



Sequential Abdominal Reexploration with the Zipper Technique

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Frequently, several multiple abdominal reexplorations are needed in patients with acute necrotizing hemorrhagic pancreatitis (ANP) or with persistent intraabdominal sepsis (PIAS). Residual undrained necrotic and septic foci lead to multiple organ failure. To provide wide-open drainage of the abdominal cavity, since 1985 we have performed sequential abdominal reexploration with the zipper technique (SARZT) in 24 patients.

Apache II score was used to evaluate expected mortality. In the pancreatic necrosis group, with a mean Apache II score of 31, the expected and the observed mortality were 70% and 29%, respectively. In the PIAS group, with a mean Apache II score of 30, the expected and observed mortality were 60 and 28%, respectively. These results are attributed to the sequential reexploration of the abdominal cavity that permits excision and drainage of necrotic and septic foci.

Indications in General Surgery

Frequently, the general surgeon is faced with the need for multiple abdominal reexplorations in patients with acute necrotizing hemorrhagic pancreatitis (ANP) or with persistent intraabdominal sepsis (PIAS) considered "impossible to control" with only 1 operation. A high mortality rate (50-80%) has been reported in these clinical situations [1-3]. The high mortality is mainly due to persistent or recurrent sepsis which frequently leads to multiorgan failure syndrome [4].

In some cases, early detection and appropriate treatment of intraabdominal sepsis in these clinical circumstances requires multiple reexplorations. Unfortunately, multiple abdominal reexplorations through the same incision can not only make the decision to operate difficult, but can also be associated with significant wound problems, including fascial necrosis and evisceration. Based on the difficulties encountered with reexplorations in some patients with intraabdominal sepsis, we have adopted the open abdomen approach with a zipper sutured to the skin as a means to manage these difficult problems in selected patients.

The aim of the present work is to review our experience with sequential abdominal reexploration with the zipper technique (SARZT) in general surgery. The indications, technique employed, and results in 24 patients are presented.

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Patients

From April, 1985 through July, 1989, we have used sequential abdominal reexploration with the zipper technique (SARZT) in 24 patients. The initial and associated diagnosis, as well as the severity of the disease according to the APACHE II classification, are listed in Tables 1 and 2. Two groups of patients were included in this study. Group I consisted of 17 patients with acute necrotizing hemorrhagic pancreatitis (ANP) and group II consisted of 7 patients with persistent intraabdominal sepsis (PIAS).

Acute Necrotizing Hemorrhagic Pancreatitis (ANP). We included in this group 17 patients with ANP with more than 4 criteria (mean, 7) according to Ranson [5, 6] and the presence of necrosis on enhanced computed tomography (CT) scan and whose clinical and roentgenological (CT scan) course showed a fulminant evolution with shock in the first days after onset or no resolution in the first 2 weeks of medical treatment (Table 1).

The etiology of pancreatitis was gallstones in 8 patients, alcohol abuse in 5 patients, biliary obstruction from hydatid cyst disease of the liver in 1 patient, and idiopathic in 3 patients. At first laparotomy, the findings were classified according to the depth of the lesion [7] as pancreatic necrosis (PN) in 11 patients (3 of them with fulminant course), while 4 presented with peripancreatic necrosis (PPN), the last 2 of which had pancreatic abscesses in the body and tail of the pancreas. The surgical procedures performed in the PN group included subtotal pancreatectomy with splenectomy (9 patients) and debridement of necrotic pancreas (2 patients).

In 4 patients with PPN, only peripancreatic necrosis was removed after determining that the pancreas was viable. In all cases (PN and PPN) it was important to achieve maximal debridement of the necrotic tissue extending into the root of the mesentery and the paracolic and perirenal spaces. In 8 patients with gallstone pancreatitis, cholecystectomy and intraoperative cholangiography were performed. In none of the 8 cases was choledocholithiasis found. Cultures of necrotic tissue and bile were performed in all cases. Packing of the debrided area was performed and then the abdominal wall was closed with the zipper technique (see "Technique").

In the first 2 patients, the zipper was attached to the fascia of

Table 1. Patient characteristics: Group ANP (acute necrotizing hemorrhagic pancreatitis).

Patient no.	Age (yr)	Initial diagnosis	Day of initial intervention	No. of laparotomies	Ranson criteria	Apache II score	Results
1	32	PN (alcohol)	13th	11	10	31	Dead
2	38	PN fulminant evolution (gallstones)	2nd	13	9	33	Alive
3	33	PN fulminant evolution (gallstones)	3rd	12	7	30	Alive
4	46	Pancreatic abscess (alcohol)	27th	5	6	24	Alive
5	60	PN (gallstones)	14th	10	8	28	Alive
6	54	PPN (alcohol)	16th	4	5	27	Alive
7	57	PPN (gallstones)	15th	3	5	29	Alive
8	46	PN ?	16th	6	6	25	Alive
9	45	PN (hydatid cyst)	8th	5	6	27	Alive
10	69	PN (gallstones)	16th	11	8	35	Dead
11	73	PN ?	15th	8	6	35	Dead
12	46	PPN (alcohol)	13th	5	6	25	Alive
13	79	PPN (gallstones)	19th	4	4	32	Dead
14	69	PN (gallstones)	16th	4	6	35	Alive
15	64	Pancreatic abscess (gallstones)	27th	10	6	30	Alive
16	41	PN fulminant evolution (alcohol)	3rd	5	7	30	Alive
17	62	PN ?	32nd	14	6	32	Dead

PN: pancreatic necrosis, PPN: peripancreatic necrosis.

Table 2. Patient characteristics: PIAS group (persistent intraabdominal sepsis).

Patient no.	Age (yr)	Initial diagnosis	Zipper insertion intervention	No. of laparotomies	Apache score II	Results
1	61	Uncontrolled peritonitis	2nd	4	28	Dead
2	45	Necrotizing fasciitis, pyloroplasty leakage	2nd	5	30	Alive
3	56	Intraabdominal abscesses after total gastrectomy	3rd	4	26	Alive
4	69	Colon perforation, colostomy, necrosis, intraabdominal sepsis	2nd	6	35	Dead
5	70	Necrosis of left colon after Hartmann procedure	2nd	4	29	Alive
6	72	Infected ascites after ligation of splenic artery aneurysm	2nd	4	26	Alive
7	44	Subphrenic abscesses, bleeding gastric ulcer	3rd	8	28	Alive

a median laparotomy; in the next 15 patients it was attached to the skin of a bilateral subcostal incision. The bilateral subcostal incision gave a better approach to the upper abdomen, specifically to the pancreatic area.

Generally, the first 3 reexplorations were performed under general anesthesia due to the complexity of the procedure. Further reexplorations, being surgically less aggressive, were performed under epidural anesthesia with premedication. All reexplorations were carried out every 24 hours. Once the zipper was opened, necrotic tissue was debrided. Copious warm saline irrigations were performed in all cases.

Once the abdominal cavity was macroscopically clean and the retroperitoneum covered by granulation tissue, the zipper was removed, leaving drains for continuous irrigation with NaCl 0.9%. The abdomen was closed primarily in 6 patients. In the other 11 patients, a Vicryl® mesh was attached to the skin,

permitting closure per secondary intention. If the continuous irrigation material contained pus and fibrin, irrigation was maintained until it became clear. The drains were then removed 2–3 days later.

All these patients were treated from the beginning in the Intensive Care Unit [8]. All of them received Total Parenteral Nutrition (TPN). Broad-spectrum antibiotics (clindamycin plus aminoglycoside) were given for at least 1 week or longer based on the clinical course of the patient.

Persistent Intraabdominal Sepsis (PIAS). Seven patients were included in this group (Table 2). In 3 of 7 cases, the indication for SARZT was the presence of intra-abdominal sepsis, as a complication of conventional surgical procedures (leakage of a pyloroplasty with peritonitis and necrotizing fasciitis after treatment of a bleeding duodenal ulcer in 1 patient, and severe



Fig. 1. Zipper attached to the skin (bilateral subcostal incision).

peritonitis with necrosis of the colostomy after a Hartmann procedure performed because of a perforated sigmoid diverticulitis in 2 patients). In the first case, a controlled duodenotomy, gastric resection with gastrojejunostomy, and resection of the necrotic abdominal wall were performed. In the other 2 cases, a transverse colostomy, resection of the left colon, and irrigation of the abdominal cavity were performed. Four patients underwent SARZT when conventional drainage of intra-abdominal abscesses did not resolve the intraabdominal sepsis. One patient developed multiple supramesocolic abscesses after a total gastrectomy for adenocarcinoma without apparent anastomotic leak. A second patient developed multiple abscesses during peritoneal dialysis treatment with a Tenckhoff catheter. The third patient developed infected ascites after ligation of a splenic artery aneurysm and splenectomy, and, the fourth patient was treated for a recurrent subphrenic abscess after surgical treatment of a bleeding gastric ulcer.

In all cases, the abdominal cavity was inspected daily in the operating room through the zipper, drained and irrigated. After a median of 5 laparotomies (range, 3–8 per patient), the abdomen was considered clean and the zipper was removed.

Technique of Inserting the Zipper

The zipper can be inserted into any laparotomy wound that requires programmed reexploration of the abdominal cavity. It may be a conventional or commercial one (Ethizip®), which comes in several lengths with broad edges and can be easily sutured to the skin or fascia with a continuous monofilament no. 0 suture, leaving the rest of the abdominal layers undisturbed (Fig. 1).

In 16 of 24 patients, the zipper was inserted at the first intervention. Of the other 6 patients, 4 had the zipper inserted at the end of the second and 2 after the third exploration.

Results

Acute Necrotic Pancreatitis

In the ANP group, an average of 8 laparotomies per patient was performed, with a range between 3 and 14 (Table 1). In the clinical evolution of these 17 patients, various complications occurred, mostly related to the septic process.

There were 3 cases of upper gastrointestinal bleeding, 2 produced by erosive gastritis, and the third by a single gastric ulcer. Only 1 needed surgical intervention (the bleeding points were sutured and a truncal vagotomy and pyloroplasty was performed). Two patients had bowel perforations, one of the small intestine and the second of the transverse colon. Five patients developed pancreatic fistulas. Two of them closed spontaneously after 2 weeks and, in the other 3 cases, the fistula closed within 3 months. Six patients developed incisional hernias which were treated conservatively.

Twelve (70%) of 17 patients developed respiratory insufficiency requiring postoperative mechanical ventilation for an average time of 16 days. Five of them developed acute renal insufficiency preoperatively, 4 of them requiring hemodialysis. None developed this complication during the postoperative period. Eight of 17 patients (47%) had several positive cultures of *Escherichia coli* (80%) obtained from the original exploration. *Klebsiella* (32%) and enterococcus (20%) were the other most common bacteria encountered. Two patients developed meningitis which cultured *Staphylococcus aureus* and *Candida albicans*. Only one patient developed diabetes mellitus requiring insulin therapy.

In the ANP group, there was an overall mortality of 29% (5 of 17 patients) (Table 3). Four (36%) of 11 patients who died were in the pancreatic necrosis group. Three of the 4 deaths were due to preoperative renal insufficiency and respiratory distress

Table 3. Correlation between expected and observed mortality rate per group.

Group	APACHE II score	Expected mortality (%)	Observed mortality (%)
ANP (17 patients)			
PN (11 patients)	31	70	36
PPN (4 patients)	23	35	25
Pancreatic abscess (2 patients)	27	55	0
PIAS (7 patients)	30	60	28

syndrome and 1 to postoperative bronchopneumonia. One (25%) of 4 patients in the peripancreatic necrosis group died from postoperative bronchopneumonia. There were no deaths in 2 patients with pancreatic abscess. The total average hospital stay was 44 days, with an average stay in the intensive care unit of 28 days.

Persistent Intraabdominal Sepsis

The results of the zipper technique in this group of patients were very encouraging. The mortality rate was 29% (2 of 7 patients). Both patients died of uncontrollable persistent sepsis after several laparotomies.

Various complications occurred, mostly related to the septic process. Seven patients (100%) developed respiratory insufficiency requiring postoperative mechanical ventilation. One patient had a small bowel perforation, which was closed during the procedure. Another patient had upper gastrointestinal bleeding, treated by peripheral embolization of the left gastric artery. Five patients developed incisional hernias which were treated conservatively.

Discussion

High mortality rates (50–80%) have been generally associated with the surgical treatment of acute necrotizing pancreatitis as well as severe persistent intraabdominal sepsis [1, 2, 9–11]. The causes of this mortality rate are due mainly to persistence or recurrence of sepsis that leads to the development of the multiple organ failure syndrome with its known consequences [2]. Attempts have been made to improve this mortality and morbidity by an aggressive initial operation which included radical debridement of necrotic tissue with extensive drainage of abscess(es). This drainage could be improved by several maneuvers such as continuous postoperative intraperitoneal lavage, with or without antibiotics [12–15], or by external drainage. But in cases of ANP or severe PIAS, these procedures, with a few exceptions, have not achieved the expected results. Therefore, another approach is to leave the abdomen open, permitting a daily programmed reexploration of the abdominal cavity for irrigation, removal of necrotic tissue, drainage of any ongoing sepsis, and the immediate and adequate surgical treatment of every complication that appears [1–3]. Originally reported by several French surgical groups, the use of this technique is based on the premise that the whole peritoneal cavity itself in severe intraabdominal sepsis acts as an abscess cavity; therefore, the treatment is to drain it,

keeping it open until resolution of the sepsis [16–29]. This is contrary to surgical treatment “on demand” of these complications, frequently performed too late, when the sepsis is often irreversible [30].

The mortality obtained with the open abdomen technique depends on the selection of patients included, giving varying results in the literature from a mortality of 7% to 60% [19, 24]. Mughal and collaborators [1] advised using this technique for properly selected cases such as postoperative intraabdominal sepsis and deep-seated intraabdominal collections of pus, and recurrent peritonitis. Other authors have recommended use of the sepsis score to permit adequate comparison of the results of different treatments in these nonhomogeneous patient groups [31–34]. Following this open abdominal approach, several techniques have been used to avoid evisceration of the abdominal organs. Total sutures of the abdominal wall that close the wound temporarily were followed by the use of extended packing or different types of meshes attached to the fascia or the skin, thereby permitting spontaneous drainage through the mesh as well as regular reexplorations if needed [35–38].

A new way of treating this “open abdomen” is the use of a zipper sutured to the wound, combining the advantages of an open abdomen with those of a temporarily closed wound. Therefore, based on the work by Leguit [39] who in 1982, originally described laparotomy with a zipper in cases of acute mesenteric ischemia, as well as reports by Stone and collaborators [40] and others [2, 3, 41–45], we began using this technique in April, 1985 [8], in cases of severe intraabdominal sepsis and ANP in the previously cited clinical categories. This method does not alter the anatomical conditions of the skin and the rest of the abdominal wall, and permits daily revision of the abdomen as many times as necessary to manage the intraabdominal surgical problems [46].

In the ANP group, we used this procedure to treat the several forms of acute necrotizing pancreatitis (ANP): pancreatic necrosis (PN), peripancreatic necrosis (PPN), and pancreatic abscess (PA). We consider that if patients with acute pancreatitis meet more than 3 criteria according to Ranson, have evidence of pancreatic necrosis on enhanced CT scan, and their clinical and radiological pictures do not resolve in the first 2 weeks of intensive treatment, then they should be considered for laparotomy, removal of necrotic tissue, and programmed reexploration with the zipper technique [3]. This group represents 5% of all cases of acute pancreatitis (AP) that were admitted to our hospital in this period of time [8].

Once a patient is included in this high-risk group of AP, the patient should be closely monitored clinically, radiologically (CT scan) [6], and cared for in the intensive care unit, where the patient is hemodynamically stabilized and treated with broad-spectrum antibiotics and TPN [47]. There are 3 different clinical evolutions according to their clinical and radiological course [3]. There is 1 group of patients with these criteria who develop a self-limiting form of ANP (10%). They have a mild clinical course in the first 2 weeks of evolution with spontaneous resolution. This group of patients should be managed conservatively. There is another group (about 10%) with a fulminant form of ANP that is characterized by a dramatic clinical course with shock in spite of intensive treatment, making immediate surgical treatment necessary in the first 2 days. But the most common group develops slowly into several forms of peripan-

creatic or pancreatic necrosis and posterior infection. In this group, patients usually develop sepsis in the second week of evolution because of infection of the necrotic tissue which leads to pancreatic abscesses and generalized sepsis [2, 3, 8, 40–43, 47, 48]. This septic situation adds a high risk factor and, therefore, early surgical treatment is indicated. This includes the practice of debridement of necrotic tissue and drainage of septic foci followed by planned laparotomies using an open abdominal approach.

Concerning the technique of debridement of necrotic tissue at the first exploration, if the entire pancreas is necrotic, a subtotal pancreatectomy should be performed. If only areas of the gland are affected or the necrosis lies in the peripancreatic area, debridement of necrotic tissue only is sufficient, leaving the gland intact. From the technical point of view, 3 aspects are important for discussion. First, necrosectomy should be performed in the areas where the necrosis has spread (guided by CT scan and inspection of the abdomen) such as the perirenal, paracolic, and mesenteric spaces. Second, in the area of confluence of the mesenteric, splenic, and portal veins, major bleeding can occur, necessitating running vascular sutures and careful dissection. It is our opinion that, in the first procedure, the necrosis in this region should not be removed since, in subsequent explorations, liquefaction of the necrosis makes its removal by blunt dissection easier. The third area of concern is the colon. Extension of necrosis into the mesocolon makes perforation of the colon a frequent complication, increasing morbidity and mortality. We recommend careful debridement of the mesocolon to avoid devascularization which may lead to colonic perforation. We could not confirm, in our limited numbers of patients, the correlation found by others [43, 49] between infected necrosis and higher mortality rates.

Our results in ANP from this technique (29% overall mortality in 17 cases treated) with the help of a zipper are encouraging specifically when compared with those results obtained with classical treatment such as conventional support of the patient [50, 51], peritoneal lavage [52–56], triple stomas [57], and extended pancreatectomies [58–61]. The results obtained in our group are comparable with those of others using the same technique [2, 3, 25]. With necrotic tissue debridement and postoperative local lavage, Beger and collaborators [49] reported a mortality rate of 8.4% in patients with ANP. On the other hand, Nicholson and collaborators [62] using the same technique as Beger, reported a mortality rate of 27%, which is similar to our results. But the group of patients treated in these different series are not homogeneous. Besides, the different treatments used makes comparison between them very difficult. Therefore, in this nonhomogeneous group of patients with ANP, some form of stratification is considered absolutely necessary [3, 8] to allow comparison of the groups and the results of different treatments used. The APACHE II score has provided this stratification [43]. The expected mortality according to the APACHE II score of 31 in the PN group should be 70%. The observed mortality of 36% in our experience represents a significant improvement (Table 3). In the group of PPN, our results showed a 25% mortality with an expected mortality based on the APACHE II score of 35%.

In cases of severe persistent intraabdominal sepsis, with associated interloop abscesses and residual necrosis, enteric fistulas and necrotizing fasciitis, the high mortality rate is

related to the delay in diagnosis and treatment in response to the complication. At the moment when sepsis becomes clinically manifest and the multiple organ failure syndrome develops, it is often too late for resolution. Therefore, the open abdomen approach with sequential reexploration of the abdomen will be effective [1–3, 29, 31, 44–46]. The open abdomen approach also offers better protection of the abdominal wall and improved perfusion of the abdominal viscera. It also diminishes the unfavorable hemodynamic effects of high intraabdominal pressure, such as pulmonary and renal complications [30, 63]. In this group, we achieved a mortality of 28% when the expected mortality according to APACHE II score of 30 was 60% (Table 3).

In general, the surgeon has to think of an open abdomen approach when (a) the abdomen cannot be closed after an acute, extensive, full-thickness loss of abdominal wall, after trauma or radical debridement for necrotizing fasciitis, and (b) when the abdomen should not be closed because of the type of intraabdominal process involved.

The majority of septic processes in the abdomen are resolved by conventional therapy with only 1 intervention. Some surgeons advocate the use of the open abdominal approach for generalized suppurative peritonitis at the first exploration, resulting in higher mortality and morbidity [24]. Most authors reserve this technique for cases of persistent intraabdominal sepsis and acute necrotizing pancreatitis [1–3, 19, 28, 29, 40–46] and, more recently, those with a high sepsis score [2, 3, 43, 64]. This patient risk score could be the sole stratification used in the future on which decisions to use this procedure are based, and should permit the qualitative comparison of different surgical treatments.

Résumé

Chez le patient qui a une pancréatite nécrosante (PN) ou une sepsis abdominale persistante (SAP), plusieurs interventions exploratrices sont parfois nécessaires. La persistance de foyers de nécrose ou d'infection peut provoquer une défaillance poly-viscérale. Pour permettre, dans ces cas, un drainage large de la cavité abdominale, nous avons pratiqué une ré-exploration répétée systématique avec la technique de fermeture éclair (SARZT) chez 24 patients depuis 1985.

Le score Apache II était utilisé pour évaluer la mortalité attendue. Dans le groupe de patients avec une pancréatite aiguë, le score d'Apache II moyen était de 31; la mortalité attendue était de 70%, la mortalité réelle de 29%. Dans le groupe de patients avec SAP, le score Apache II moyen était de 30, la mortalité attendue de 60% et la mortalité réelle de 28%. Ces résultats favorables sont attribués à la technique de ré-exploration répétée de la cavité abdominale qui permet l'excision et le drainage efficace de tout foyer de nécrose ou de sepsis.

Resumen

Con frecuencia se requieren reexploraciones abdominales repetidas en pacientes con pancreatitis necrotizante hemorrágica (PNH) o con sepsis intra-abdominal persistente (SIAP). Focos necróticos y sépticos residuales no drenados inducen falla orgánica múltiple. Con el objeto de proveer drenaje abierto

amplio de la cavidad abdominal, hemos realizado desde 1985 la reexploración abdominal secuencial por medio de la técnica del zipper en 24 pacientes.

Se utilizó el puntaje APACHE II para hacer la valorización de la mortalidad previsible. En el grupo de pacientes con necrosis pancreática el puntaje APACHE II promedio fue 31, y las tasas de mortalidad previsible y de mortalidad real fueron 70% y 29%, respectivamente. En el grupo con SIAP, con un puntaje APACHE II promedio de 30, las tasas de mortalidad previsible y de mortalidad real fueron 60% y 28%, respectivamente. Se atribuyen estos resultados a las reexploraciones secuenciales de la cavidad abdominal, las cuales permiten la remoción y drenaje de focos necróticos y sépticos.

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Invited Commentary

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This report by Cuesta and associates provides additional support for the concept of open drainage and repeated pack changes in the treatment of intraabdominal necrotizing inflammations. The basic procedure advocated is essentially the same, regardless of whether the responsible destructing enzymes are secreted by bacterial pathogens or the patient's own uncontrolled release of pancreatic ferments. The source of these digestive agents must be eradicated by debridement, when practical, of all infected tissues or, correspondingly, excision of as much involved pancreas as possible without risking the need for a duodenal, bile duct, or mesenteric

vascular suture line. For the latter, such is best accomplished by distal pancreatectomy en bloc with the spleen in cases of true pancreatic abscess.

It is a phlegmonous inflammation with which one must deal. The principle is not new even though considerable controversy has been generated by its fresh application. The indurated mass and its attendant feculent peritonitis as noted with perforating acute sigmoid diverticulitis is a good parallel. Mere drainage and proximal alimentary tract diversion only temporizes the process. Those patients with a more advanced state of sepsis seldom rally unless the offending segment of colon is first extirpated. Open packing is then used only for those cases with an already established localized process and/or for the counter pressure necessary to stem a potentially exsanguinating ooze in instances complicated by a significant coagulopathy. Insertion of the zipper is not a gimmick, but just a convenient door mechanism to facilitate the required frequent pack changes.