

Necrosectomy in Acute Pancreatitis – Who is Better: the Surgeon’s View

Blaž Trotovšek*

Division of HPB Surgery and Liver Transplantation, Department of Abdominal Surgery, University Medical Centre Ljubljana, Ljubljana, Slovenia

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ABSTRACT

In recent years we witnessed dramatic changes in the management of patients with acute necrotizing pancreatitis. We moved from open surgery which was often performed too early in the course of disease to less aggressive procedures, trying to delay surgical treatment as long as possible. Surgery might be considered as an option in the early phase of the disease only when abdominal compartment syndrome evolves as a consequence of underlying disease and resuscitation. Additionally, surgical treatment is required in late phase for patients with proven infected pancreatic necrosis and organ failure where other measures and techniques have failed to improve patient’s condition. For these patients, surgical debridement is still considered the treatment of choice. The strategy of a ‘step-up’ approach, performing first percutaneous or even endoscopic drainage of infected collections, and continuing with surgical procedures through new access routes (preferably retroperitoneal) or endoscopic necrosectomy in case of absence of improvement, has been now widely adopted. These concepts require a multi-disciplinary approach to acute necrotizing pancreatitis regarding open necrosectomy in the management of

severe acute necrotizing pancreatitis. The ‘step-up’ approach significantly reduced morbidity and mortality in acute necrotizing pancreatitis when compared to primary surgical intervention. Patients have to be referred to reference centers where all the needed resources, knowledge and logistics is available.

INTRODUCTION

Acute pancreatitis (AP) is associated with an overall mortality of about 5% and due to an incidence between 30 and 45/100.000 people per year; it is a frequent and potentially fatal disease (1, 2). In most cases, AP represents a mild, self-limited disease but in 15–25% severe acute pancreatitis (SAP) develops, manifested with pancreatic parenchymal and peripancreatic tissue necrosis (3). The mortality, however, depends on disease severity and may be as high as 20% in patients with severe and complicated pancreatitis (1, 3). Pancreatic necrosis (PN) accounts for substantial additional morbidity, with mortality rates remaining as high as 10–20% despite the advances in critical care (3). Characteristics of moderate and severe pancreatitis are local or systemic complications. Local complications include acute peripancre-

*Assistant Professor Blaž Trotovšek, MD, PhD

Division of HPB Surgery and Liver Transplantation, Department of Abdominal Surgery, University Medical Centre Ljubljana, Zaloška cesta 7, 1000 Ljubljana, Slovenia

E-mail: blaz.trovsek@kclj.si

atic fluid collections, pancreatic pseudocysts, acute necrotic collections and walled-off necrosis (WON). Acute necrotizing pancreatitis (ANP) evolves in about 10–30% of the patients with AP and is associated with a particularly poor outcome (1, 3). The clinical course of SAP is divided in two phases. An early inflammatory phase that lasts first two weeks, and a late phase after the first two weeks marked by infectious complications. Mortality rates in the event of infected ANP increase up to 30% with surgical intervention and nearly 100% in the absence of any intervention (4).

Historically, early open surgical intervention with laparotomy for extensive PN had been broadly adopted. Nearly all patients with ANP have been treated with open necrosectomy (ON). ON used to be performed early in the course of the inflammation, even in patients with sterile necrosis (5). However, due to a high morbidity and the need of repetitive laparotomy, outcomes were unsatisfactory (6). During the last decade, several studies showed better outcome for less invasive treatment approaches including transgastric and percutaneous drainage or endoscopic necrosectomy (ENS). Nowadays, it is accepted that intervention is only indicated if infected necrosis is suspected and that intervention should be delayed for at least 3–4 weeks after onset of pancreatitis if possible. The so-called step-up approach consisting of conservative treatment followed by drainage and minimally invasive interventions results in a decrease in overall morbidity and defines the recommended standard care of therapy nowadays (7).

The most common indication for surgery of PN is infection which can be accompanied by single or multiple organ failure. It is a rare event during the first week of clinical course. Secondary infection of PN develops later in 40–70% of patients with a mortality rate greater than 20%. Infected PN is found in 80% of patients dying from AP. In contrast, mortality for sterile PN is low and can be successfully treated by a conservative approach, although surgery might be required for late complications or persistent ANP (8).

The diagnosis of infected PN is based on the presence of sepsis with CT findings of extraluminal gas in necrotic areas of pancreas and surrounding tissue. Diagnosis is confirmed by positive cultures of percutaneous fine-needle aspirates of necrosis and fluid. A persistent single or multiple organ failure refractory to supportive treatment may also constitute an indication for surgery. Several studies have shown that, oppositely to what happens when infection constitutes the indication for surgery, necrosectomy does not provide a significant benefit regarding mortality, and thus, it must be considered as the last resource in a patient in whom medical treatment does not result in improvement (9). Indication for surgery in ANP must derive from the need to control complications and not to influence the inflammatory process itself. The intention of every procedure must be removal of all necrotic and infected tissue. Number and localization of fluid collections and viscosity of the content are determining factors for the selection of the best therapeutic approach. Morbidity associated to open pancreatic debridement includes pancreatic fistula (50%), endo- and exocrine pancreatic failure (20%), intestinal fistula (10%) and the common prolonged hospitalization and delay in the incorporation to daily life activities (10).

In surgical approach, debridement is preferred over resection because it preserves the most of functional pancreatic tissue. Resection is often technically impossible and is associated with unacceptable morbidity and mortality in patients with ANP (10). The best results are obtained when the indication for surgery may be delayed up to one month after the onset of the clinical symptoms. Unless evident infection of necrosis exists, survival improves as the surgical procedure is postponed. A better demarcation of necrosis and its conversion to WON involves less bleeding and less removal of viable tissues during surgical procedure (9).

Two different treatment strategies define the timing of the surgical approach for a patient with ANP. ‘Step-down’ consists of immediate surgical approach when there is an established indication, and later a more conservative treatment for the residual disease. Currently, there is increasing evidence in the literature,

that a 'step-up' concept, where more conservative procedures (percutaneous, laparoscopic or endoscopic) constitute the initial treatment of patients with ANP and a final surgical ON is performed later in the course of disease, and only when necessary, is superior to the 'step-down' concept regarding the survival and morbidity.

RATIONALE AND TIMING OF NECROSECTOMY

Intention of necrosectomy performed with preservation of remaining vital pancreatic tissue is to accomplish locally focused control of necrosis and ascites from the lesser sac and the peritoneal cavity. Continuous lavage of the lesser sac and peritoneal cavity influences the systemic inflammatory response and has been shown to be a useful adjunct of necrosectomy (11). This diminishes or interrupts the devastating progress of inflammation and absorption or systemic release of various inflammatory mediators that account for remote organ failure (12).

Also, necrosectomy should be restricted to patients with PN in whom conservative, endoscopic or interventional treatment has failed. Development of multiple organ dysfunction syndrome (MODS) or even failure (MOF) frequently complicates the early phase of the disease, but half of these patients respond well to conservative management (13). Therefore, prolonged intensive conservative treatment is essential for the selection of patients who do not require surgery. The effectiveness of necrosectomy in patients with PN is also directly related to the grade of demarcation of necrosis. Demarcation develops at the end of the 2nd week after symptom onset (14). The presence of infected PN is nowadays a uniformly accepted indication for drainage, interventional or surgical. However, this indication for surgery has also been challenged, and even some patients with infected PN can be treated conservatively, and extended conservative treatment protocols may result in a favorable outcome (15). In critically ill patient with infected PN, it remains to be proven how much conservative treatment someone can bear before interventional or sur-

gical techniques becomes necessary to prevent further deterioration of patient's condition. Deterioration with MODS and MOF can occur in SAP within a few hours or days after the onset of symptoms. In the past, early surgical intervention was favored. However, outcomes were rather disappointing and associated with mortality rates of up to 65%. When comparing early (within 72 hours of symptoms) with late (at least 12 days after onset) pancreatic debridement in patients with ANP, mortality rates were 56% and 27%, respectively (16). Every effort should be made to avoid surgical intervention in the first two weeks even in the presence of MOF and withholding of necrosectomy until four weeks (17). Nowadays, there is general agreement that surgery in ANP should be performed as late as possible (8). The late phase, two weeks after the onset of the disease, is agreed to provide optimal operative conditions with well demarcated necrotic tissue. Procedures should be limited to pure debridement and only one single intervention. This approach decreases the risk of bleeding, perforation of intestine and occurrence of intestinal fistula, minimizes the loss of vital pancreatic tissue, and thus reduces the rate of endocrine and exocrine pancreatic insufficiency. Only in the case of proven infected necrosis, uncontrollable intraabdominal hypertension with compartment syndrome or in the presence of rare complications, such as massive bleeding or bowel perforation, early surgery is justified in patients with SAP.

OPEN PANCREATIC NECROSECTOMY

During the last decades, numerous surgical procedures in SAP has been proposed for the surgical management of SAP, from minimally invasive to extensive resections. Neither of them accomplished a significant reduction in the overall mortality of SAP (16). The reason for such disappointing results is linked to the fact that none of these treatment protocols sufficiently addressed the underlining pathophysiological mechanisms of the disease.

It is obvious that appropriate operative technique for the treatment of ANP is not resection but should consist of careful removal of PN and preservation of vital

pancreatic tissue and organs in vicinity. This concept resulted in decreased mortality rates that were originally greater than 50%, to about 20% (18). However, despite these improvements, recurrent sepsis after necrosectomy because of inadequate drainage or incomplete necrosectomy, continues to pose a major drawback. Currently, necrosectomy aims to remove the focus of necrotic and infected tissue so that further complications are avoided by limiting the inflammatory process. This can be achieved with minimal injury to vital pancreatic tissue and organs in vicinity and maximization of postoperative removal of pus, necrotic remnants, and fluid with pancreatic exocrine secretions and other inflammatory mediators (19).

ON was considered as the standard gold treatment for decades, and it was usually associated to a therapeutic ‘step-down’ approach. Traditional ON through a mid-line or subcostal bilateral incision consists of assessment of the entire abdominal cavity, debridement of the necrotic pancreatic tissue and the access to lesser sac and pancreatic area through the hepatogastric and gastrocolic ligament or by a transmesenteric access through the transverse mesocolon, depending on necrosis extension and localization. Once the necrosis is exposed and samples for bacterial and fungal cultures taken, debridement is carried out bluntly. After all loose debris has been removed, the retroperitoneal cavity is irrigated. Whenever it is possible adequate debridement should be achieved within a single procedure. Once the necrosectomy has been performed, the options that were described are:

- Closure of the abdominal wall over drains and ‘relaparotomy on demand’ depending on clinical course (20);
- Scheduled laparotomies with repeated lavage, usually every second day, until debridement has been completed. Open abdomen and temporary abdominal closure techniques are recommended when this approach is selected, but scheduled laparotomies closing the abdomen after each revision have also been reported (21);
- Necrosectomy combined with open packing (22);
- Necrosectomy combined with closed packing (23);

- Closed technique with abdominal wall closure over lavage system with large-bore drains in the pancreatic area (24);
- Focused open necrosectomy (FON) with US guidance (25);
- Necrosectomy with scheduled re-explorations combined with open abdomen treatment and temporary abdominal closure with negative pressure wound therapy with instillation (NPWTi) in retroperitoneum.

Currently closed technique of ON with abdominal wall closure over lavage system in the pancreatic area is the most recommended option based on mortality below 10%. This is significantly inferior to those associated to the rest of the techniques except to the NPWTi technique. Comparing different methods of ON is difficult because of the heterogeneity of patients and surgeons (9, 10, 26). Although necrosectomy is performed in a more or less identical fashion, the techniques differ in the way they provide exit channels pus and infected debris. In some techniques drainage of the retroperitoneum is active, combined with either continuous lavage or intermittent soaking. Series of patients treated with ON at experienced care centers showed mortality rates below 15% for all techniques. Results of different techniques of ON are presented in Table 1.

On-demand relaparotomy

When adequate debridement is achieved during ON within a single procedure, drains are placed in retroperitoneum, or abdominal cavity and abdominal wall is closed. If adequate source control is achieved no further relaparotomies are needed. Relaparotomy is only performed in patients with clinical deterioration or lack of clinical improvement with a likely intra-abdominal cause. Other infections must be ruled out using laboratory tests, imaging modalities, or both. Deterioration after the previous procedure is considered in case of ACS, intra-abdominal bleeding with hemodynamic instability, burst abdomen, perforation of visceral organ, anastomotic leakage, ischemia or necrosis of a visceral organ and finally intra-abdominal abscess that cannot be drained percutaneously.

Table 1. Mortality of open necrosectomy procedures

Technique	Patients (n)	Infected necrosis, n (%)	Mortality, n (%)	Relaparotomy, n (%)
Open packing				
Bradley 1993	71	71 (100)	15	1–5/patient
Branum 1998	50	42 (84)	6 (12)	2–13/patient
Bosscha 1998	28	28 (100)	11 (39)	17/patient
Nieuwenhuijs 2003	38	18 (47)		
Planned relaparotomies				
Sarr 1991	23	18 (75)	4 (17)	2–>5/patient
Tsiotos 1998	72	57 (79)	18 (25)	1–7/patient
Closed packing				
Fernandez 1998	64	36 (56)	4 (6)	11 (17)
Rodriguez 2008	167	120 (72)	19 (11.4)	21 (12.6)
Closed continuous lavage				
Beger 1988	95	37 (39)	8 (8)	26 (27)
Farkas 1996	123	123 (100)	9 (7)	
Buchler 2000	29	27 (93)	7 (24)	6 (22)
Nieuwenhuijs 2003	21		7 (33)	
Negative pressure wound therapy-instillation				
Trotovšek 2017	10	10 (100)	1 (10%)	3/patient

Scheduled laparotomies with repeated lavage

The necrotic space is unroofed in a controlled fashion, with care to protect neighbouring vital anatomical structures. Necrosectomy is carried out by a non-aggressive, blunt dissection without inducing hemorrhage. All necrotic tissues amenable to debridement are removed at the initial procedure. After necrosectomy and irrigation of the debrided areas, abdominal wall closure is performed. Fascia can be sewn, and abdominal wall closed. Contemporary approach is to leave abdomen open and to temporarily close the abdominal wall with one of the temporary abdominal wall closure techniques. Negative pressure wound closure techniques, especially V.A.C.[®] with ABThera[™] dressing (KCI, San Antonio) are most often used with

currently the best results regarding the survival rate and frequency of delayed primary fascial closure (27). Reoperation is performed 48 hours after the initial procedure, and additional necrosectomy and debridement are performed as needed. Procedures are repeated at 48 hours intervals until source control has been achieved. When all necrotic debris has been removed, the abdomen is closed over drains.

Necrosectomy combined with open packing

The open packing technique is based on the continuous re-exploration principle, with open lavage of the necrotic areas. After debridement, the lesser sac is lined with non-adherent sheet, to protect adjacent intestinal surfaces and to prevent injuries, and packed.

The abdomen is left open, and re-exploration and debridement performed every 24 to 48 hours until necrosectomy is complete and there is evidence of granulations. The wound then heals entirely by secondary intention, or it is closed over drains, with or without lavage of the cavity (22). This approach has been mostly abandoned.

Necrosectomy combined with closed packing

The goal of this technique is to perform a single operation with thorough debridement and removal of necrotic and infected tissue while minimizing the need for reoperation or subsequent pancreatic drainage. Access to the pancreas is gained via the left mesocolon. Entry into the necrotic cavity is made bluntly, and the cavity with its recesses is explored and necrotic tissue and fluid evacuated. When necrosis is present also on the right side, an additional incision in the right mesocolon is made, or even paracolic gutters are opened to remove all necrotic tissue. After irrigation of pancreatic bed, Penrose drains stuffed with gauze (23) are used for packing the large, stiff cavity that results after debridement. Drains fill the cavity and provide compression and not only drain the area. The number of drains depends on the size of the cavity, and they are gradually removed during the first week after procedure.

Also, soft, silicone, closed suction drains are introduced in cavity too and are removed when they have no more output. The abdomen is closed, primarily as usual (23).

Closed technique with lavage system

ON with continuous lavage of the lesser sac and retroperitoneum is performed over two to four flushing drains. The

abdomen is closed and lavage with 10–15 L/24 hours is performed for few days to allow sufficient drainage of debris and exudates. This procedure seems to have the lowest mortality and is advocated by the authors (26).

Focused open necrosectomy with ultrasound guidance

Laparotomy and FON is performed with the assistance of perioperative ultrasound. FON can be an alternative method to conventional ON in patients with infected necrosis and unresolved sepsis. After routine implementation of intraoperative navigation with ultrasound, FON was implemented using small lumbar and subcostal approaches in the surgical treatment of patients with infected necrosis. ON and drainage were performed through small, focused lumbar or subcostal incisions accessing infected necrotic tissue and fluid collections. Percutaneous catheter drainage inserted before surgery for temporary sepsis control is used as a guide and helps to perform less traumatic intervention. In patients with several distant infected necrosis or fluid collections, repeated interventions to achieve drainage and removal of sequestrations is used, providing necrosectomy and drainage in several steps, when necessary. Mortality can be as low as 6% in selected patients.



Figure 1. The V.A.C. VERAFLO CLEANSE™ dressing (KCI, San Antonio) is inserted in retroperitoneal space through opened gastrocolic ligament

Negative pressure wound therapy with instillation

After entering the peritoneal cavity through bilateral upper transversal incision, gastrocolic ligament is divided. Exploration of the entire pancreas, as well as determination of the extent of necrosis, is performed. The necrotic space is unroofed in a controlled fashion, with care to protect neighbouring vital anatomical structures. Necrosectomy is carried out, and all devitalized tissues amenable to debridement are removed avoiding hemorrhage at the initial necrosectomy. After necrosectomy, an extensive irrigation of the debrided areas is performed. The V.A.C. VERAFLU CLEANSE™ dressing (KCI, San Antonio) is inserted in retroperitoneal space. The tubular shape of it allows flexibility in addressing wounds with complex geometries. Special structure and material of the foam provides non-aggressive way of tamponade, suction, and instillation of fluid in retroperitoneal space where ON was performed (Figure 1). Temporary abdominal wall clo-

sure with ABThera™ dressing (KCI, San Antonio) is achieved and tubular foam is pulled through the ABThera™ dressing (Figure 2) and positioned under the double channel T.R.A.C. pad® intended for use with V.A.C. ULTA™ Negative Pressure Wound Therapy System with instillation capability. Reoperation is performed 48 hours after the initial procedure, and not more than three changes of dressings are performed to avoid damage to surrounding organs and vessels and to prevent lateralization of the abdominal wall. Instillation is performed for 30 minutes with 500 mL of saline in cycles of 4–6 hours of continuous negative pressure (125 mmHg). Additional necrosectomy and blunt debridement are performed as needed. In 6–8 days after initial procedure, when pancreatic bed is clean of necrotic debris, the abdomen is closed over drains. Drains are routed through retroperitoneum to the flanks, posterior to the hepatic and splenic flexure of colon. Abdominal wall is closed with continuous slowly absorbable suture. Mortality in feasibility study was 10%.



Figure 2. The V.A.C. VERAFLU CLEANSE™ dressing (KCI, San Antonio) (thick arrow) is inserted in retroperitoneal space. Temporary abdominal wall closure with ABThera™ dressing (KCI, San Antonio) (long arrow) is achieved and tubular foam is pulled through the ABThera™ dressing

CONCLUSION

The operative management of AP is focused on managing the acute complications and the long-term sequelae. Using the least amount of intervention to achieve the stated goals has always been the case. However, the evolution of interventional, endoscopic and minimally invasive surgical techniques has greatly expanded the tools available. With new approaches and with introduction of less invasive treatment modalities than ON, patients are experiencing a much lower morbidity and mor-

tality than in the past. ON has been a golden standard of surgical procedures for infected necrotizing pancreatitis. Currently, the management is moving toward minimally invasive techniques for necrosectomy, obviating the need for ON in most cases. Percutaneous drainage by itself can eliminate the need for necrosectomy in many patients. But in selected cases where other methods have failed, surgery and ON remains the last option in managing of these critically ill patients.

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