

## Clinical Science

## Surgical management of complicated pancreatic pseudocysts after acute pancreatitis

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910 Madison Avenue, Suite 203, Memphis, TN, 38163, USA***KEYWORDS:**Acute pancreatitis;  
Pancreatic pseudocyst;  
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Location**Abstract****BACKGROUND:** Management of pancreatic pseudocysts (PP) is unclear when located in areas outside the lesser sac, infected, or when portal venous (PV) occlusion is present.**METHODS:** Patients having internal drainage of PP. Management and outcome were assessed relative to location, presence of infection, and/or PV occlusion.**RESULTS:** No patient required transfusion, and there were no readmissions in 9 patients with PV occlusion. Eleven patients had infected PP including 5 extending outside the lesser sac. Six had postoperative imaging, 4 readmission, and 3 required adjunct postoperative percutaneous drainage. All but 2 with PP beyond the lesser sac had Roux-en-Y cystjejunostomy including 4 with 2 anastomoses. Nine, 4, and 5 required reimaging, readmission, and postoperative therapeutic intervention, respectively.**CONCLUSIONS:** (1) Open PP drainage in the face of PV occlusion confers a low risk of bleeding and a minimal need for reimaging or readmission; (2) internal drainage of infected PP is a viable option to external drainage; and (3) PP extending beyond the lesser sac can most often be managed successfully by Roux-en-Y drainage but may require additional intervention.

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The management of pancreatic pseudocysts (PPs) that fail to resolve after acute pancreatitis (AP) has evolved from a primary surgical approach (open and laparoscopic) to nonsurgical drainage techniques using percutaneous and endoscopic drainage. Endoscopic drainage either by the conventional transmural method or under ultrasound guidance has proven to be particularly efficacious with results mimicking the traditional surgical outcomes whereas minimizing the need for general anesthesia and reducing hospital length of stay (LOS) and costs. In fact, studies have suggested that endoscopic management of PP should be

considered first-line therapy with other methods used only for treatment failures or complications after an endoscopic approach.<sup>1-3</sup> The predominance of literature comparing surgery to endoscopic management has focused on uncomplicated pseudocysts most often confined to the lesser sac and readily accessed via the transgastric or transpapillary approach. Although most PP manifests these traits it must be acknowledged that others may present with features more challenging particularly with respect to a successful and safe endoscopic procedure. Patients with splenic and/or portal vein occlusion and perigastric varices, those with infected PP and those with pseudocysts located outside the lesser sac represent a cohort that may present a relative or absolute contraindication for endoscopic drainage. Indeed, there is a paucity of literature, both surgical and nonsurgical, defining management of PP under these neither

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circumstances nor series that report outcomes relative to the need for reimaging, repeat therapeutic intervention or the need for readmission. We reviewed short- and long-term outcome of surgical management of these difficult PP.

## Methods

Records of all patients who had internal drainage of a PP after AP at Baptist Memorial Hospital from 2004 to 2014 were retrospectively reviewed after Institutional Review Board approval. The definition of PP was defined in accordance with the 2012 updated Atlanta classification guidelines.<sup>4</sup> Indications for surgical intervention included increasing size or failure to resolve if >6 cm, persistent pain and/or nausea and vomiting regardless of size, infection, and pseudocysts located or extending outside the lesser sac precluding internal drainage by endoscopic means. Patients with splenic and/or portal vein thrombosis with associated perigastric varices were referred for surgical drainage up front or when a vessel-free path could not be found by endoscopic means. Otherwise, no patient in this series had a preoperative attempt at endoscopic drainage primarily for the reasons noted previously mentioned. Those patients having percutaneous drainage (PD) before surgical intervention were included. However, patients having PD of PP as definitive management and those having successful endoscopic drainage were not captured in this study. No patient had external drainage of an infected PP.

Pseudocyst size was measured in its greatest dimension by computed tomography (CT) imaging. Portal venous (PV) occlusion was defined as splenic vein occlusion with or without portal and/or superior vein occlusion that resulted in perigastric varices. An infected PP was defined when a patient with a previously stable fluid collection, but without evidence of pancreatic necrosis, after AP demonstrated evidence of fever, sepsis, and/or developed an elevated-white blood cell count or left shift on the differential analysis and had fluid that was culture positive at the time of surgical intervention. For the purposes of this study, fluid collections outside the lesser sac were tabulated and recorded in the after anatomic spaces: subhepatic, right and left paracolic gutters, and base of mesentery.

Factors examined included etiology of pancreatitis, pseudocyst size, preoperative therapeutic intervention, operative procedure and time, and transfusion requirements. The microbiology of infected PP was recorded. Outcomes assessed included procedure-related morbidity, postoperative LOS, the need for reimaging or readmission after surgery and the need for any therapeutic intervention after primary surgical intervention.

## Results

During the 10-year time period, 48 patients had internal drainage of a PP, 36 of who had a complicated PP. Mean age was 48.3 years (range, 24 to 72; median, 47) and 32

were male. The etiology of AP was gallstones, alcohol, postoperative, idiopathic, hypertriglyceridemia, endoscopic retrograde cholangiopancreatography induced, and hypercalcemia in 21, 11, 6, 5, 2, 1, and 1, respectively. Mean pseudocyst size was 13.3 cm (range, 3 to 24.5). The most common presenting symptom was abdominal pain. Early satiety and weight loss occurred in 48% of patients and nausea and/or vomiting in 37.5%. Eight patients had fever before operation. Only 3 patients were completely asymptomatic. A total of 21 patients required perioperative nutrition support with all but 1 receiving total parenteral nutrition.

Nine patients had PV occlusion with associated perigastric varices including 8 and 1 with splenic and portal vein thrombosis, respectively. All occlusions were diagnosed preoperatively. No patient had variceal bleeding before surgical intervention. Two patients were referred for surgical intervention when a vessel-free path could not be identified by endoscopic means. The etiology of AP in this cohort included gallstone induced in 5 and alcohol and idiopathic in 2 each. Mean pseudocyst size was 11.6 cm (range, 7.5 to 16). Four patients had PP isolated to the lesser sac. Three patients had cyst extension into the base of the mesentery and 1 patient each had a mediastinal and a left paracolic gutter extension. Three were infected. The indication for surgery was pain in 7, early satiety and weight loss in 4 each, cyst expansion in 4, fever and cyst infection in 3, and non-resolution in 1. All patients but 1 (nonresolution) had more than 1 indication for operative intervention.

Operative procedures performed included Roux-en-Y cystjejunostomy to the base of the colonic mesentery in 7 patients (including 2 separate anastomoses in 1 because of extension of the cyst to the left paracolic gutter) and cystgastrostomy in 2. Mean operative time was 182 minutes (range, 139 to 238). No patient required perioperative transfusion, and there was no postoperative morbidity. Median postoperative LOS was 6 days (range, 5 to 14). Only 1 patient required postdischarge CT imaging that was negative, and no patient required hospital readmission or the need for reoperation.

Eleven patients had internal drainage for infected PP. These patients all had known pseudocysts by prior imaging but demonstrated clinical evidence of secondary infection during surveillance. Three and 5 had concurrent PV occlusion and PP extending beyond the lesser sac, respectively. Factors suggesting infection included fever in 5, increased abdominal pain in 7, elevated-white blood cell count in 3, bacteremia in 6, and a new finding of air within the cyst on CT imaging in 4. In 4 patients, clinical deterioration was preceded by a documented central venous line infection confirmed by catheter-tip culture 2 to 5 days beforehand. These patients had cultures from both sites positive for methicillin-resistant *Staphylococcus aureus*. One of the 11 patients had 3 prior percutaneous interventions for cyst drainage that was felt to seed a previously sterile process. An antecedent etiology for seeding the PP could not be determined in 6.

Organisms recovered, procedures performed, and outcomes are summarized in Table 1. Eight patients had Roux-en-Y cystjejunostomy and 3 had cystgastrostomy. The 5 patients that had infected PP extending beyond the lesser sac all of who had Roux-en-Y reconstruction including 2 patients that required 2 separate anastomoses for definitive dependent drainage. Six of 11 patients required repeat abdominal CT imaging because of complaints of pain or continued clinical signs of infection. Of these 6, 2 were negative and 1 patient had an ileus. Two patients had an intra-abdominal abscess (IAA) away from the PP and 1 patient had a residual PP in a left paracolic gutter. PD was used in these 3 patients as definitive management. Four patients required readmission, 3 for procedure-related complications (1 deep venous thrombosis, 1 IAA, 1 residual PP in the left paracolic gutter). There was no mortality. Median postoperative LOS was 10 days (range, 5 to 32).

A total of 24 patients had PP that extended beyond, or occurred outside, the lesser sac to anatomic areas that may not have allowed optimal dependent drainage and/or a viable window for endoscopic drainage (Table 2). The most common extension was caudad into the base of the mesentery in 19 patients. Extension into the right of left paracolic gutter occurred in 9 patients. Eleven patients had PP extending to more than 1 location outside the lesser sac. Five and 4 patients had infected cysts and PV occlusion, respectively. Etiology of disease was alcohol or gallstones in two thirds, and the mean pseudocyst size was 13.2 cm in the greatest cross-sectional diameter.

All but 2 patients with PP extending beyond the lesser sac had internal drainage via Roux-en-Y cystjejunostomy to maximize dependent drainage and for cysts located or

extending beyond the lesser sac. Three patients had 2 separate Roux-en-Y anastomoses, and 2 patients had a cystgastrostomy in addition to Roux-en-Y cystjejunostomy to drain cysts located in 2 different anatomic regions. Median and mean LOS was 7 and 12.8 days, respectively (range, 5 to 75 days). There was no mortality. Ten patients required reimaging because of continued complaints of abdominal pain, an elevated-white blood cell count or fever with 4 negative examinations. Five patients required adjunct PD including 3 patients that had infected PP and 2 patients that had 2 anastomoses. Four of these drains were placed during the index admission. Three of 5 had drainage of incompletely drained left gutter collections one of which was infected. One patient had drainage of an IAA after drainage of an infected PP and 1 had drainage of an incompletely drained PP in the pancreatic bed that was sterile. PD resulted in complete resolution in all avoiding reoperation. Four patients required readmission for *Clostridium difficile* infection, deep vein thrombosis, PD, and a malfunctioning percutaneous drain.

Twelve of 36 patients had 2 complications of their PP at the time of surgical intervention including 7 of 9 with PV occlusion, 8 of 11 with infection, and 9 of 24 with PP extending outside the lesser sac (Fig. 1).

## Comments

Operative internal drainage of PP has become less common coinciding with developing expertise in endoscopic techniques particularly when pseudocysts are uncomplicated and confined to the lesser sac as are most

**Table 1** Infected PPs: organisms recovered, procedures performed, and patient outcomes

Patients	Microbiology	Reimage	Complications	Postoperative percutaneous drainage	Readmission	Postoperative LOS
1	<i>Klebsiella pneumoniae</i>	Yes	None	No	No	6
2	MRSA	No	None	No	No	6
3	MRSA	No	None	No	No	5
4	MRSA	Yes	IAA, pneumonia, clostridium difficile	Yes	Yes	25
5	<i>Candida albicans</i> , <i>Lactobacillus sp.</i>	No	None	No	No	7
6	<i>Candida albicans</i> , <i>Enterococcus faecium</i>	No	None	No	No	32
7	<i>Enterococcus faecium</i> , <i>Candida albicans</i> , MRSA	Yes	Residual left paracolic PP	Yes	No	25
8	<i>Streptococcus viridans</i>	Yes	IAA	Yes	Yes	10
9	<i>Escherichia coli</i>	Yes	Myocardial infarction, ileus	No	Yes	21
10	<i>Candida lusitanae</i>	No	Bleed from jejunostomy	No	No	14
11	MRSA	Yes	DVT	No	Yes	7

DVT = deep vein thrombosis; IAA = intra-abdominal abscess; LOS = length of stay; MRSA = methicillin-resistant *Staphylococcus aureus*; PP = pancreatic pseudocyst.

**Table 2** PPs extending outside the lesser sac

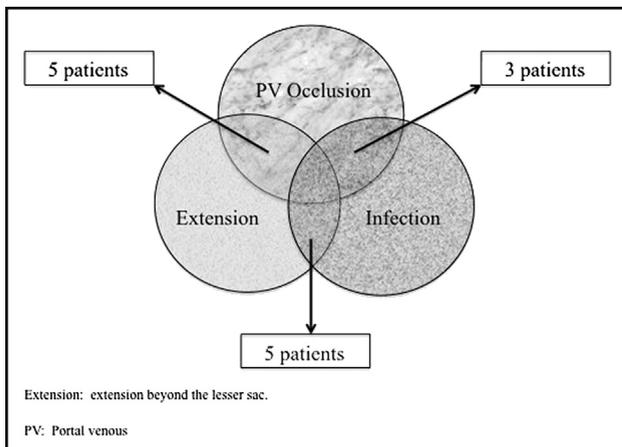
Patients	Location	Size (cm)	Infection	Procedure	Reimaging	Postoperative percutaneous drainage
1	SH, LG	19	No	Roux	No	No
2	SH	6	No	Roux	No	No
3	L, M	8	No	Cyst	Yes	No
4	L, M	8.8	No	Roux	Yes	Yes
5	L, SH	4.1	Yes	Roux	Yes	No
6	L, M, LG	24.5	Yes	Roux × 2	Yes	Yes
7	L, M	16	No	Roux	Yes	No
8	L, M	14	No	Roux	Yes	No
9	L, M	16	No	Roux	No	No
10	L, LG	8	No	Roux × 2	No	No
11	L, M, SH	17	No	Roux/cyst	No	No
12	L, mediastinum	14	No	Roux	No	No
13	L, M	6	No	Roux	No	No
14	L, M, LG	10.3	Yes	Roux	Yes	Yes
15	L, M, LG	21	Yes	Roux × 2	Yes	Yes
16	L, M, LG, SH	13	No	Roux	No	No
17	L, M, LG	17.5	No	Roux	Yes	Yes
18	L, M	16	No	Roux	No	No
19	L, M	17	Yes	Roux	No	No
20	L, M	13	No	Roux	No	No
21	L, M, SH	12.2	No	Roux	No	No
22	L, M, SH	21	No	Roux	No	No
23	L, LG	10	No	Roux	No	No
24	L, M, LG, RG	13.8	No	Roux/cyst	Yes	No

Cyst = cystgastrostomy; L, lesser sac; LG = left paracolic gutter; M = base of mesentery; PP = pancreatic pseudocyst; R = right paracolic gutter; RG, right paracolic gutter; Roux = Roux-en-Y cystjejunostomy; SH = subhepatic.  
Size: greatest dimension.

common. However, complications such as infection and the development of gastric varices from splenic vein thrombosis may represent relative contraindications to endoscopic management. Furthermore, though uncommon, pseudocysts can extend outside the lesser sac that may be inaccessible and/or not offer good dependent drainage when managed via a transgastric route. Little guidance exists in the current literature to direct management of

these complicated pseudocysts by any means including surgical, percutaneous, or endoscopic techniques. Results of this study suggest that operative drainage in these complicated cohorts of PP is safe and most often successful in a single stage but may require repeat imaging, readmission and the need for postoperative PD for definitive management. However, the development of pancreaticocutaneous fistulae and the need for reoperation can most often be avoided.

Splenic and/or portal vein thrombosis after AP may complicate pseudocyst drainage via the transgastric route because of engorged perigastric veins that can lead to hemorrhage if disrupted. Endoscopic drainage using ultrasound guidance has been reported in several series and is likely safer when compared with conventional transmural drainage as a means to avoid venous collaterals but specific outcomes relative to this group have been limited to small series.<sup>5-7</sup> Sriram et al<sup>6</sup> reported on 23 patients with chronic pancreatitis and intervening vessels or collateral channels having attempted endoscopic ultrasound (EUS)-guided PP drainage. Twelve procedures were aborted due to acute inflammation, small PP size, or patient refusal. Three patients required open surgery because of the extent of collateral vessels precluding safe endoscopic drainage. Eight patients had successful EUS-



**Figure 1** Patients with concurrent pseudocyst complications.

guided endoscopic drainage with no morbidity and complete resolution at 6 weeks by ultrasound surveillance. Antillon et al<sup>7</sup> identified 8 patients with gastric varices in a series of 33 patients having EUS-guided transmural drainage of PP. Although successful drainage was ultimately achieved in 31 patients, no subset analysis specific to the 8 patients with varices was reported. However, 1 patient with varices did require transfusion because of bleeding from the gastric puncture site.

There have been no surgical series specifically addressing this cohort. All 9 of our patients had internal drainage with no transfusion or procedure-related morbidity and a negligible need for reimaging or readmission. One certain advantage to operative drainage is that gastric varices can be completely avoided if pseudocyst location is amendable to anastomosis via Roux-en-Y cystjejunostomy through the mesocolon as was the case in 7 of our patients. Transgastric drainage, if necessary, allows satisfactory hemostasis with interrupted suture maturation of the stomach to the cyst wall, however, the potential for hemorrhage cannot be completely eliminated.

Infected PPs mandate urgent therapeutic intervention but appropriate management strategies have been incompletely defined. Much of the available medical literature is clouded by definitions of pancreatic infections that are inconsistent between studies.<sup>8</sup> While the current Atlanta classification defines PP the nomenclature “infected pseudocyst” does not exist although we felt it appropriate in those with previously identified PP that became infected whereas being observed.<sup>4</sup> We were careful to exclude patients that had fluid collections associated with walled-off necrosis or acute necrotic collections. Given the above noted shortcomings, studies have reported outcomes of infected PP that have been managed by percutaneous catheter, endoscopic transmural, and open surgical drainage.

Gerzof et al<sup>9</sup> reported on 11 infected PP in 10 patients, 9 of which occurred after AP. Pseudocyst age was estimated at less than 3 weeks in 8 patients suggesting these patients more likely may have had infected-acute necrotic collections or an acute peripancreatic fluid collection. *Streptococcus*, *Enterococcus*, and gram-negative bacteria predominated. Two patients died, 1 of septic complications but success was reported in 8. Other series have reported results of PD of infected PP, however, data relative to those that had AP (vs chronic pancreatitis) were incomplete, definition of infected PP not defined, and treatment outcomes were incomplete assessed.<sup>10,11</sup>

Transmural drainage of infected PP has only been reported in small series and several case reports. Rische et al<sup>12</sup> analyzed the outcome of 13 procedures on 9 patients (5 with AP). Pseudocyst definition was in accordance with the Atlanta classification. Only gram-negative bacteria were noted. No patient required salvage surgery, and there was no mortality.

The paucity of data regarding optimal management of infected PP is reflected in a recent surgical review of

pseudocyst management where definitive therapy is limited to one paragraph supporting PD, and another paragraph discussing surgical external drainage with no references.<sup>13</sup> Fedorak et al<sup>14</sup> reported on 23 well-defined patients with infected PP after AP having internal, external and PD in 15, 4, and 4, respectively. Abscess and pancreatic fistula occurred in 4 and 2 each but it was not reported in which treatment arm these complications occurred. Approximately 55% and 10%, respectively, had at least 1 isolate that was gram-positive and fungal.

Boerma et al<sup>15</sup> reported on 15 patients (8 with AP) with known pseudocysts as defined by the Atlanta classification that developed clinical signs of infection and compared outcomes of the 8 that had internal drainage vs 7 that had external drainage. Pseudocyst infections were thought to be on the basis of instrumentation in 13 via transmural stent, pancreatic stent, and PD. Internal drainage was accomplished by cystgastrostomy in 7 with a median hospital stay of 13 days not dissimilar to the present study. Four patients having external drainage developed pancreaticocutaneous fistulae requiring prolonged drainage and endoscopic placement of a pancreatic stent. Enteric organisms predominated but 2 patients that had preoperative PD had gram-positive infections. One patient having internal drainage developed a postoperative paracolic abscess that required operative drainage after failed PD.

Similar to Boerma, we demonstrated reasonable outcomes after internal drainage of infected PP given that more than one-half of our patients had PP that extended beyond the lesser sac. We found that venous catheter-related sepsis was a risk factor for secondary infection of previously sterile PP contributing to a higher incidence in gram-positive organisms encountered in this study as opposed to those previously reported. In contradistinction to prior studies, we also noted a significant incidence of fungal infections. Morbidity approached 50% and one-third to one-half of our patients required reimaging, readmission, or postoperative PD for definitive resolution. Nonetheless, operative management was isolated to a single-stage procedure with a zero incidence of pancreaticocutaneous fistula. It must be acknowledged, however, that if percutaneous catheter drainage is required postoperatively, the potential for an external pancreatic fistula certainly exists.

While most PP are confined to the lesser sac, and thus are most often amendable to endoscopic transmural drainage via the stomach, pseudocyst extension to other anatomic areas can occur that may not allow endoscopic access or satisfactory dependent drainage. Failure to obtain adequate dependent drainage after internal anastomosis has been associated with the development of retroperitoneal sepsis because of colonization with enteric organisms from the gastrointestinal tract.<sup>16,17</sup> Varadarajulu et al<sup>2</sup> reported on 211 patients having endoscopic transmural drainage of pancreatic fluid collections including 23 patients with PP due to AP. Overall, 94% of all patients had drainage via the stomach and duodenum. Four patients

with PP had drainage via a transesophageal or transjejunal route (2 each). Outcomes specific to these extra-anatomic drainage procedures in those with PP due to AP was not reported.

We were quite liberal in employing Roux-en-Y drainage to the most dependent anatomic region in our 24 patients with PP extending outside the lesser sac. Furthermore, we performed more than 1 anastomosis in 20% of our patients to enhance drainage in 2 anatomic locations. By using this strategy, the need for postoperative therapeutic intervention for definitive resolution was necessary in only 5 patients despite the extensive location and size of these cysts, there was no procedure-related mortality, and postoperative LOS was not significantly different than that reported in surgical series of uncomplicated PP.

Finally, we noted that having one complication of a PP is a harbinger of developing another. Approximately 75% of patients that had PV occlusion or infection suffered another complication related to their PP. Nearly 40% of those with PP extending beyond the lesser sac had a similar fate. The principles of surgical management remain unchanged even if more than one complication occurs, dependent drainage and avoidance of venous collaterals in the presence of PV occlusion both of which can be maximized by using Roux-en-Y drainage.

The limitations of this study include its retrospective nature and the small number of patients assessed. The accrual of additional patients with more complications and/or the need for postoperative therapeutic intervention might lead to less favorable outcomes than reported herein. Finally, we were unable to capture complicated PP that may have been successfully managed nonoperatively during this time period. Thus, any potential comparison of outcome relative to those after surgical drainage was not possible.

Treatment of complicated PP after AP remains challenging and is encumbered by a dearth of literature reporting management and outcome regardless of the therapeutic strategy used. Results from this series offer a benchmark for management of complicated PP that will allow comparison of treatment outcomes going forward regardless of the drainage technique used.

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