Chapter 38
Management of Symptomatic Pancreatic Pseudocyst

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Abstract Management options for pancreatic pseudocyst are numerous and include endoscopic and surgical approaches. Much debate exists regarding which of these approaches is superior and when each is most appropriate. While endoscopy offers less post-procedural pain, shorter length of stay, and fewer complications, laparoscopic surgical approaches are more suitable for pseudocysts whose locations or other characteristics present significant technical challenge or are otherwise unamenable to endoscopic drainage. Endoscopic management should be attempted when technically feasible, and a laparoscopic approach should be employed when endoscopic drainage would be technically difficult or in symptom recurrence following initial endoscopic management.

Keywords Pancreatic pseudocyst • Laparoscopy • Endoscopy • Cystgastrostomy

Introduction

Pancreatic pseudocysts are collections of pancreatic fluid and necrotic tissue surrounded by a non-epithelial perimeter persisting for greater than 6 weeks and arising following pancreatitis or trauma. Although usually asymptomatic, pseudocysts can cause symptoms by mass effect (abdominal or back pain, obstructive symptoms, or jaundice), infection, or hemorrhage. Though spontaneous resolution is typical, serious complications, such as rupture, infection, bleeding, or obstruction, can occur. Management options can be broadly classified as surgical or endoscopic. Within the surgical domain, laparoscopy has emerged as a safe and effective method for management of pancreatic pseudocysts and typically is associated with less postoperative pain, shorter length of stay, and non-inferior success rates compared to open surgical management. Endoscopic approaches offer even less pain,

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J.M. Millis, J.B. Matthews (eds.), *Difficult Decisions in Hepatobiliary and Pancreatic Surgery*, Difficult Decisions in Surgery: An Evidence-Based Approach, DOI 10.1007/978-3-319-27365-5_38

procedural invasiveness, and hospital length of stay, but may require more than one treatment to achieve pseudocyst resolution. As a result, there is significant controversy and uncertainty regarding optimal management of pancreatic pseudocyst.

Several laparoscopic surgical techniques have been described. The most common among these include pseudocystgastrostomy via anterior (intraluminal) or posterior (extraluminal) approaches, pseudocystduodenostomy, and Roux-en-Y pseudocystjejeunostomy. Likewise, several endoscopic options have been described, including the use of ultrasound or fluoroscopic guidance for pseudocyst localization, plastic vs. metal stent use, single vs. multiple stent placement, and concomitant ERCP to identify need for and facilitate pancreatic duct (PD) stent placement. For the purpose of this review, studies involving any combination of these techniques have been considered collectively as either laparoscopic or endoscopic management techniques, respectively.

Search Strategy

A Medline search was performed in PubMed using the following search strings based on PICO elements (Table 38.1): "pancreatic AND pseudocyst AND (laparoscopic OR laparoscopy OR endoscopic OR endoscopy)". The search was limited to studies on human subjects written in the English language since 2000. All results were read and reviewed, and irrelevant results were excluded from the analysis. Single-case reports, systematic and other reviews, and editorials and commentaries were also excluded.

Results

There is a paucity of prospective clinical trials comparing surgical and endoscopic management of pancreatic pseudocysts. No studies have directly compared laparoscopic management to endoscopy, and there is substantial heterogeneity in the techniques and adjuncts used in the series that are available. Furthermore, numerous series include both pseudocysts and necrotic fluid collections, further complicating the interpretation of their outcomes given the reduced efficacy of endoscopic

Table 38.1 PICO table for management of symptomatic pancreatic pseudocyst

P (Patients)	I (Intervention)	C (Comparator group)	O (Outcomes measured)
Patients with symptomatic pancreatic pseudocyst undergoing curative management	Laparoscopic operative management	Endoscopic management	Resolution of symptoms, complications, recurrence, need for additional or more invasive management

management of walled-off necrotic fluid collections. Finally, much of the literature represents experience of a single surgeon or endoscopist or within a single institution, limiting their generalizability and comparative usefulness.

Surgical Versus Endoscopic Management

In a prospective randomized clinical trial involving 40 patients at a single institution with symptomatic pancreatic pseudocysts, Varadarajulu et al. compared open surgical and endoscopic management. Twenty patients underwent either ultrasound- and fluoroscopic-guided cystgastrostomy with stoma balloon dilation and placement of two plastic stents immediately followed by ERCP and PD stent placement if PD leak was identified or open surgical cystgastrostomy by a single surgeon via an upper midline laparotomy and an anterior (intraluminal) gastric approach using an endovascular stapler to create a 6-cm communication. Successful treatment was noted in 95 % (19/20) of patients undergoing endoscopic management and in 100 % (20/20) of patients undergoing surgical management, although one surgical patient developed a recurrent pseudocyst with ongoing alcohol use. There were no complications in the endoscopy group, while one wound infection and one upper GI bleed occurred in the surgical group, the latter of which required endoscopic cauterization at the anastomosis. Another patient had a surgical feeding tube placed for persistent intolerance of oral intake, and another developed a pancreatic duct stricture at the tail requiring distal pancreatectomy after attempted stent placement via ERCP. Overall, there were no significant differences between arms in success rates, complications, or need for further interventions with or without crossover. However, hospital length of stay was significantly shorter in the endoscopic group (2 days versus 6 days), and overall treatment cost per patient was significantly lower in the endoscopic group. The utility of the study was limited by its small sample size and its inclusion of data generated by only one surgeon and two endoscopists at a single institution [1].

Melman et al. performed a retrospective review of a series of 83 patients who had undergone endoscopic, laparoscopic, or open cystgastrostomy over the prior 8 years at a single institution. Primary success, defined as resolution of symptoms or pseudocysts following the initial intervention, was more common in patients with laparoscopic and open surgical management compared to endoscopic management (87.5 %, 81.2 %, and 51.1 %, respectively; $p<0.01$). However, overall success, defined as resolution of symptoms or pseudocysts at last patient follow-up regardless of number of attempts of or techniques for intervention, was not significantly different between laparoscopic, open, and endoscopic groups (93.8 %, 90.9 %, and 84.6 %, respectively; $p>0.05$). One patient in the laparoscopic group had recurrent symptomatic pseudocyst and underwent successful endoscopic management. One patient in the open group had recurrent pancreatitis and underwent necrosectomy, and another who had a residual pseudocyst was managed with percutaneous drainage. In the endoscopic group, 13 initial failures were managed via open

surgical management, and 3 had percutaneous drainage. Six initial failures were successfully managed with repeat endoscopic procedures; the overall success rate among endoscopic patients who did not require subsequent surgical or percutaneous procedures was 64.4 % (29/45). Surgical complications in the laparoscopic group were encountered in 25 % (4/16) of patients and included two upper gastrointestinal hemorrhages, one of which required endoscopic management. Among open surgical patients, complications occurred in 22.7 % (5/22) and included one patient who developed a wound infection, two patients with incisional hernias, and one patient who developed multi-system organ failure and prolonged respiratory failure requiring tracheostomy. Complications in the endoscopic group occurred in 15.6 % (7/45) of patients and included three patients who needed urgent laparotomy for unspecified reasons, two with gastric perforation, one with cystgastrostomy unable to be managed endoscopically, and one with upper gastrointestinal hemorrhage who was managed conservatively. The complication rates did not differ significantly between groups ($p = 0.6448$). However, crossover rates from endoscopic to any surgical management and from laparoscopic or open surgical to endoscopic management for either treatment failure or management of complications was significantly higher in the initial endoscopic group (15.6 % versus 2.6 %, $p = 0.0475$). Interpretation of these results is made complicated by the inclusion of debris-containing fluid collections (suggestive of walled-off necrosis, which has lower rate of successful endoscopic treatment) and the lack of clarification as to the conduct of interventions (i.e. PD stent placement) when PD leak was identified. This study was further limited by inclusion of patients within a single institution and bias associated with non-randomized patient groups [2].

Nealon et al. retrospectively reviewed 79 patients over a 10-year period at a single institution who developed complications after initial endoscopic and/or percutaneous management of pancreatic pseudocysts and compared outcomes and characteristics of this cohort with those of 100 consecutive patients who underwent initial open operative management. Additionally, pancreatic ductal anatomy and the relationship of the pseudocyst to the rest of the pancreas were assessed and classified in all patients using ERCP or MRCP. There were no statistical differences in disease severity, pseudocyst size or location, or anatomic relationship of the pseudocyst to the main pancreatic duct between patients undergoing initial endoscopic and/or percutaneous management versus operative management. Treatment failure was noted in 83.5 % (66/79) patients undergoing endoscopic and/or percutaneous management; all 66 patients required subsequent open operative management. Of these, two-thirds were noted to have pancreatic duct disruption and had not had PD stent placement prior to referral for operative management. Sepsis eventually occurred in 91.1 % (72/79) of patients with initial endoscopic and/or percutaneous management. The most common operative technique in patients with initial failed therapy was open cystjejunostomy (47/66, 71.2 %). There were no mortalities or need for reoperation among this group. While the rate of patients requiring ICU admission, ICU admissions per patient, episodes of sepsis, complications related to bleeding or renal failure, need for mechanical ventilation, and persistent pancreatic fistula were significantly lower among patients with initial operative management compared to

those with initial endoscopic and/or percutaneous management ($p<0.05$), these results must be interpreted with caution as the non-operatively managed patients included in this study only included those who were initially unsuccessful or developed complications, and included percutaneous drainage as a treatment modality, which is not currently accepted as a definitive treatment modality. Finally, details regarding the specific non-operative approaches used are not provided [3].

Laparoscopic Management

We identified six retrospective reports of case series primarily involving laparoscopic management of pancreatic pseudocysts. Overall, treatment success was noted in 83–100 % of patients, with complications occurring in 0–27 %. The recurrence rates were 0–20 %, and 0–20 % of patients required operative or other procedural management following the initial operative therapy.

In the largest case series by Palanivelu et al., which included 106 patients who underwent laparoscopic management, the treatment success rate was 100 %. Complications occurred in 6.6 % of patients, and recurrence was noted in 0.9 %, while the need for further surgical or other management was noted in 1.9 %. Laparoscopic cystgastrostomy was the most common procedure, accounting for 83.4 % of the cases in this series [4].

No other case series involving primarily laparoscopic patients included more than 17 patients, limiting the significance of their conclusions. However, a summary of the findings from these smaller studies is presented in Table 38.2.

Endoscopic Management

We identified 11 retrospective reports of case series primarily involving endoscopic management of pancreatic pseudocysts. Overall, treatment success was noted in 75–100 % of patients, with complications occurring in 0–26 %. The recurrence rates were 0–16 %, and 0–28 % of patients required additional operative management following the initial endoscopic therapy.

The largest case series involving primarily endoscopic management was reported by Weckman et al. Among 165 patients who underwent endoscopic therapy and completed follow-up, treatment success (i.e. those with no or only mild pancreatic symptoms) was noted in 75.2 %. The 170 patients examined in this study underwent a total of 380 endoscopic procedures; complications occurred in 10.0 % of these. Recurrence was noted in 5.6 % of patients, and 13.9 % of patients initially managed endoscopically subsequently underwent a surgical procedure in their course of treatment [10].

In another series, Varadarajulu et al. compiled outcomes of patients treated for pancreatic pseudocysts, abscesses, or necrosis. In 154 patients undergoing endo-

Table 38.2 Studies involving laparoscopic management of pancreatic pseudocyst

Study	n	Male	Male %	Resolution	Resolution %	Complications	Complications %	Recurrence	Recurrence %	Further surgery required	Further surgery %	Follow up	Notes
Dávila-Cervantes (2004)	10	6	60.0 %	9	90.0 %	2	20.0 %	0	0.0 %	2	20.0 %	22 months	Study compared open vs laparoscopic procedures; among 10, 4 RY cyst-J, 4 extraluminal cyst-G, 2 intraluminal cyst-G; 2 required further procedures (1 endoscopic cyst-D, 1 open surgery); lap less morbidity, less pain, shorter LOS
Hauters (2004)	17	9	52.9 %	16	94.1 %	2	11.8 %	0	0.0 %	2	11.8 %	12 months	Complications: 1 open conversion followed by retrocolic abscess requiring perc drainage, 1 with residual infection secondary to gastrotomy closure requiring endoscopic stent
Hindmarsh (2005)	15	5	33.3 %	10	83.3 %	4	26.7 %	2	20.0 %	2	13.3 %	37 months	12 of 15 underwent lap operation; 3 conversions to open; recurrences were prior to discharge and managed by open cyst-G; (1 also underwent subsequent open panc/splenic for path with serous cystadenoca)

Barragan (2005)	8	1	12.5 %	8	100.0 %	0	0.0 %	1	12.5 %	1	12.5 %	NR	All secondary to gallstone pancreatitis s/p lap chole; 4 anterior (intraluminal), 4 posterior (extraluminal); posterior deemed superior due to no gastrotomy closure and better visualization of cyst
Palanivelu (2007)	108	76	70.4 %	106[a]	100.0 %	7[a]	6.6 %	1	0.9 %	2	1.9 %	54 months	[a]among 106 who underwent initial laparoscopic drainge
Oida (2009)	7	7	100.0 %	7	100.0 %	0	0.0 %	0	0.0 %	0	0.0 %	65 months	

References for table in order: [4–9]

[a]Refers to the columns “complication” and “resolution” in the same row to deliniate specific subsets of the study

scopic management for pancreatic pseudocysts or abscesses, successful treatment was achieved in 93.5 %. Complications and recurrence were noted in 5.2 % and 5.0 %, respectively, of patients undergoing endoscopic therapy for pseudocyst, abscess, or necrosis. Operative management was required in 13.3 % of treated patients [11].

These and several smaller studies, none including more than 60 patients, are summarized in Table 38.3.

Recommendations Based on the Data

1. For patients with favorable size and location of pseudocyst (with respect to the stomach and/or duodenum) and favorable pancreatic duct anatomy, endoscopic management is recommended (evidence quality moderate, moderate recommendation).
2. Evaluation of pancreatic ductal anatomy for identification of associated pancreatic duct disruption or stricture and the presence of communication between the duct and pseudocyst should be performed. If disruption or stricture is identified, particularly in the setting of communication with the pseudocyst, placement of a pancreatic duct stent to bridge the disruption/stricture may increase the likelihood of successful endoscopic management (evidence quality moderate, moderate recommendation).
3. If "disconnected duct" syndrome is identified, laparoscopic drainage may be preferable to endoscopic management as the latter may require pseudocyst stent placement of indeterminate length with attendant increased risks of stent migration and associated complications (evidence quality weak, recommendation weak).
4. For patients in whom endoscopic pseudocyst drainage would be technically challenging or has already been attempted with procedural failure or symptom recurrence related to unanticipated presence of necrotic debris, surgical management is recommended (evidence quality moderate, moderate recommendation).
5. Laparoscopic approaches should be attempted during surgical drainage procedures when technically feasible and commensurate with the proficiency of the surgeon (evidence quality moderate, moderate recommendation).

A Personal View of the Data

Numerous minimally invasive techniques exist in the management of pancreatic pseudocyst. Definitive algorithms are lacking due to inconsistent application of appropriate pancreatic fluid collection terminology (2013 revised Atlanta classification) and variability of local expertise in both endoscopic and laparoscopic techniques. Endoscopic management appears to result in shorter length of stay and fewer complications, though at the cost of more frequent interventions. Laparoscopic

Table 38.3 Studies involving endoscopic management of pancreatic pseudocyst

Study	n	Male	Male %	Resolution	Resolution %	Complications	Complications %	Recurrence	Recurrence %	Surgery required	Surgery %	Follow up	Notes
Sharma (2002)	38	25	65.8 %	37	97.4 %	5	13.2 %	6	16.2 %	2	5.3 %	44 months	Usefulness of ERCP for stenting or stone removal; selection of only patients with bulging/ communicating pseudocysts; 50 % of recurrences symptomatic
Baron (2002)	95	54	56.8 %	82	86.3 %	17	17.9 %	9	11.0 %	7	7.4 %	766 days	Divided into acute/chronic pseudocyst + pancreatic necrosis groups; surgery crossover figure combined amonth groups; endoscopic drainage most favorable for chronic pseudocysts >4 weeks
Will (2006)	13	NR	NR	11	84.6 %	1	7.7 %	0	0.0 %	0	0.0 %	NR	Study also included patient groups treated by percutaneous transgastric drainage and by EUS-guided cystagastrostomy with necrosectomy; success, recurrence, and complication rates similar among groups
Kahalek (2006)	99	76	76.8 %	93[a]	93.9 %	19	19.2 %	NR	NR	2	2.0 %	13.9 months	Included patients undergoing EUS-guided or conventional transmural drainage; success and complication rates were similar between groups, [a]at 1 month follow-up; resolution rates at 13.9 months were 84 % (27/32, EUS) and 91 % (41/45, CTD)

(continued)

Table 38.3 (continued)

Study	n	Male	Male %	Resolution	Resolution %	Complications	Complications %	Recurrence	Recurrence %	Surgery required	Surgery %	Follow up	Notes
Weckman (2006)	170	125	73.5 %	124[a]	75.2 %	38[b]	10.0 %	8	5.6 %	23	13.9 %	34 months	[a]124 of 165 patients with full follow-up and with no or only mild pancreatic symptoms; [b]among 380 total endoscopic procedures
Varadarajulu (2008)	20	18	62.1 %	27	93.1 %	2	6.9 %	0	0.0 %	2	6.9 %	142 days	
Sharma (2008)	9	6	66.7 %	9	100.0 %	0	0.0 %	0	0.0 %	0	0.0 %	5.7 years	Pediatric population
Park (2009)	60	47	78.3 %	50	83.3 %	5	8.3 %	4	8.5 %	4[a]	6.7 %	26 months	[a]Surgical or percutaneous management
Varadarajulu (2011)	154[a]	88	57.1 %	144	93.5 %	8	5.2 %	9[b]	5.0 %	28[c]	13.3 %	367 days[a]	[a]Among only study patients with pancreatic pseudocyst or abscess, [b]among all study patients with successful treatment, [c]among all study patients treated
Will (2011)	113	76	67.3 %	110	97.3 %	19	16.8 %	17	15.5 %	13	11.5 %	21 months	
Seewald (2012)	80	49	61.3 %	67	83.8 %	21	26.3 %	9	13.4 %	22	27.5 %	31 months	

References for table in order: [10–20]
[a]Refers to the columns in the same row to deliniate specific subsets of the study
[b]Refers to the columns in the same row to deliniate specific subsets of the study
[c]Refers to the columns in the same row to deliniate specific subsets of the study
[d]Refers to the columns in the same row to deliniate specific subsets of the study

management as first-line therapy may be more successful in resolution of symptoms and reducing the need for additional procedural intervention, though length of stay is longer and complications can be more serious. The first important clinical clarification is whether the pancreatic fluid collection (PFC), typically seen initially on computerized tomography (CT) imaging, represents a pseudocyst or walled-off pancreatic necrosis. The presence of solid debris may reduce the efficacy and increase the risk of adverse outcomes of standard endoscopic pseudocystgastrostomy and may favor the use of a laparoscopic approach given the more thorough concomitant debridement that can be performed. Because computerized tomography (CT) cannot reliably identify the presence of solid (necrotic) debris within a PFC, EUS or MRI/MRCP can be invaluable during the formulation of the treatment plan. These modalities also offer an opportunity to differentiate the PFC from features consistent with pancreatic cystic neoplasm. The second important anatomic clarification required in the formulation of a treatment plan is assessment of the PD anatomy and its relationship to the pseudocyst, with appropriate PD stent placement to enhance the likelihood of success with endoscopic pseudocystgastrostomy. Alternatively, if "disconnected duct" with a viable pancreatic tail remnant is identified, laparoscopic drainage or even distal pancreatic resection may be more appropriate.

Given the complexity and range of the available treatment modalities and the relative infrequency and clinical heterogeneity of patients presenting with pancreatic pseudocysts, a multidisciplinary approach to treatment plan formulation involving surgeons, endoscopists, and other interventionalists should be an integral part of the management of patients with pancreatic pseudocyst. On the whole, given the presence of appropriate local expertise and anatomic features, endoscopic approach should be given strong consideration as first-line treatment, but may require several interventions before resolution is complete. Laparoscopic management may be a more definitive approach, particularly in the setting of disconnected duct syndrome, but is associated with greater morbidity, and requires that the patient be able to undergo general anesthesia.

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