Abstract

This review details the indications, technique, and outcomes of endoscopic necrosectomy for the treatment of pancreatic necrosis. Data from 14 previous reports revealed that the rate of complete resolution of pancreatic necrosis with endoscopic necrosectomy ranged from 53% to 100%. The procedure-related morbidity was 0–46% and the overall mortality was 0–13%. In particular, two recent multicenter studies with large cohort numbers reported that successful resolution was achieved in 80–91% of cases, morbidity was 14–26% and mortality was 5.8–7.5%. Interestingly, delayed intervention is currently preferred to early intervention, since maturation of the necrotic bed develops encapsulation and demarcation of peripancreatic collections, namely walled-off pancreatic necrosis. Such structural changes facilitate necrosectomy and improve conditions for intervention, thereby decreasing the risk of complications such as bleeding and perforation. It is now believed that intervention should be delayed to approximately 3–4 weeks after the onset of pancreatitis if the patient’s condition is kept stable by conservative treatment.

Keywords: Endoscopic necrosectomy, Pancreatic necrosis, Walled-off pancreatic necrosis

Introduction

Pancreatic necrosis affects approximately 20% of patients with acute pancreatitis, and is associated with a poor prognosis and high rate of mortality ranging from 10% to 25%. When pancreatic necrosis is accompanied by infection in the necrotic bed, mortality up to 40% has been reported. Surgical interventions, including open necrosectomy and drainage, are widely performed as a standard treatment, but they are also associated with high morbidity (19–62%) and mortality (6–28%).

Endoscopic treatments have recently been attempted as a minimally invasive therapeutic alternative.

In 1996, Baron et al. first described effective removal of infected pancreatic necrosis with endoscopic transmural drainage and lavage. Later, Seifert et al. described the technique of direct endoscopic necrosectomy, which involved direct entry of the endoscope into the necrotic cavity with subsequent removal of necrotic tissue using endoscopic accessories. There have been several subsequent case reports describing the successful application of endoscopic necrosectomy for the treatment of infected pancreatic necrosis.

The current status of endoscopic necrosectomy for infected pancreatic necrosis is assessed in this review.

Indications for endoscopic necrosectomy

What is walled-off pancreatic necrosis?

Endoscopic necrosectomy is indicated in cases of infected walled-off pancreatic necrosis (WOPN). WOPN is a term used to describe encapsulated collections of fluid and solid debris that develop as a result of acute necrotizing pancreatitis.

According to the revised Atlanta classification of acute pancreatitis (2007), fluid collections arising in patients with acute necrotizing pancreatitis are termed post-necrotic pancreatic/peripancreatic fluid collection (PNPFC). PNPFC is distinguished from acute peripancreatic fluid collection (APFC) and pseudocyst because it results from necrotizing pancreatitis and contains necrotic tissue. As pancreatic parenchymal or peripancreatic necrosis matures, liquefaction develops as the necrotic tissue breaks down. This process usually begins 2–6 weeks after the onset of pancreatitis. PNPFC is characterized by distinct morphologic features that can be identified on contrast-enhanced computed tomography (CT) of both necrotic tissues and fluid within the same circumscribed area. As the PNPFC matures, the interface between necrosis and the adjacent viable tissue becomes established; this is usually by a thickened wall lacking an epithelial lining. This entity is
termed WOPN, which was referred to previously in the literature as organized necrosis.8

Timing of the procedure and current opinion

Recently, the timing of intervention in acute necrotizing pancreatitis has changed dramatically. Necrosectomy was once performed at a very early stage, whereas it is now believed that intervention should be delayed to approximately 3–4 weeks after the onset of pancreatitis.11

Basselink et al12 retrospectively examined the effect of early and late surgical intervention for the treatment of necrotizing pancreatitis in 53 patients. Patients who underwent surgery on Day 30 or later after admission had significantly lower mortality (8%) than those who underwent surgery within the first 14 days (75%) or between Days 15 and 29 (45%). A further systematic review of 11 studies with a total of 1136 patients also showed a significant correlation between timing of intervention and mortality ($R = -0.603$, $P = 0.05$).12

The Dutch Pancreatitis Study Group compared the outcomes of a step-up approach, which began with percutaneous drainage, and was followed if necessary, by minimally invasive retroperitoneal necrosectomy, to those of standard open necrosectomy in a multicenter randomized controlled trial (RCT).13 Major complications occurred less frequently with the step-up approach than with open necrosectomy (40% vs. 69%; $P = 0.006$), and 35% of patients in the step-up group were only treated with percutaneous drainage. Later, the same authors prospectively collected data from 639 consecutive patients with necrotizing pancreatitis. Mortality was reduced among the 242 patients who underwent surgery on Day 30 or later after admission had significantly lower mortality (8%) than those who underwent surgery within the first 14 days (75%) or between Days 15 and 29 (45%). A further systematic review of 11 studies with a total of 1136 patients also showed a significant correlation between timing of intervention and mortality ($R = -0.603$, $P = 0.05$).12

The current standard approach for endoscopic necrosectomy involving the following steps:15,17,18: (1) Linear-array endoscopic ultrasound (EUS) is used to visualize the extent of the necrosis and to determine the optical puncture site. Under EUS guidance, the cavity content is aspirated to con...
necrotic cavity is irrigated with normal saline via the nasocystic catheter; and (4) repeated sessions at intervals of 1–4 days are carried out until the majority of the necrotic material is removed.

Treatment results

After the initial report by Seifert et al.9 several subsequent reports have described the successful application of endoscopic necrosectomy for the treatment of infected pancreatic necrosis.15–27 However, most of these reports were small case series, which are summarized in Table 1.9,15–27 Haghshenasskashani et al.28 analyzed data from 260 cases derived from previously published case reports.8,16,17,19

Table 1 Previous Reports on Endoscopic Necrosectomy for Infected Pancreatic Necrosis

<table>
<thead>
<tr>
<th>Author (y)</th>
<th>Study design</th>
<th>n</th>
<th>Success rate</th>
<th>Morbidity</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seifert (2000)17</td>
<td>Case series</td>
<td>3</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Seewald (2005)19</td>
<td>Case series</td>
<td>13</td>
<td>69%</td>
<td>31%</td>
<td>0%</td>
</tr>
<tr>
<td>Charnley (2006)20</td>
<td>Case series</td>
<td>13</td>
<td>92%*</td>
<td>0%</td>
<td>15%*</td>
</tr>
<tr>
<td>Papachristou (2007)21</td>
<td>Retrospective cohort</td>
<td>53</td>
<td>53%</td>
<td>21%</td>
<td>0%</td>
</tr>
<tr>
<td>Voermans (2007)22</td>
<td>Retrospective cohort</td>
<td>25</td>
<td>93%</td>
<td>7%</td>
<td>0%</td>
</tr>
<tr>
<td>Kang (2008)23</td>
<td>Case report</td>
<td>1</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Mathew (2008)24</td>
<td>Case series</td>
<td>6</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Escourrou (2008)25</td>
<td>Case series</td>
<td>13</td>
<td>100%</td>
<td>46%</td>
<td>0%</td>
</tr>
<tr>
<td>Schrover (2008)26</td>
<td>Retrospective cohort</td>
<td>8</td>
<td>75%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>Gardner (2009)16</td>
<td>Retrospective cohort</td>
<td>25</td>
<td>88%</td>
<td>32%</td>
<td>0%</td>
</tr>
<tr>
<td>Seifert (2009)17</td>
<td>Retrospective cohort</td>
<td>93</td>
<td>80%</td>
<td>26%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Seewald (2011)27</td>
<td>Retrospective cohort</td>
<td>80</td>
<td>83.8%</td>
<td>26%</td>
<td>0%</td>
</tr>
<tr>
<td>Gardner (2011)18</td>
<td>Retrospective cohort</td>
<td>104</td>
<td>91%</td>
<td>14%</td>
<td>5.8%</td>
</tr>
<tr>
<td>Bakker (2012)19</td>
<td>RCT**</td>
<td>10</td>
<td>80%</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Fig. 2. (A) Dilation of the transmural tract using a large balloon. (B) Endoscopic removal of necrotic tissue using pentapod forceps.

They reported that the rate of complete resolution of pancreatic necrosis with endoscopic intervention alone was 76%, while the mean procedure-related morbidity was 27% and the overall mortality was 5%. Recently, multicenter study data with a large number of subjects was reported from Germany17 and the United States.18 Seifert et al17 reported a large series dataset with long-term follow-up in 2009. They collected the data of 93 patients from 6 different centers retrospectively. Initial clinical success was obtained in 80% of patients, with a 26% complication and a 7.5% mortality rate at 30 days. Complications included 13 cases of bleeding, five perforations of the necrotic cavity, two cases with fistula formation, two cases of air embolism, and two cases of complications at other organs. In total, seven patients died during the initial hospital stay (7.5%); one patient died after surgery and six died prior to surgery. Overall, one death was due to fatal bleeding, one was due to air embolism, four were due to sepsis, and one occurred after surgery due to multiple organ failure. One of the most feared complications, namely air embolism, was encountered twice during this series. Therefore, after the publication of this study, carbon dioxide is used instead of room air for endoscopic insufflation in many centers. With respect to long-term outcomes, 16% of the patients experienced recurrent pancreatitis, 10% received further endoscopic treatment, and 4% received surgical treatment for recurrent cavities after a mean follow-up period of 43 months.

Gardner et al18 analyzed data from 104 patients, which was collected retrospectively from six U.S. tertiary medical centers. Successful resolution was achieved in 91% of the patients, with a 32% complication rate and 5.8% mortality rate. Complications included 19 cases of bleeding requiring endoscopic intervention during their initial necrosectomy, three cases of bleeding that could not be controlled endoscopically, two cases of retrogastric perforation, three cases of pneumoperitoneum, four cases of infections, one case of balloon dilation in retroperitoneum, and one case of periprocedural hypotension and subsequent cardiac arrest. The patient with peri-procedural hypotension is thought to have died because of an air embolism during the initial necrosectomy, while another patient died due to massive duodenal bleeding. Death in another five patients resulted from acute superior mesenteric artery thrombosis, myocardial infarction, progressive renal failure, massive bleeding from a small gastroduodenal artery pseudoaneurysm, and an unknown reason during the follow-up period before cavity resolution.

The previous studies suggest a high success rate and acceptable complication rate with endoscopic necrosectomy for the treatment of pancreatic necrosis.
Conclusions

Endoscopic necrosectomy is a promising method with a relatively high success rate and acceptable complication rate. The minimally invasive technique can be attempted in patients who are already severely ill. Delayed intervention is currently preferred to early intervention, because maturation of the necrotic tissue (WOPN) facilitates the procedure of necrosectomy and thereby theoretically reduces the risk of complications such as bleeding and perforation.

Conflict of interest

The author declares that no conflict of interest.

References