe use of porcine collagen mesh for extensive abdominal wall reconstruction have been of much smaller numbers of

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patients[19–21] and generally not in association with intestinal resection and anastomosis. Nevertheless, given the fact that the use of porcine collagen mesh might be expected to be associated with lower, rather than higher complication rates, the present findings suggest that it should be used with great caution in cases where reconstruction of both the intestinal tract and abdominal wall are required. Experimental studies have suggested that the capacity of biologic materials to resist infection may be no greater than that of synthetic prostheses[22] and previous studies of contaminated abdominal wounds containing prosthetic material, have suggested that avoiding further use of nonabsorbable prosthetic mesh is desirable, either by using plastic surgical techniques to reconstruct the abdominal wall[23,24] or by using absorbable mesh until contamination has resolved, pending definitive repair of the defect in a clean surgical field.[25] The findings of the present study support this conclusion and suggest that the technique chosen for abdominal wall reconstruction may have a significant bearing on the outcome of surgery for enterocutaneous fistula in the open abdomen.

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