Hypothesis: Proximal intestinal stomas established by the exteriorization of leaking anastomosis in the presence of peritonitis can be used to reinfuse succus entericus and provide adequate enteral nutrition.

Design: Retrospective analysis of prospectively gathered data from a cohort of consecutive patients admitted between January 1993 and December 1999 for postoperative peritonitis requiring laparotomy and the construction of one or more small-bowel stomas.

Setting: Tertiary referral center with a surgical intensive care unit experienced in the treatment of intra-abdominal sepsis and succus entericus reinfusion.

Patients: Twenty-one consecutive patients with postoperative peritonitis originating from a jejunal or ileal leak. We excluded patients with established enterocutaneous fistulae, abscesses amenable to percutaneous drainage or other conservative treatments, and postoperative peritonitis caused by ileocolic or ileorectal anastomosis.

Interventions: Early laparotomy with exteriorization of small-bowel leak(s), and continuous enteral nutrition (CEN) and succus entericus reinfusion (SER) via the distal portion of the stoma until gastrointestinal continuity was restored.

Main Outcome Measures: Feasibility of CEN and SER with temporary, diverting small-bowel stomas and their associated postoperative morbidity and mortality rates.

Results: One patient died, and 14 experienced complications. For technical reasons, CEN and SER were discontinued early on in 7 patients. The mean duration of CEN and SER was 58 days and 61 days, respectively. Enteral feedings allowed the suppression of central venous access after a median of 28 days, with 82 days as a median time to restoration of intestinal continuity.

Conclusions: Although the exteriorization of small-bowel leaks with CEN and SER is generally feasible and effective in the treatment of critically ill patients with peritonitis secondary to small-bowel leaks, it is associated with significant morbidity and mortality, in part relating to patients’ underlying diseases.

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POSTOPERATIVE peritonitis (POP) requiring reoperation is a serious condition associated with a mortality rate approximating 50%.5-8 Successful treatment requires complete control of the source of peritoneal contamination,5-8 necessitating exteriorization of the leaking intestinal segment whenever possible.9,10 Although this approach is generally accepted for colonic and distal small-bowel leaks, its use with proximal small bowel leakage remains contentious, proximal stomas result in a significant loss of intestinal fluid, rendering maintenance of the fluid and electrolyte balance difficult. Moreover, it is generally believed that proximal stomas preclude enteral nutrition and limit patient nutrition. Total parenteral nutrition (TPN) may be used, but experimental studies have demonstrated many advantages of continuous enteral nutrition (CEN) with regard to mucosal atrophy, gut barrier function, and peritoneal and pulmonary macrophage function.11-14 Since 1969, we have avoided primary repair for any dehisced small-bowel anastomosis causing leakage and generalized peritonitis.10 We have previously reported the benefits of reinfusing succus entericus from proximal to distal small-bowel stomas in patients receiving TPN.13 We have subsequently practiced succus entericus reinfusion (SER) with CEN in the treatment of patients with proximal small-bowel stomas. In this article we report our initial results in a homogenous group of patients with proximal small-bowel stomas constructed to treat POP caused by small-bowel-leaking anastomoses.

RESULTS

OPERATIVE FINDINGS

The underlying disease, initial procedure, and small-bowel abnormalities leading to subsequent peritonitis are detailed in the Table. Fourteen patients had a single
PATIENTS AND METHODS

We included patients admitted to the surgical intensive care unit between January 1993 and December 1999 for POP requiring laparotomy and the construction of small-bowel stomas. Patients with established enterocutaneous fistulae, a single abscess accessible with percutaneous drainage or conservative treatment, or postoperative peritonitis caused by ileocolic or ileorectal anastomosis were excluded.

Our study used 21 consecutive patients: 11 men and 10 women with a median age of 43 years (range, 18-74 years; mean±SD, 46±15 years). Four patients had initially undergone surgery in our own department (primary cases), whereas 17 patients had been referred from other centers, either at the time the POP developed (secondary cases: n=3) or following a failed attempt at controlling sepsis with a further surgical procedure (tertiary cases: n=12). The initial operation was performed for an underlying small-bowel lesion in 11 patients (52%) (Table). Among the 21 patients, 11 urgently needed the initial operation, including 6 patients with peritonitis. Preexisting extra-abdominal diseases were present in 10 patients, including cardiovascular diseases (n=3), chronic respiratory insufficiency (n=3), diabetes (n=2), and others (n=6).

The median time elapsed between the initial operation and reoperation in our department was 17 days (range, 3-170 days; mean±SD, 25±35 days). Fourteen of the 17 secondary and tertiary patients were operated on within 24 hours of admission into our department. Among the tertiary patients, the median time between the last operation at the referring institution and reoperation in our department was 9 days (range, 1-42 days; mean±SD, 14±13 days). The median Acute Physiology and Chronic Health Evaluation (APACHE) II score, measured within 24 hours of admission into our intensive care unit, was 16 (range, 10-22).

SURGICAL SALVAGE PROCEDURES

Indications for reoperation were worsening clinical signs of sepsis or the demonstration of a diffuse accumulation of fluid on a computed tomographic scan. Reoperations included relaparotomy with complete dissection and exploration of the peritoneal cavity to expose all sources of infection, exteriorization of leaking intestinal loops as stomas, insertion of drainage tubes and/or capillary (Mikulicz) drainage, and tension-free closure of the abdominal wall using longitudinal relaxation skin and anterior aponeurosis of the rectus sheath incisions when deemed necessary.

CEN AND TECHNIQUES OF SER

The succus entericus was collected in a sterile karaya gum-sealed stoma appliance connected to aspiration pumps at a pressure of 100 to 200 millibars. It was then refrigerated at +4°C and reinfused continuously through a silicone balloon rubber catheter inserted into the distal limb of the stoma at a rate corresponding to the stoma output. In patients with multiple small-bowel stomas, progressive staged reinfusions were used. Enteral nutrients (Nutrition Multi Fibre; Nutricia Clinical Care, Trowbridge, England) were administered via a percutaneous gastrostomy (n=15), using a nasogastric tube (n=1), or directly into the distal stomas (n=5) with the succus entericus. Patients were allowed to eat and drink when possible.

source of intestinal leakage requiring a single exteriorization, whereas 7 needed multiple stomas. An associated large-bowel lesion was present in 4 patients: those with a leaking colorectal anastomosis (n=2), a leaking colocolic anastomosis (n=1), and leakage at the closure site of a transverse colon fistula (n=1). However, the principal source of contamination of the peritoneal cavity was small-bowel leakage in all 21 patients.

OPERATIVE PROCEDURES

The number and site of stomas as well as the length of the residual small bowel proximal and distal to the stoma(s) for each patient are shown in the Figure. The median distance between the duodenjejunal flexure and the first stoma was 90 cm (range, 0-250 cm; mean±SD, 90±66 cm). A cholecystostomy to prevent postoperative cholecystitis was performed in 14 patients. A Mikulicz packing was placed in the pelvis in 15 patients. The abdominal wall was closed in all cases, conventionally in 7 patients but with additional, previously described relaxing incisions in 14 patients. In all cases, Vicryl mesh was placed deep into the peritoneum of the anterior abdominal wall; it was interposed between the small bowel and the Mikulicz packing whenever this was used.

MORBIDITY AND MORTALITY

Patient 19 died postoperatively, for an overall mortality rate of 5%. This patient was aged 72 years and had initially been operated on for an abdominal stab wound. During a laparotomy, 2 small-bowel lacerations and 1 colonic laceration were identified. A simple repair of these lesions was performed. The patient was readmitted 14 days later to our institution with sepsis and a burst abdomen. Leakage from a jejunal repair 30 cm distal to the duodenojejunal flexure was identified. Peritoneal washout, exteriorization of the small bowel, and drainage of all abdominal spaces with a pelvic Mikulicz packing were performed as well as a tracheotomy and gastrostomy for future CEN. The patient was admitted to the surgical intensive care unit and required assisted ventilation and vasoconstrictors. His condition initially improved with weaning from all cardioactive drugs and ventilatory support, and CEN and SER were introduced after 18 days of TPN. However, the patient developed multiple organ failure 54 days after the second operation. He had previously contracted pneumonia caused by Pseudomonas aeruginosa and was being treated with appropriate antimicrobials. A further relaparotomy did not identify any source of intra-abdominal infection or complication. The patient died the day after his third operation. Overall medical and surgical complications, including those described previously, occurred in 14 patients (67%): surgical complications developed in 3 patients (small-bowel occlusion, wound infection, and small-bowel fistula), and medical complications in 12 patients (6 patients had pneumonia, 2 had septicemia secondary to central venous access, 2 had pulmonary embolism, and 3 had miscellaneous complications). Some had more than
SUCCUS ENTERICUS REINFUSION

Continuous enteral nutrition and SER were commenced once the intra-abdominal sepsis had been controlled and small-bowel function had resumed (indicated by reduced nasogastric aspirate and active stoma output). The median time to starting CEN and SER was 10 days (range, 5-22 days; mean±SD, 11±5 days) and 12.5 days (range, 5-23 days; mean±SD, 13±5 days), respectively. Central venous access was maintained for a median time of 28 days (range, 9-82 days; mean±SD, 29±23 days), with TPN being used for a median of 14 days (range, 0-69 days; mean±SD, 22±19 days) and the catheter being perfused for a median of 28 days (range, 9-76 days; mean±SD, 35±21 days).

In 7 patients, SER was discontinued early in the course of treatment. In 4 patients (patients 1, 16, 18, and 21), the succus entericus was markedly digested and desiccated, resulting in a thick, stool-like stoma output and making reinfusion impracticable. The stomas were 120 cm, 150 cm, 150 cm, and 250 cm from the duodenojejunal flexure, respectively. Patient 3 had only 10 cm of ileum distal to the stoma with a thick, desiccated succus entericus. In these 5 patients, reinfusion was left to be of limited benefit, and CEN alone avoided the need for venous access. In patient 16, both CEN and SER were stopped because of the development of another ileal fistula and peritonitis. In patient 20, SER led to abdominal pain and was discontinued.

In the remaining patients in whom there was no contraindication, SER was continued for a median duration of 61 days (range, 14-76 days; mean±SD, 55±18 days), and CEN for 58 days (range, 16-85 days; mean±SD, 54±19 days). The mean±SD output from the proximal stoma prior to commencing CEN was 570±660 mL/24 h. Once continuous enteral nutrition was begun, the mean±SD proximal stoma output was 2240±1248 mL/24 h, with a mean±SD volume of continuous enteral nutrition of 1910±900 mL/24 h. Dur-

<table>
<thead>
<tr>
<th>Patient No./Sex</th>
<th>Class</th>
<th>APACHE II Score</th>
<th>Age, y</th>
<th>Underlying Disease</th>
<th>Initial Procedure</th>
<th>Small-Bowel Abnormalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F Primary</td>
<td>14</td>
<td>40</td>
<td>Adenocarcinoma of the rectum invading the small-bowel</td>
<td>Proctectomy and small-bowel resection/anastomosis</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>2/F Tertiary</td>
<td>17</td>
<td>42</td>
<td>Crohn disease with pelvic abscess</td>
<td>Surgical drainage and small-bowel resection/anastomosis</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>3/F Secondary</td>
<td>15</td>
<td>58</td>
<td>Blunt abdominal trauma</td>
<td>Ileal resection</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>4/M Tertiary</td>
<td>10</td>
<td>35</td>
<td>Crohn disease with perforation of the terminal ileum</td>
<td>Surgical drainage, ileal suture, and ileocolic resection</td>
<td>Anastomotic leak and unrecognized small-bowel injury</td>
<td></td>
</tr>
<tr>
<td>5/M Tertiary</td>
<td>15</td>
<td>60</td>
<td>Small-bowel obstruction</td>
<td>Lysis of adhesions</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
</tr>
<tr>
<td>6/F Secondary</td>
<td>13</td>
<td>32</td>
<td>Spontaneous postpartum ileal rupture</td>
<td>Ileal stoma</td>
<td>Unrecognized small-bowel injury</td>
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<tr>
<td>7/M Primary</td>
<td>14</td>
<td>57</td>
<td>Adenocarcinoma of the right colon fistulated to the ileum</td>
<td>Colectomy and ileal resection</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>8/M Primary</td>
<td>15</td>
<td>42</td>
<td>Gastric adenocarcinoma</td>
<td>Total gastrectomy</td>
<td>Leaking Roux-en-Y anastomosis</td>
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</tr>
<tr>
<td>9/F Tertiary</td>
<td>14</td>
<td>43</td>
<td>Ovarian cyst</td>
<td>Hysterectomy and ileal resection/anastomosis</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>10/F Tertiary</td>
<td>18</td>
<td>74</td>
<td>Diverticulosis</td>
<td>Sigmoidectomy</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
</tr>
<tr>
<td>11/M Tertiary</td>
<td>15</td>
<td>25</td>
<td>Stab wound</td>
<td>Laparoscopic exploration</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
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<tr>
<td>12/M Tertiary</td>
<td>22</td>
<td>46</td>
<td>Pancreatic pseudocyst</td>
<td>Corporocaudal splenopancreatectomy and transverse colectomy</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
</tr>
<tr>
<td>13/F Tertiary</td>
<td>18</td>
<td>35</td>
<td>Appendicitis</td>
<td>Laparoscopic appendectomy</td>
<td>Unrecognized small-bowel injury (and ischemic colon)</td>
<td></td>
</tr>
<tr>
<td>14/M Tertiary</td>
<td>17</td>
<td>59</td>
<td>Diverticulosis</td>
<td>Sigmoidectomy</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
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<tr>
<td>15/M Primary</td>
<td>16</td>
<td>39</td>
<td>Crohn disease</td>
<td>Total colectomy with ileorectal anastomosis, partial gastrectomy, and jejunal resection/anastomosis</td>
<td>Anastomotic leak</td>
<td></td>
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<tr>
<td>16/F Tertiary</td>
<td>13</td>
<td>50</td>
<td>Appendicular peritonitis</td>
<td>Appendectomy</td>
<td>Unrecognized small-bowel injury</td>
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<tr>
<td>17/M Tertiary</td>
<td>16</td>
<td>33</td>
<td>Cholelithiasis</td>
<td>Laparoscopic cholecystectomy</td>
<td>Unrecognized small-bowel injury</td>
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<tr>
<td>18/M Secondary</td>
<td>20</td>
<td>65</td>
<td>Closure of postoperative fistula (4 months after laparotomy for adhesion obstruction with subsequent fistulation)</td>
<td>Small-bowel resection/anastomosis</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>19/M Secondary</td>
<td>22</td>
<td>73</td>
<td>Stab wound</td>
<td>Jejunostomy</td>
<td>Anastomotic leak</td>
<td></td>
</tr>
<tr>
<td>20/M Tertiary</td>
<td>18</td>
<td>49</td>
<td>Gastric adenocarcinoma</td>
<td>Distal gastrectomy</td>
<td>Unrecognized small-bowel injury</td>
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</tr>
<tr>
<td>21/F Secondary</td>
<td>18</td>
<td>18</td>
<td>Salpingitis</td>
<td>Salpingectomy and appendectomy</td>
<td>Unrecognized small-bowel injury</td>
<td></td>
</tr>
</tbody>
</table>

*APACHE indicates Acute Physiology and Chronic Health Evaluation.
ing the collection, storage, and reinfusion of succus entericus, some infusate was lost.

The median time from the salvage procedure to the restoration of intestinal continuity was 82 days (range, 40-99 days; mean±SD, 80±14 days). There was no morbidity or mortality after the restoration of intestinal continuity. The mean±SD weight of the patients prior to the first intervention for peritonitis in our department was 66.8±18.7 kg. Prior to the restoration of intestinal continuity, it was 61±13 kg (P = .27). The mean±SD total protein concentration was 5.0±1.0 g/dL prior to the first intervention, and 6.8±1.1 g/dL prior to the restoration of intestinal continuity (P = .001).

**COMMENT**

A distinction should be made between intra-abdominal sepsis and external intestinal fistula, the latter the result of spontaneous exteriorization of an intestinal leak that may be associated with intra-abdominal sepsis. In the absence of significant sepsis, conservative therapy is the initial treatment of choice, surgery being reserved for patients in whom the fistula has not healed 6 weeks after nonsurgical treatment and/or in whom local conditions preclude spontaneous closure. With significant clinical sepsis, a successful outcome is contingent on the adequate control of the source of infection and contamination. Any attempt at anastomosis should be avoided because the risk of leakage is unacceptably high. In the presence of small-bowel leaks, exteriorization of the contaminating source rarely represents a technical problem. However, the high output from proximal stomas likely contraindicates the exteriorization of proximal small-bowel leaks. We have demonstrated that the use of proximal stomas is feasible with encouraging results, and since the early 1970s, the exteriorization of all small-bowel leaks has been the preferred treatment in our unit. This series presents a homogenous group of patients with postoperative peritonitis originating from a small-bowel leak, treated with exteriorization of the small bowel.

Peritonitis in the postoperative period results from 3 separate pathologic entities: the primary disease, first operation, and subsequent septic injury. This partly accounts for the high mortality rate reported in series focusing on this subject, typically around 50%, and
differentiates postoperative peritonitis from other forms in which the mortality rate is lower (20%). In patients with intra-abdominal sepsis and an APACHE II score of 16, the predicted mortality rate according to Wittmann et al. would be 35%. Our 5% mortality rate and the absence of mortality directly due to intra-abdominal sepsis compare favorably. The control of abdominal sepsis was achieved during the first operation for peritonitis in all but 1 patient without systematic second-look laparotomies. We believe that this is due to the removal of all sources of contamination from the peritoneal cavity and achieving adequate drainage. The low incidence of intra-abdominal morbidity in this group of at-risk patients justifies this approach and confirms the importance of avoiding any intestinal suture with severe peritonitis, even in the presence of a proximal diverting stoma.

Patients recovering from intra-abdominal sepsis with multiple small-bowel stomas present significant nutritional problems, often treated for prolonged periods with parenteral nutrition. The disadvantages of parenteral nutrition compared with CEN are now well recognized. In an experimental study, Delaney et al. demonstrated significant advantages in 70% of hepatectomized rats fed enterally compared with those fed parenterally. In other animal studies, TPN has been demonstrated to induce peritoneal macrophage suppression and bacterial translocation to mesenteric lymph nodes and to impair pulmonary macrophage function, whereas oral provision of 10% essential for digestion. Moreover, mucosal atrophy has been observed in bypassed small-bowel segments as compared with a small bowel that remains in continuity, supporting the hypothesis that intraluminal nutrients have a trophic effect. It is currently our policy to feed enterally when possible. However, with proximal small-bowel stomas, CEN frequently seems impractical because of the high output from the stoma. Although we have previously demonstrated the inhibitory effect of SER on upper gastrointestinal secretions in bypassed small-bowel segments as compared with a small bowel that remains in continuity, supporting the hypothesis that intraluminal nutrients have a trophic effect. Currently our policy is to feed enterally whenever possible. However, with proximal small-bowel stomas, CEN frequently seems impractical because of the high output from the stoma. Although we have previously demonstrated the inhibitory effect of SER on upper gastrointestinal secretions, in that study, patients were fed parenterally. In the current study, patients underwent SER in association with CEN. Our results demonstrate this technique to be feasible. Succus entericus reinfusion was stopped early on in 7 patients, in 5 because of a minimal benefit. In only 2 patients was the reinfusion stopped because of complications. With the use of SER and CEN, fluid loss is minimized and reinfusion improves hydration and supplies nutrients, including the pancreatic and biliary secretions essential for digestion.

This article does not attempt to ascertain the nutritional benefit of SER and CEN, but there is certainly no evidence of any detrimental effect. The documented weight loss is common in patients with intra-abdominal sepsis and is partly accounted for by third-space fluid losses during the acute phase of the illness. This is supported by the changes in total protein concentration, the low reading initially being part of the septic picture, but also by the intestinal effect following aggressive fluid resuscitation.

We have demonstrated that CEN in association with SER is feasible in many patients after the establishment of proximal intestinal stomas. Given those findings, we recommend that in the presence of small-bowel disruption leading to peritonitis, all sites of small-bowel leakage be exteriorized in conjunction with thorough drainage, CEN, and SER, thus controlling peritoneal contamination and improving nutrition and the ultimate outcome. Further studies will be needed to extend these observations in a greater number of patients.

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