J Hepatobiliary Pancreat Surg (2009) 16:605–612
DOI 10.1007/s00534-009-0130-6

TOPICS

Current topics in endoscopic treatment of pancreatobiliary diseases

Endotherapy for pancreatic necrosis and abscess: endoscopic drainage and necrosectomy

Jayant P. Talreja · Michel Kahaleh

Received: 1 March 2009 / Accepted: 31 March 2009 / Published online: 24 June 2009

Abstract Pancreatic necrosis and abscess are among the most severe complications of acute pancreatitis. Endoscopic drainage of pancreatic fluid collections has been increasingly performed in many tertiary care centers. The type of fluid collection that is being intervened upon determines the outcome. The development of endoscopic ultrasonography (EUS) has expanded the safety and efficacy of this modality by allowing one to access and drain more challenging fluid collections. The technique and review of current literature regarding endoscopic therapy of pancreatic necrosis and abscess will be discussed.

Keywords Pancreatic fluid collections · Pseudocyst · Necrosis · Necrosectomy · Cystoenterostomy

Introduction

Pancreatic fluid collections (PFCs) develop secondary to either fluid leakage or liquefaction of pancreatic necrosis [1] following acute pancreatitis, chronic pancreatitis, surgery, or abdominal trauma [2–5]. The accepted nomenclature for classifying PFCs has been defined by the Atlanta Classification [6, 7]. The presence of underlying ductal damage, the severity of acute pancreatitis, and maturation of the collection in relation to the onset of acute pancreatitis are factors that influence formation and composition of the PFC [7–11].

J. P. Talreja · M. Kahaleh (✉)
Digestive Health Center of Excellence,
University of Virginia Health System,
Box 800708, Charlottesville, VA 22908-0708, USA
e-mail: mk5ke@virginia.edu

The Atlanta Classification defines pancreatic necrosis as diffuse or focal areas of nonviable pancreatic parenchyma, usually with associated peripancreatic fat necrosis, and often accompanied by the development of major pancreatic ductal disruptions [6]. Over a period of several weeks, the initial focus of necrosis may expand and can contain both liquid and solid debris [1, 2]. In many cases, pancreatic necrosis tracks widely into the retroperitoneal space and may even erode retroperitoneal vessels [13]. The gross radiographic appearance of organized pancreatic necrosis may be similar to that of an acute pseudocyst on CT.

Radiographically, there are features that may help one identify the presence of solid debris. These include significant glandular necrosis on initial contrasted CT, MRI depicting solid debris, and also the presence of large filling defects upon contrast injection, which indicates the presence of solid debris [12, 14, 15]. A pancreatic abscess is defined as a circumscribed intra-abdominal collection of pus, usually in proximity to the pancreas, that contains little or no necrosis. It has a well-defined wall, can be multiloculated, and is prone to rupture [12, 13]. These collections are uncommon.

The traditional mainstay of treatment for pancreatic necrosis and abscess has been surgery; however, this modality has been associated with high morbidity and mortality [16–18]. Percutaneous drainage may be effective for a subgroup of patients; however, this modality is not effective when the fluid collection contains thick, purulent debris [19–21]. Also, catheter placement can be associated with bacterial colonization and can leave the patient with a disconnected gland [22, 23].

Endoscopic drainage for pancreatic fluid collections has been performed for over two decades, with pancreatic necrosis and abscesses being the most challenging to treat [7, 24]. The evolution of endoscopic ultrasound (EUS) has extended the indications for transmural drainage to include non-bulging or high risk fluid collections [1, 7]. Endoscopic therapy may involve the following: ERCP and pancreatic sphincterotomy and stenting, transmural, EUS-guided puncture, dilation, and drainage, endoscopic necrosectomy, lavage, and fistula sealing [1, 7, 25–27].

Materials and methods

Side viewing endoscope

Endoscopes offering a working channel of at least 3 mm should be used to drain pseudocysts. For example, the therapeutic videoduodenoscope with a 4.2 mm working channel can be used (TJF 160; Olympus Optical Co, Ltd, Tokyo, Japan).

Therapeutic gastroscopes (GIF 1T 140, Q140/160, GIF-1T100-140, GIF XT 30; Olympus) and pediatric gastroscopes (GIF XP 160 and 240; Olympus) can be used in aspirating necrotic pseudocysts.

Echo-endoscopes

Linear array echo-endoscopes offering a working channel of at least 3 mm should be used. This includes the FG 38 UX, the E.G 38UT (Hitachi/Pentax, Japan) and the GF-UCT140 (Olympus, Japan). The E.G 38UT and the GF-UCT 140, which have working channels of 3.8 and 3.7 mm, respectively, allow placement of a 10-French double pigtail stent. On the other hand, the FG 38X has a working channel of 3.2 mm, which only permits placement of an 8.5-French stent. These instruments are coupled with an ultrasound processor such as the Aloka (Tokyo, Japan) or the EUB 6000 from Hitachi (Tokyo, Japan).

The difficulty with conventional therapeutic oblique-viewing (45°) echo-endoscopes is that the force that is applied while introducing instruments through the working channel is not fully exerted at the tip of the accessory, but instead drives the endoscope away from the gut wall. The concept of the forward viewing scope (XGiF-UCT160; Olympus Medical Systems Europe, Hamburg, Germany) is to overcome this difficulty by exerting force in a straight line with the scope. This allows the endoscopist to puncture the cyst wall in a straight line with the scope. This also allows the endoscopist to maintain orientation and an adequate endoscopic view with the punctured cyst when switching to endoscopic vision from EUS vision [28, 29].

Devices

Needle-knife catheters can be used to gain access, but the tip can be difficult to see by endosonography. We tend to use a 19- or 22-gauge needle (EUSN-19-T or EUS-1-CS, Wilson-Cook, Winston Salem, NC) (Figs. 1, 2). Although correct orientation of the 19-gauge needle is more challenging than the 22 gauge, it permits placement of a 0.035-inch guidewire, such as the Terumo (Boston Scientific) or theTeflon (THSF-35-480; Wilson Cook). This wire size is more easily manipulated than a 0.018-inch guidewire (Pathfinder, Boston Scientific Corp., Natick, Mass). The fistula between the fluid collection can be enlarged using either a 10–20 mm wire-guided balloon catheter (Max-Force; Microvasive) (Figs. 3, 4, 5), 10F or 11F bougie

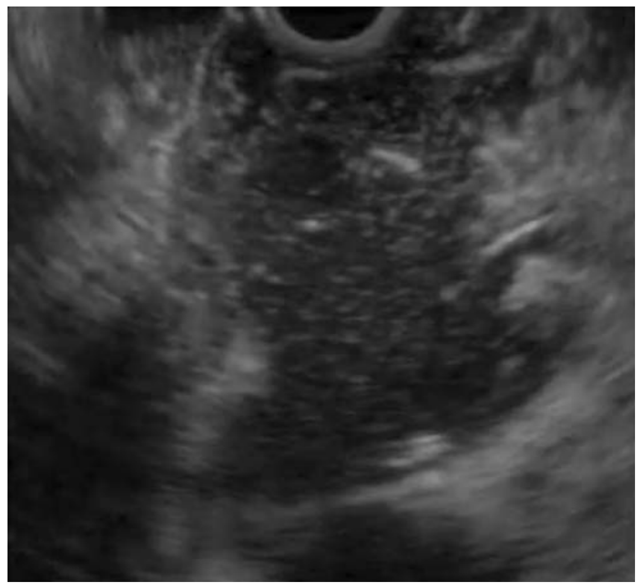

Fig. 1 EUS image of a large retrogastric abscess

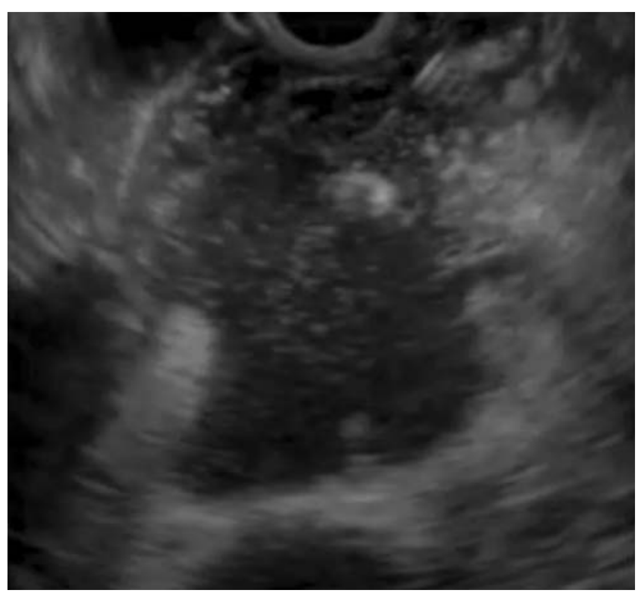

Fig. 2 EUS guide puncture of the abscess

Fig. 3 Fluoroscopic image during dilation of the fistula created between the stomach and the abscess

Fig. 4 Endoscopic image during dilation of the fistula created between the stomach and the abscess

Fig. 5 Decompression of the abscess post dilation of the fistula

(SBDC-10 or 11; Wilson-Cook) or a 10 Fr cystenterostome (EndoFlex, Voerde, Germany) before deployment of a double pigtail stent (Fig. 6).

Fig. 6 Fluoroscopic images of deployment of a double pigtail 10 Fr stent across the fistula created

Seifert et al. [30] described a device that consists of a 19-gauge fistulotome over a Teflon guidewire, a pusher tube and a 7–10 Fr plastic stent, designed for controlled one-step placement and release.

Appropriate candidates

Adequate cross-sectional imaging is required before the procedure to define the patient's anatomy, the "window of entry," and to distinguish whether the fluid collection is primarily liquid or with significant solid debris. Most experts also recommend assessing the integrity of the main pancreatic duct with pancreatography when considering drainage [31].

The decision to endoscopically intervene in patients with sterile pancreatic necrosis must be carefully considered because it is technically more difficult, the procedure carries a higher rate of complications, and tends to involve severely ill patients [12]. It is typically undertaken once the collection becomes organized, which may take several weeks. Infected pancreatic necrosis, on the other hand, should be drained promptly. A pancreatic abscess is infected by definition, and always requires prompt drainage [12].

The presence of non-bulging fluid collections, known portal hypertension/high pretest probability of bleeding, prior failed transmural entry using non-EUS guided techniques, or the need to exclude cystic neoplasm are all reasons to consider EUS-guided drainage [32–35].

Appropriate endoscopists

Only endoscopists skilled at ERCP and EUS should perform these procedures. Additionally, it should be performed in a tertiary care center where pancreatico-biliary surgeons as well as interventional radiologists are available in the event of a complication.

Patient preparation

Endoscopic drainage is a time-consuming and technically challenging procedure that involves the use of both fluoroscopy and ultrasonography in multiple steps. Therefore, performance of the procedure with the assistance of anesthesia is recommended. All patients should receive periprocedural antibiotics.

Pre-drainage evaluation

The goals of a pre-drainage evaluation include determining whether or not the collection can be drained safely. Determining the presence of coagulopathy and thrombocytopenia should be done prior to considering transmural drainage. Contrast-enhanced abdominal CT or magnetic resonance imaging should be performed to ascertain whether the collection contains liquid or solid debris, to visualize the relationship of the collection to surrounding luminal and vascular structures, and to rule out underlying etiologies of true pancreatic pseudocyst, for which therapy may be different [32, 36]. The combination of ultrasonographic features and analysis of cyst contents allows one to confirm the diagnosis of a pseudocyst prior to performing drainage [36].

Procedure description

As described by Baron et al. [12], transmural drainage is the preferred approach for these collections. After entering the collection, the gastric or duodenal wall is dilated to 15 mm to allow a wide diameter for the solid material outflow around the endoprostheses (generally two 10F stents). A 7F irrigation tube is placed into the collection for aggressive irrigation of the solid debris. Initially, up to 200 ml of normal saline is forcefully and rapidly infused via the tube every 2–4 h. If the patient is intolerant of the standard nasobiliary tube, an alternative is to place a PEG tube with placement of a jejunal extension into the collection. Pre-procedural antibiotics should be administered and patients should be admitted to the hospital after the procedure for observation and irrigation. Antibiotics and irrigation should be continued until serial imaging reveals resolution of the collection. At that point, internal drains may be endoscopically removed.

Fig. 7 Debridement during necrosectomy with a rat tooth forceps

Fig. 8 Water jet lavage during necrosectomy

The procedure, as described by Seewald et al. [13] involves a more aggressive algorithm. The first session includes endoscopic transpapillary and/or transmural EUS guided access of the necrosis followed by balloon dilation of the fistula created. This is followed by daily necrosectomy, lavage, and repeated balloon dilation.

The technique of endoscopic necrosectomy and lavage is performed daily until complete evacuation of necrotic and purulent fluid. A Dormia basket (FG-18Q-1; Olympus, Tokyo, Japan) or rat tooth forceps (Fig. 7) is used to remove necrotic material. Endoscopic lavage is performed using a 10F spray catheter connected to an Endo Water-Jet system (Pauldrach Medical GmbH, Garbsen, Germany) (Fig. 8).

Following evaluation of the pancreatic ductal system, if a communication between the pancreatic duct and the cavity was found, a 7F Teflon nasopancreatic catheter was placed over the guidewire after pancreatic sphincterotomy.

Literature review

In 2002, Baron et al. [7] compared outcome differences after endoscopic drainage of pancreatic necrosis, acute pancreatic pseudocysts, and chronic pancreatic pseudocysts. In this retrospective study, patients with necrosis had less frequent resolution following endoscopic drainage (72%) than patients with acute pseudocysts (92%) or chronic pseudocysts (74%). Complications were more common in patients with necrosis (37%) than in patients with chronic pseudocysts (17%) or acute pseudocysts (19%). Recurrent fluid collections developed more commonly in patients with necrosis (29%) than in patients with acute pseudocysts (9%) or chronic pseudocysts (12%) [7, 37].

Additional studies have been published (Tables 1, 2) which have demonstrated the efficacy of endoscopic treatment of pancreatic necrosis and abscesses. In 2001, Park et al. [27] assessed the feasibility, safety, and effectiveness of endoscopic transmural drainage for the treatment of pancreatic abscesses compressing the gut lumen. In this study, 11 pancreatic abscesses in nine patients were drained endoscopically. Ten abscess cavities (91%) resolved completely after stent placement for a mean duration of 32 days. In two patients, a nasopancreatic catheter was required to irrigate thick pus or necrotic debris. Uncomplicated bleeding occurred in one case. The relapse rate was 13% over a mean follow-up of 18 months.

In 2000, Venu et al. [26], demonstrated comparable results by using a transpapillary approach. In this study, 11 patients underwent endoscopic transpapillary drainage with technical success in 10 patients (90%). Eight patients (74%) had resolution of their pancreatic abscess. Nasopancreatic catheter drainage and intracavitary instillation of gentamicin was used in two patients. The patient in whom endoscopic treatment was technically unsuccessful underwent successful percutaneous drainage, and the two patients in whom endoscopic drainage failed underwent successful operative drainage.

In 2000, Seifert et al. [38] were the first to describe the combination of EUS-directed, transmural puncture into necrotizing pancreatitis or abscess followed by tract dilation and repeated, direct endoscopic debridements of the lesser sac [35]. In this study, fenestration of the gastric wall and debridement of infected necrosis by direct retroperitoneal endoscopy was performed on three patients. This strategy led to rapid clinical improvement and no serious complications.

In 2001, Giovannini et al. [39] reported their experience with EUS-guided drainage of pancreatic pseudocysts and pancreatic abscesses in 35 patients. Twenty of these patients had pancreatic abscesses, located either in the

Table 1 Case studies of pancreatic necrosis treated endoscopically

Pancreatic necrosis	Year	Number of patients	Procedure-related complications	Success rate
Baron [1]	1996	11	Bleeding ($n = 5$)	9/11
Baron [7]	2002	43	Infection and bleeding ($n = 16$)	31/43
Seewald [13]	2005	5	Bleeding ($n = 4$)	4/5
Papachristou [40]	2007	53	Cutaneous fistula ($n = 2$) colonic obstruction ($n = 1$) perforation ($n = 1$), and flank abscess ($n = 1$)	43/53
Hookey [24]	2006	8	Bleeding ($n = 2$)	2/8
Total		123	Pneumoperitoneum ($n = 8$), bleeding ($n = 9$), superinfection ($n = 9$), migration ($n = 2$)	89/120 (74.2%)

Table 2 Case studies of pancreatic abscesses treated endoscopically

Pancreatic abscess	Year	Number of patients	Procedure-related complications	Success rate
Park [27]	2001	11	Bleeding ($n = 1$)	10/11
Venu [26]	2000	11	Post ERCP pancreatitis ($n = 1$)	8/11
Giovannini [39]	2001	20	Pneumoperitoneum ($n = 1$)	18/20
Seewald [13]	2005	8	None	8/8
Hookey [24]	2006	9	None	8/9
Lopes [41]	2006	26	Stent migration ($n = 1$) pneumoperitoneum ($n = 1$)	24/26
Total		85	Pneumoperitoneum ($n = 1$), bleeding ($n = 1$), superinfection ($n = 1$), migration ($n = 1$) post-ERCP pancreatitis ($n = 1$)	76/85 (89.4%)

pancreatic tail (17 patients) or adjacent to the gastric wall (3 patients). Placement of a 7F nasocystic drain was successful in 18 of 20 patients. The remaining two patients required surgery. Over a mean of 27 months of follow-up, two relapses occurred.

In 2005, Seewald et al. [13] performed a retrospective study of the outcome of consecutive patients with pancreatic necrosis and pancreatic abscesses, all unfit to undergo surgery. The treatment included synchronous EUS-guided multiple transmural and/or transpapillary drainage procedures followed by balloon dilation of the cystogastrostoma or cystoduodenostoma, daily endoscopic necrosectomy and saline solution lavage, and sealing of pancreatic fistula by N-butyl-2-cyanoacrylate. This study was performed over a 7 year period, with 13 consecutive patients, 5 with infected pancreatic necrosis, and 8 with pancreatic abscesses. Endoscopic therapy was successful in resolving the infected necrosis or abscess in 12 of 13 patients over a median follow-up time of 9.5 months. One patient required additional surgery to evacuate necrosis that extended into the paracolic gutter. Two patients with a disconnected duct gland syndrome developed recurrent fluid collections after 2 and 4 months. These patients ultimately required pancreatic head resections. Two patients had their persistent ductal leaks glued. Complications included three episodes of locally controlled bleeding. The median number of daily necrosectomies was 7, and the number of high volume irrigations ranged between 2 and 41.

In 2007, Papachristou et al. [40] performed a retrospective analysis in which 53 patients underwent transoral/transmural endoscopic drainage/debridement of sterile (27 patients) and infected (26 patients) walled-off pancreatic necrosis. A median of three sessions per patient were performed. Final outcome after initial endoscopic intervention revealed successful endoscopic therapy in 81% (43 patients) and persistence of walled-off pancreatic necrosis in 19% (10 patients).

Twenty-one patients (40%) required concurrent radiologically-guided catheter drainage and 12 patients (23%) required open operative intervention due to persistence of walled-off pancreatic necrosis (3 patients), fluid collection recurrence (2 patients), cutaneous fistula formation (2 patients), or technical failure, persistence of pain, colonic obstruction, perforation, and flank abscess (1 patient each).

In 2006, Hookey et al. [24] compared etiologies, drainage techniques and outcomes in 116 patients who underwent endoscopic drainage of pancreatic fluid collections. Of the 116 patients, 8 patients had pancreatic necrosis, and nine had pancreatic abscesses. In this study, drainage of organized necrosis was associated with a significantly higher failure rate than other collections. Drainage of necrosis resulted in clinical success in only 25% of cases and technical success in 50%. Six of eight patients had a nasocystic catheter placed and one patient experienced recurrence. There were two procedure related complications in this subgroup. Nine patients underwent endoscopic drainage for pancreatic abscesses. Seven of nine patients had a nasocystic catheter placed. All procedures were technically successful, and eight of nine (88.9%) patients had clinical success. One abscess recurred and there were no procedure related complications.

In 2007, Lopes et al. [41] performed a retrospective analysis of 51 patients who underwent EUS-guided transmural drainage of pancreatic fluid collections. Twenty-six of these patients had pancreatic abscesses. What is notable in this study regarding pancreatic abscesses is that the endoscopic approach was not more hazardous for abscesses in regard to complications rate when compared to other pancreatic fluid collections. Placement of a nasocystic drain did not decrease the complications rate, but the placement of two stents did decrease the rate of complications.

One of the challenges encountered during EUS-guided drainage is the process of sequential transgastric stenting and nasocystic catheter placement, which may be difficult because of poor visibility from draining fluid, a tangential puncture axis that hinders the passage of a catheter into the cavity, and the presence of solid debris [42, 43].

Another challenge encountered involves the success of conventional necrosectomy using plastic stents, which have a small diameter. Antillon et al. [44] report a case in which they used a large diameter removable metallic esophageal stent to facilitate drainage of infected pancreatic necrosis after multiple failed conventional necrosectomies. This approach needs to be further evaluated.

Conclusion

Pancreatic necrosis and abscess are among the most severe complications of acute pancreatitis. The last two decades have seen the rise of endoscopic management of pancreatic necrosis and abscess, and more recently, we have seen the rise of EUS-guidance in the drainage of these types of pancreatic fluid collections. A variety of studies have been conducted and expert opinion has been reported to answer the question as to whether endoscopic management is superior to surgical or interventional radiological management; however, a large, prospective, multi-center, randomized and controlled trial has not been performed that compares these modalities. The advantage to endoscopic management includes its minimally invasive approach, which eliminates the morbidity associated with post-operative wound healing and percutaneous drain management, as seen with a surgical or interventional radiological approach. The specific advantages of using EUS-guided drainage include the following: the ability to define the characteristics of the fluid collection, to rule out alternative diagnoses, and assess for intervening vasculature. From a therapeutic stand point, one can access non-bulging collections, collections in challenging locations, or at high risk for complications [34]. Disadvantages to using an endoscopic approach are that it is not readily available at all facilities and that the procedure time is generally longer, especially if EUS-guidance is used. The placement of a naso-pancreatic catheter may be associated with patient discomfort, when daily necrosectomy is necessary. Further progress in instrumentation is required to make this technique safer and more efficacious. In the meantime, the endoscopic approach should be dictated by local expertise and the individual patient presentation.

References

1. Baron TH, Thaggard WG, Morgan DE, Stanley RJ. Endoscopic therapy for organized pancreatic necrosis. Gastroenterology. 1996;111:755–64.
2. Baillie J. Pancreatic pseudocysts (part I). Gastrointest Endosc. 2004;59:873–9.
3. Yeo CL, Cameron JL, Sohn TA, Lillemoe KD, Pitt HA, Talamini MA, et al. Six hundred fifty consecutive pancreaticoduodenectomies in the 1990s: pathology, complications, and outcomes. Ann Surg. 1997;226:248–60.
4. Arvanitakis M, Delhaye M, Chamlou R, Matos C, Closset J, Medhi A, et al. Endoscopic therapy for main pancreatic duct rupture after silastic-ring vertical gastroplasty. Gastrointest Endosc. 2005;62:143–51.
5. Kloppel G. Pseudocysts and other non-neoplastic cysts of the pancreas. Semin Diagn Pathol. 2000;17:7–15.
6. Bradley ELIII. A clinically based classification system for acute pancreatitis. In: Summary of the international symposium on acute pancreatitis, Atlanta, GA, September 11 through 13, 1992. Arch Surg. 1993;128:586–90.
7. Baron TH, Harewood GC, Morgan DE, Yates MR. Outcome differences after endoscopic drainage of pancreatic necrosis, acute pancreatic pseudocysts, and chronic pancreatic pseudocysts. Gastrointest Endosc. 2002;56:7–17.
8. Baron TH, Morgan DE. The diagnosis and management of fluid collections associated with pancreatitis. Am J Med. 1997;102:555–63.
9. Yeo CJ, Bastidas JA, Lynch-Nyhan A, Fishman EK, Sinner MJ, Cameron JL. The natural history of pancreatic pseudocysts documented by computed tomography. Surg Gyn Obstet. 1990;170:411–7.
10. Bradley EL, Clements JL Jr, Gonzalez AC. The natural history of pancreatic pseudocysts: a unified concept of management. Am J Surg. 1979;137:135–41.
11. Gouyon B, Levy P, Ruszniewski P, Zins M, Hammel P, Vilgrain V, et al. Predictive factors in the outcome of pseudocysts complicating alcoholic chronic pancreatitis. Gut. 1997;41:821–5.
12. Baron T. Endoscopic drainage of pancreatic fluid collections and pancreatic necrosis. Tech Gastrointest Endosc. 2004;6:91–9.
13. Seewald S, Groth S, Omar S, Imazu H, Seitz U, de Weerth A, et al. Aggressive endoscopic therapy for pancreatic necrosis and pancreatic abscess: a new safe and effective treatment algorithm (videos). Gastrointest Endosc. 2005;62:92–100.
14. Morgan DE, Baron TH, Smith JK, Robbin ML, Kenney PJ. Pancreatic fluid collections prior to intervention: evaluation with MR imaging compared with CT and US. Radiology. 1997;203:773–8.
15. Balthazar EJ, Freeny PC, van Sonnenberg E. Imaging and intervention in acute pancreatitis. Radiology. 1994;193:297–306.
16. Uhl W, Warsaw A, Imrie C, Bassi C, McKay CJ, Lankisch PG, et al. IAP guidelines for the surgical management of acute pancreatitis. Pancreatology. 2002;2:565–73.
17. Fernandez-del Castillo C, Rattner DW, Makary MA, Mostafavi A, McGrath D, Warshaw AL. Debridement and closed packing for the treatment of necrotizing pancreatitis. Ann Surg. 1998;228:676–84.
18. Hartwig W, Werner J, Muller CA, Uhl W, Buchler MW. Surgical management of severe pancreatitis including sterile necrosis. J Hepatobiliary Pancreat Surg. 2002;9:429–35.
19. Mithofer K, Mueller PR, Warshaw AL. Interventional and surgical treatment of pancreatic abscess. World J Surg. 1997;21:162–8.
20. van Sonnenberg E, Wittich GR, Chon KS, D'Agostino HB, Casola G, Easter D, et al. Percutaneous radiologic drainage of pancreatic abscesses. Am J Roentgenol. 1997;168:979–84.
21. van Sonnenberg E, Wittich GR, Goodacre BW, Casola G, D'Agostino HB. Percutaneous abscess drainage: update. World J Surg. 2001;25:362–9.
22. Freeny PC, Hauptmann E, Althaus SJ, Traverso LW, Sinanan M. Percutaneous CT-guided catheter drainage of infected acute necrotizing pancreatitis: techniques and results. Am J Roentgenol. 1998;170:969–75.
23. Memis A, Parildar M. Interventional radiological treatment in complications of pancreatitis. Eur J Radiol. 2002;43:219–28.
24. Hookey LC, Debroux S, Delhaye M, Arvanitakis M, Le Moine O, Deviere J. Endoscopic drainage of pancreatic fluid collections in 116 patients: a comparison of etiologies, drainage techniques, and outcomes. Gastrointest Endosc. 2006;63:635–43.
25. Seifert H, Dietrich C, Schmitt T, Caspary W, Wehrmann T. Endoscopic ultrasound-guided one-step transmural drainage of cystic abdominal lesions with a large-channel echo endoscope. Endoscopy. 2000;32:255–9.
26. Venu RP, Brown RD, Marrero JA, Pastika BJ, Frakes JT. Endoscopic transpapillary drainage of pancreatic abscess: technique and results. Gastrointest Endosc. 2000;51:391–5.
27. Park JJ, Kim SS, Koo YS, Choi DJ, Park HC, Kim JH, et al. Definitive treatment of pancreatic abscess by endoscopic transmural drainage. Gastrointest Endosc. 2002;55:256–62.
28. Voermans RP, Eisendrath P, Bruno MJ, Le Moine O, Deviere J, Fockens P, et al. Initial evaluation of a novel prototype forward-viewing US endoscope in transmural drainage of pancreatic pseudocysts (with videos). Gastrointest Endosc. 2007;66:1013–7.
29. Trevino JM, Varadarajulu S. Initial experience with prototype forward-viewing echoendoscope for therapeutic interventions other than pancreatic pseudocyst drainage (with videos). Gastrointest Endosc. 2009;69:361–5.
30. Seifert H, Faust D, Schmitt T, Dietrich C, Caspary W, Wehrmann T. Transmural drainage of cystic peripancreatic lesions with a new large-channel echo endoscope. Endoscopy. 2001;33:1022–6.
31. Baron TH. Endoscopic drainage of pancreatic pseudocysts. J Gastrointest Surg. 2008;12:369–72.
32. Jacobson BC, Baron TH, Adler DG, Davila RE, Egan J, Hirota WK, et al. ASGE guideline: the role of endoscopy in the diagnosis and the management of cystic lesions and inflammatory fluid collections of the pancreas. Gastrointest Endosc. 2005;61:363–70.
33. Varadarajulu S, Wilcox CM, Tamhane A, Eloubeidi MA, Blakey J, Canon CL. Role of EUS in drainage of peripancreatic fluid collections not amenable for endoscopic transmural drainage. Gastrointest Endosc. 2007;66(6):1107–19.

34. Kahaleh M, Shami VM, Conway MR, Tokar J, Rockoff T, De La Rue SA, et al. Comparison of EUS and conventional endoscopic drainage of pancreatic pseudocyst. Endoscopy. 2006;38:355–9.
35. Giovannini M. EUS-guided pancreatic pseudocyst drainage. Tech Gastrointest Endosc. 2007;9(1):32–8.
36. Baron TH. Endoscopic drainage of pancreatic pseudocysts, abscesses and organized (walled-off) necrosis. In: ERCP Baron TH, Kozarek R, Carr-Locke DL, (eds) Saunders Elsevier, Philadelphia, 2008; Chapter 45.
37. Kozarek R. Endoscopic management of pancreatic necrosis: not for the uncommitted. Gastrointest Endosc. 2005;62:101–4.
38. Seifert H, Wehrmann Schmitt T, Zeuzem S, Caspary WF. Retroperitoneal endoscopic debridement for infected peripancreatic necrosis. Lancet. 2000;356:653–5.
39. Giovannini M, Pesenti C, Rolland AL, et al. Endoscopic ultrasound-guided drainage of pancreatic pseudocysts or pancreatic abscesses using a therapeutic echo endoscope. Endoscopy. 2001;33:473–7.
40. Papachristou GI, Takahashi N, Chahal P, Sarr MG, Baron TH. Peroral endoscopic drainage/debridement of walled-off pancreatic necrosis. Ann Surg. 2007;245:943–51.
41. Lopes CV, Pesenti C, Bories E, Caillol F, Giovannini M. Endoscopic-ultrasound-guided endoscopic transmural drainage of pancreatic pseudoscysts and abscesses. Scan J Gastroenterol. 2007;42:524–9.
42. Seewald S, Thonke F, Ang TL, Omar S, Seitz U, Groth S, et al. One-step, simultaneous double-wire technique facilitates pancreatic pseudocyst and abscess drainage (with videos). Gastrointest Endosc. 2006;64:805–8.
43. Ang TL, Teo EK, Fock KM. EUS-guided drainage of infected pancreatic pseudocyst: use of a 10F Soehendra dilator to facilitate a double-wire technique for initial transgastric access (with videos). Gastrointest Endosc. 2008;68:192–4.
44. Antillon MR, Bechtold ML, Bartalos CR, Marshall JB. Transgastric endoscopic necrosectomy with temporary metallic esophageal stent placement for the treatment of infected pancreatic necrosis (with video). Gastrointest Endosc. 2009;69:178–80.