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ORIGINAL ARTICLE

Management and outcomes of peripancreatic fluid collections and pseudocysts following non-operative management of pancreatic injuries in children

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Abstract

Background Peripancreatic fluid collection and pseudocyst development is a common sequela following non-operative management (NOM) of pancreatic injuries in children. Our purpose was to review management strategies and assess outcomes.

Methods A multicenter, retrospective review was conducted of children treated with NOM following blunt pancreatic injury at 22 pediatric trauma centers between the years 2010 and 2015. Organized fluid collections were called "acute peripancreatic fluid collection" (APFC) if identified < 4 weeks and "pseudocyst" if > 4 weeks following injury. Data analysis included descriptive statistics Wilcoxon rank-sum, Kruskal–Wallis and *t* tests.

Results One hundred patients with blunt pancreatic injury were identified. Median age was 8.5 years (range 1–16). Forty-two percent of patients (42/100) developed organized fluid collections: APFC 64% (27/42) and pseudocysts 36% (15/42). Median time to identification was 12 days (range 7–42). Most collections (64%, 27/42) were observed and 36% (15/42) underwent drainage: 67% (10/15) percutaneous drain, 7% (1/15) needle aspiration, and 27% (4/15) endoscopic transpapillary stent. A definitive procedure (cystogastrostomy/pancreatectomy) was required in 26% (11/42). Patients with larger collections (≥ 7.1 cm) had longer time to resolution. Comparison of outcomes in patients with observation vs drainage revealed no significant differences in TPN use (79% vs 75%, $p = 1.00$), hospital length of stay (15 vs 25 median days, $p = 0.11$), time to tolerate regular diet (12 vs 11 median days, $p = 0.47$), or need for definitive procedure (failure rate 30% vs 20%, $p = 0.75$).

Conclusions Following NOM of blunt pancreatic injuries in children, organized fluid collections commonly develop. If discovered early, most can be observed successfully, and drainage does not appear to improve clinical outcomes. Larger size predicts prolonged recovery.

Level of evidence III

Study type Case series

Keywords Trauma · Pseudocysts · Pediatric pseudocysts · pancreatic trauma

Introduction

The pancreas is the fourth most commonly injured solid organ following blunt abdominal trauma in children, with a reported incidence of 2–5% [1, 2]. While many surgeons approach these children with pancreatic resection, the success of non-operative management (NOM) is well established in the pediatric population [3]. The controversy about how best to manage high-grade injuries that involve pancreatic duct disruption has resulted in significant variation

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in the treatment of these injuries at American pediatric trauma centers [4]. The most common reported sequela of NOM is pseudocyst formation due to leakage of pancreatic enzymes from the injured pancreatic duct, reported in as low as 29% to as high as 83% in retrospective pediatric series [5, 6]. Some of this variability likely arises from inconsistent definitions of what is reported as a "pseudocyst" versus an acute peripancreatic fluid collection, as this the definition of pseudocyst is not described in the vast majority of published studies. The optimal approach to management of post-traumatic pseudocysts in children is unclear, since these are rare injuries at any given center.

Traumatic pseudocysts have a variable presentation, ranging from asymptomatic to causing symptoms of abdominal pain, vomiting, and fever secondary to infection [7]. In adults, a shifting paradigm in the management principles of pancreatic pseudocysts has occurred over the past decade, from an approach depending on pseudocyst size to an approach based on symptoms [8, 9]. In children, however, pseudocyst management has been shown to be highly variable among pediatric trauma centers, ranging from observation to percutaneous drainage to endoscopic stent placement, which is likely a reflection of the rarity of pediatric pancreatic injuries [3]. The objective of this study was to describe the incidence, management, and outcomes of children with traumatic peripancreatic fluid collections or pseudocysts following NOM for high-grade pancreatic trauma in a large multicenter cohort to understand the natural progression and elucidate successful management options. We hypothesized that observation is safe and effective.

Methods

This study was a planned secondary analysis of a large, multicenter cohort of children with high-grade pancreatic injuries [4]. Twenty-two pediatric trauma centers were recruited for participation through the Pediatric Trauma Society. Institutional Review Board (IRB) approval for retrospective chart review was obtained at each center. Chart review was performed on children 18 years or younger who were treated for a pancreatic injury following blunt abdominal trauma with clear or suspected duct transection based on imaging and were initially managed non-operatively between 2010 and 2015. De-identified data were entered into a centralized (REDCap) database. Data were collected on demographics, injury grade, mechanism of injury, imaging findings, interventions, time to regular diet, hospital length of stay, re-hospitalizations, complications, and incidence and management of peripancreatic fluid collections and pseudocysts.

According to the revised Atlanta classification for acute pancreatitis [10], an acute collection identified within the first 4 weeks after acute, non-necrotic pancreatitis (as in trauma) should be referred to as an acute peripancreatic fluid collection (APFC), and named a pseudocyst when persistent for 4 weeks and containing an enhancing capsule. To differentiate an organized APFC from peripancreatic edema commonly seen after injury, we excluded collections that were visualized prior to 1 week of injury or admission (when injury date was unknown).

Chi-square and Fisher's exact tests were used to evaluate categorical data, reported as frequencies and proportions. Wilcoxon rank-sum tests were used to evaluate continuous data, reported as median and interquartile range (IQR). An alpha of < 0.05 was considered statistically significant. All data management and statistical analysis was performed using STATA statistical software package version 14.2 (StataCorp LLC, College Station, Texas).

Results

Among 100 patients managed non-operatively, 42% patients (42/100) developed organized fluid collections (range 1–5 patients per center). Of these, 64% (27/42) were APFCs identified between 1–4 weeks and 36% (15/42) were pseudocysts after 4 weeks. Seventy-four percent of patients (31/42) were male. The median age was 8.5 years (range 1–16). The most common mechanisms of injury were: 36% (15/42) bicycle handlebar injuries, 19% (8/42) non-accidental traumas and 10% (4/42) motor-vehicle accidents. The median time from injury to emergency room presentation was 10 h (range 0.5–96 h, $n = 30$). The median injury severity score was 16 (IQR 9–25). Ten percent of patients (4/42) had concurrent duodenal injuries. All patients had CT imaging. The location of injury was not reported for 27% (11/42) of patients. When reported, the most common American Association for the Surgery of Trauma (AAST) grade was III (67%), followed by grade IV (19%) and grade II (14%). Twelve percent of patients ($n = 5$) underwent endoscopic retrograde cholangiopancreatography (ERCP) within 3 days of admission, and stents were placed in four of these patients, all with proximal pancreatic head injuries.

The median time to fluid collection identification was 12 days (range 2–42) (Fig. 1). Those patients with collections identified earlier than 1 week of injury were only included if repeat imaging showed persistence. The median initial maximum diameter was 7.1 cm (range 2.2–33 cm). Sixty-four percent (27/42) of patients were observed and 36% (15/42) underwent a drainage procedure to attempt to decompress the collections when identified. All of these were APFC. The variety of methods used for drainage were: percutaneous drain in 67% (10/15), multiple percutaneous aspiration attempts followed by percutaneous drain in 7% (1/15), and ERCP with transpapillary pancreatic duct stent placement in 27% (4/15) (Fig. 1). There were not enough

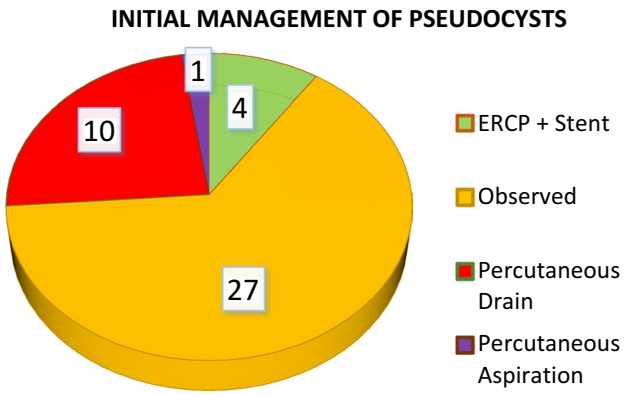

Fig. 1 Initial management of pseudocysts

cases to compare outcomes of specific early intervention strategies.

Twenty six percent of patients (11/42) required a definitive procedure for persistent pseudocysts, 73% (8/11) of whom had initially been observed and 27% (3/11) who had initial drainage (all had percutaneous drainage). Of these, 64% (7/11) were identified as APFC but persisted and became pseudocysts and 36% (4/11) were identified when they were already pseudocysts. The procedures were: nine cystogastrostomies (1 endoscopic and 8 operative), one cystojejunostomy, and one distal pancreatectomy. Since most surgeons do not jump straight to a definitive procedure unless patients are symptomatic, we considered the need for a definitive procedure as failure of initial management; thus, the failure rate of observation was 30% (8/27) and early intervention was 20% (3/15) (Fig. 2).

Comparison of patients who underwent fluid collection observation (*O*) vs drainage (*D*) after identification revealed no significant differences in: TPN use (*O* 79% vs *D* 75%, 1.00, $n=40$), hospital length of stay (*O* 15 [13–31] vs *D* 25 [IQR 21–38] median days, $p=0.11$, $n=42$), time to tolerate regular diet (*O* 12 [IQR 8–39] vs *D* 11 [7–43] median days, $p=0.47$, $n=33$), or requirement of a definitive procedure for persistent pseudocyst (*O* 30% vs *D* 20%, $p=0.75$, $n=42$) (Fig. 3). The median diameter of the fluid collections in these groups was similar (*O* 6 cm vs *D* 8 cm; $p=0.08$).

When compared by fluid collection size, patients with larger collections at identification (≥7.1 cm maximum diameter) had significantly longer hospital stay (median days 33 vs 15, $p=0.045$, $n=31$) and longer time to tolerate regular diet (median days 42 vs 11, $p=0.045$, $n=25$), but had similar incidence of persistence of symptoms or need for a definitive procedure (41% vs 45% $p=1.00$) compared to those with fluid collections less than 7.1 cm maximum diameter.

A subset analysis of patients with large fluid collections showed that 41% of patients (7/17) had drainage and 59% (10/17) were initially observed. Twenty-four percent of patients (4/17) required a definitive procedure for persistent pseudocyst. When comparing the rate of failure of initial management, 43% (3/7) of patients in the drainage group failed initial management, compared to 40% (4/10) in the observation group. This suggests that draining larger organized fluid collections when they are identified may not necessarily improve outcomes.

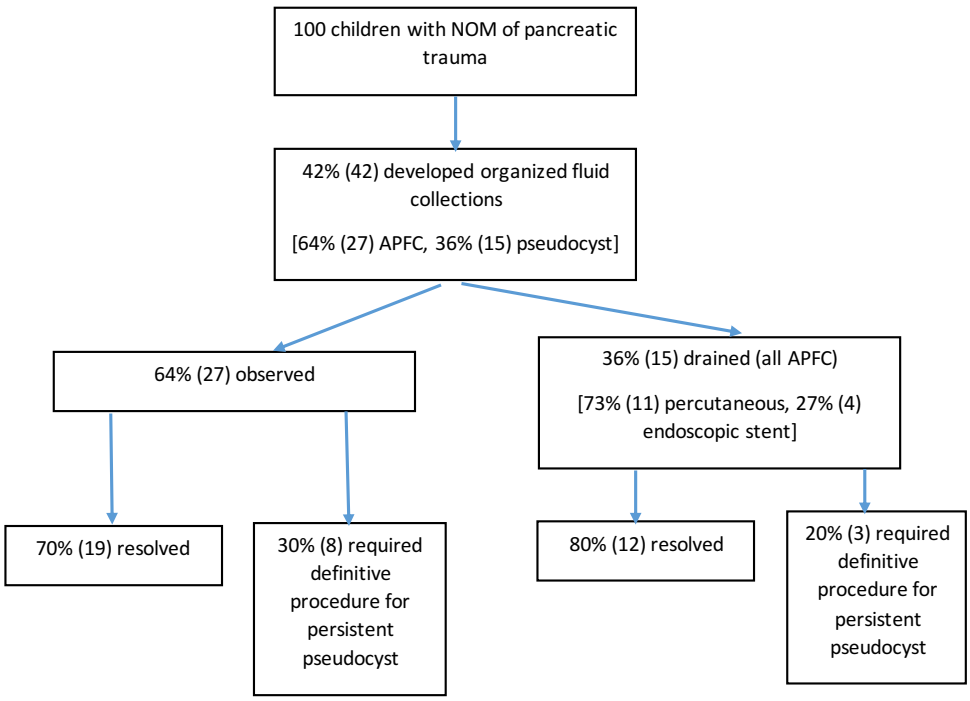

Fig. 2 Summary of management and outcomes of organized fluid collections following non-operative management of pancreatic trauma in children

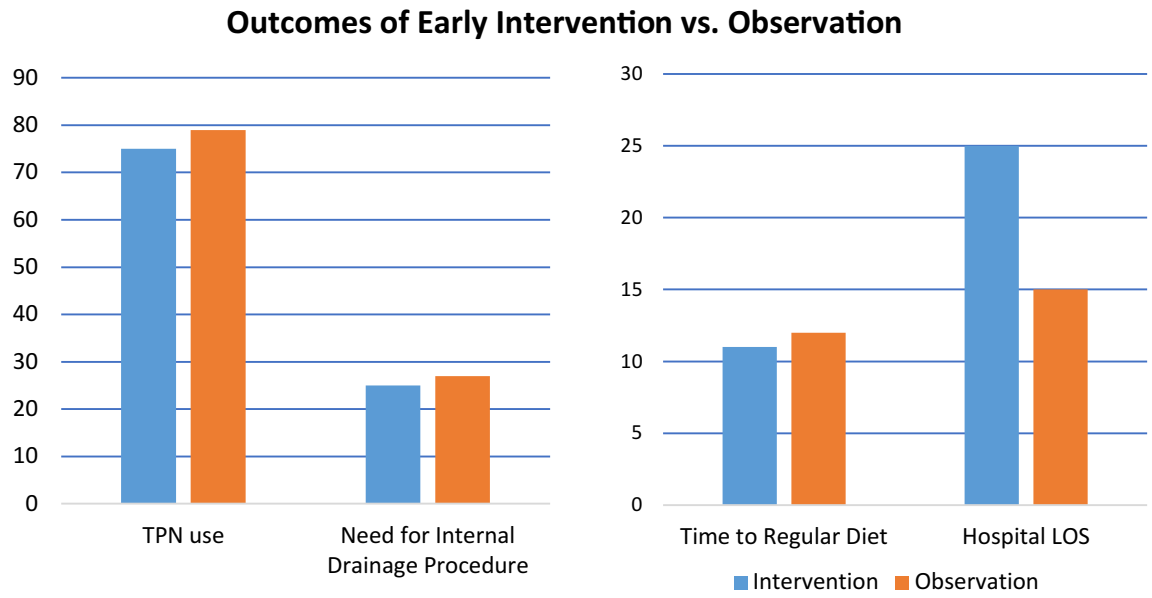

Fig. 3 Outcomes of intervention (drainage) vs observation

There was one complication of NOM: portal vein thrombosis that required anticoagulation, but no direct complications due to pseudocyst such as cyst rupture, bleeding or infection were reported.

Discussion

Pancreatic pseudocysts are a well-recognized complication of blunt pancreatic injuries, particularly among patients treated non-operatively. Studies describing the natural history and outcomes for children with blunt pancreatic injury are lacking and are necessary to guide management. The available literature is difficult to interpret because in all except one study [10], pseudocyst definition is not included; therefore, acute fluid collections documented shortly after injury may have been included in data analysis, which may bias the reported outcomes. It is notable that when the centers included in this study were asked to provide their pseudocyst data, every center reported ALL organized fluid collections as "pseudocysts", regardless of the time of identification. This is quite possibly the case in the other published single and multi-center studies. To clearly elucidate the management and progression of all organized fluid collections following NOM of pancreatic trauma, we have used clear definitions of acute peripancreatic fluid collection vs. pseudocyst, and have excluded collections identified less than 7 days after injury to avoid including edema or non-organized fluid collections. Furthermore, this is the largest series in this population to date.

A previous series that examined children with traumatic pancreatic injuries in which pseudocyst was defined as a fluid collection present at least 4 weeks after injury reported 7% incidence of pseudocysts in children with grade II injuries and 44% incidence in children with grade III injuries [5]. In our series, we included APFC, as we aimed to examine the outcomes of early management when an organized fluid collection is identified following injury. We have previously shown that at some centers, frequent re-imaging is performed shortly following injury, which may pick up collections that are not otherwise symptomatic [11]. Identification alone may prompt some surgeons to intervene to try to minimize the morbidity of a pancreatic fluid collection and hasten time to diet. Since the management of APFC/pseudocysts is unclear, we aimed to evaluate what the current practices are when these organized fluid collections are identified.

The incidence of 42% of organized fluid collections in our series, which consists of mostly grade III injuries, is similar to the previous study. Fifteen patients (36%) in our series underwent drainage (percutaneous or transpapillary) after initial APFC identification. Unfortunately, due to the retrospective nature of the study, it was difficult to define the exact clinical decision making which prompted these early interventions: symptoms, collection size, or other reasons. In children with pancreatic injury, a small case series reported three cases that failed percutaneous drainage and subsequently underwent distal pancreatectomy [12]. In our series, percutaneous drainage was successful in 80% of patients with APFC, although outcomes were no different from collections that were simply observed.

The status of the major pancreatic duct, whether intact or disrupted, is a major factor determining whether a traumatic pancreatic pseudocyst resolves, so those that are unresponsive to percutaneous drainage may require investigation of the major pancreatic duct to rule out persistent duct leak [13]. Amylase levels greater than ten times the upper limit of normal 2 h after injury as well as persistently elevated amylase have been shown to be predictive of the development of pseudocysts [14]. ERCP has been shown to be an effective tool for the definitive diagnosis of duct injury in children with pancreatic injuries and may be useful for stent placement across a duct leak; some centers have shown success in using ERCP for diagnosis and management in children with suspected pancreatic trauma [6, 15]. For pseudocysts that persist longer than 6 weeks, definitive internal drainage by cystogastrostomy or cystenterostomy (jejunum or duodenum) has historically been recommended [13, 16]. Endoscopic procedures are also increasingly being used. The transmural method involves creating a tract through the gastric or duodenal wall followed by balloon dilation and stent placement [17, 18]. Because the narrow stent may become prematurely occluded (reported in up to 18% of cases), stent exchange may be necessary [19]. Newer, fully covered, self-expanding metal stents have larger luminal diameter (> 10 mm) with a lower likelihood of stent occlusion [20]. These stents, however, can migrate, causing leakage and inadequate drainage [21]. A large retrospective study of 230 adults comparing the outcomes of plastic and metal stents demonstrated a higher resolution rate with metal stents (89% vs 98%; $p = 0.01$) and threefold higher likelihood of adverse outcomes for those with plastic stents [22]. The literature on endoscopic cystogastrostomy in children is limited to a few small case series [23–25].

Our results are similar to the other large series of 28 children by Shiylansky et al. who were managed with NOM. They reported pancreatic-related morbidity for children treated with NOM to be 40% due to pseudocyst formation (timing of identification not defined, so this may include APFC), which is in line with the 42% in our series. In their series, ten children developed pseudocysts, 60% of whom had percutaneous drainage and none required surgical intervention. In contrast, in our larger series of 42 patients, 36% had percutaneous drainage/pancreatic stent and 26% required definitive intervention. The difference in drainage likely reflects varying practice patterns.

The results of this study support the hypothesis that observation for APFC/pseudocysts after NOM of pancreatic trauma in children is safe and effective. Of the collections that were observed, 70% resolved spontaneously. Of those that were drained, 80% resolved. It is impossible to know how many of those that were drained would have resolved had they simply been observed; however, clinical outcomes of initial observation and drainage were similar. This is a retrospective study and the numbers are small, so not reaching statistical significance is not surprising; however, TPN use, time to diet, and need for a definitive procedure were too similar to even have clinical significance, whereas the 10-day shorter length of hospital stay in the observation group is clinically significant and shows an advantage of observation. Furthermore, time to diet and discharge was within a few weeks for all except the larger collections, and there were no pseudocyst-related complications. All of these findings demonstrate that the morbidity of APFC/pseudocysts is not as significant as some may believe. Of course, a larger, prospective study is needed to confirm these findings.

This study has several limitations. Because this study was retrospective, the exact indications for interventions or reasoning for types of interventions were difficult to elucidate. Selection bias may also have occurred, because this is a cohort of pediatric trauma centers who voluntarily participated in this study due to interest in pancreatic trauma management; therefore, practice patterns may not be representative of management at other institutions. Surgeon and institutional variability may also contribute to selection bias.

Conclusion

Following non-operative management of blunt pancreatic injuries with suspected duct disruption in children, organized peripancreatic fluid collections and pseudocysts are common sequelae. Current clinical management varies significantly. Observation appears to be safe and effective and the morbidity is low. Early percutaneous or transpapillary drainage does not appear to improve outcomes or avoid progression to symptomatic pseudocysts that require surgical intervention. Collections larger than 7 cm are predictive of longer recovery and may benefit from drainage. A prospective trial is required to validate these findings.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Stawicki SP, Schwab CW (2008) Pancreatic trauma: demographics, diagnosis, and management. Am Surg 74(12):1133–1145
2. Jobst MA, Sr. Canty TG, Lynch FP (1999) Management of pancreatic injury in pediatric blunt abdominal trauma. J Pediatric Surg 34(5):818–823 **(discussion 23–4)**

3. Shilyansky J, Sena LM, Kreller M, Chait P, Babyn PS, Filler RM, Pearl RH (1998) Nonoperative management of pancreatic injuries in children. J Pediatr Surg 33(2):343–349
4. Naik-Mathuria B (2016) Practice variability exists in the management of high-grade pediatric pancreatic trauma. Pediatr Surg Int 32(8):789–794
5. Iqbal CW, St Peter SD, Tsao K, Cullinane DC, Gourlay DM, Ponsky TA, Wulkan ML, Adibe OO (2014) Operative vs nonoperative management for blunt pancreatic transection in children: multiinstitutional outcomes. J Am Coll Surg 218(2):157–162
6. Canty TG Sr, Weinman D (2001) Management of major pancreatic duct injuries in children. J Trauma 50(6):1001–1007
7. Andren-Sandberg A, Dervenis C (2004) Pancreatic pseudocysts in the 21st century. Part II: natural history. J Pancreas 5(2):64–70
8. Cheruvu CV, Clarke MG, Prentice M, Eyre-Brook IA (2003) Conservative treatment as an option in the management of pancreatic pseudocyst. Ann R Coll Surg Engl 85(5):313–316
9. Subramanian A, Dente CJ, Feliciano DV (2007) The management of pancreatic trauma in the modern era. Surg Clin N Am 87(6):1515–1532 **(x)**
10. Foster BR, Jensen KK, Bakis G, Shaaban AM, Coakley FV (2016) Revised atlanta classification for acute pancreatitis: a pictorial essay. Radiographics 36(3):675–687
11. Naik-Mathuria BJ, Rosenfeld EH, Gosain A, Burd R, Falcone RA Jr, Thakkar R, Gaines B, Mooney D, Escobar M, Jafri M et al (2017) Proposed clinical pathway for nonoperative management of high-grade pediatric pancreatic injuries based on a multicenter analysis: a pediatric trauma society collaborative. J Trauma Acute Care Surg 83(4):589–596
12. Rescorla FJ, Cory D, Vane DW, West KW, Grosfeld JL (1990) Failure of percutaneous drainage in children with traumatic pancreatic pseudocysts. J Pediatr Surg 25(10):1038–1042
13. Lin BC, Fang JF, Wong YC, Liu NJ (2007) Blunt pancreatic trauma and pseudocyst: management of major pancreatic duct injury. Injury 38(5):588–593
14. Aydogdu B, Arslan S, Zeytun H, Arslan MS, Basuguy E, Icer M, Goya C, Okur MH, Uygun I, Cigdem MK et al (2016) Predicting pseudocyst formation following pancreatic trauma in pediatric patients. Pediatr Surg Int 32(6):559–563
15. Rosenfeld EH, Vogel AM, Klinkner DB, Escobar M, Gaines B, Russell R, Campbell B, Wills H, Stallion A, Juang D et al (2018) The utility of ERCP in pediatric pancreatic trauma. J Pediatric Surg 53(1):146–151
16. Bass J, Di Lorenzo M, Desjardins JG, Grignon A, Ouimet A (1988) Blunt pancreatic injuries in children: the role of percutaneous external drainage in the treatment of pancreatic pseudocysts. J Pediatr Surg 23(8):721–724
17. Libera ED, Siqueira ES, Morais M, Rohr MR, Brant CQ, Ardengh JC, Ferrari AP (2000) Pancreatic pseudocysts transpapillary and transmural drainage. HPB Surg 11(5):333–338
18. Binmoeller KF, Seifert H, Walter A, Soehendra N (1995) Transpapillary and transmural drainage of pancreatic pseudocysts. Gastrointest Endosc 42(3):219–224
19. Tyberg A, Karia K, Gabr M, Desai A, Doshi R, Gaidhane M, Sharaiha RZ, Kahaleh M (2016) Management of pancreatic fluid collections: a comprehensive review of the literature. World J Gastroenterol 22(7):2256–2270
20. Talreja JP, Shami VM, Ku J, Morris TD, Ellen K, Kahaleh M (2008) Transenteric drainage of pancreatic-fluid collections with fully covered self-expanding metallic stents (with video). Gastrointest Endosc 68(6):1199–1203
21. Muthusamy VR, Chandrasekhara V, Acosta RD, Bruining DH, Chathadi KV, Eloubeidi MA, Faulx AL, Fonkalsrud L, Gurudu SR, Khashab MA et al (2016) The role of endoscopy in the diagnosis and treatment of inflammatory pancreatic fluid collections. Gastrointest Endosc 83(3):481–488
22. Sharaiha RZ, DeFilippis EM, Kedia P, Gaidhane M, Boumitri C, Lim HW, Han E, Singh H, Ghumman SS, Kowalski T et al (2015) Metal versus plastic for pancreatic pseudocyst drainage: clinical outcomes and success. Gastrointest Endosc 82(5):822–827
23. Sharma SS, Maharshi S (2008) Endoscopic management of pancreatic pseudocyst in children-a long-term follow-up. J Pediatr Surg 43(9):1636–1639
24. Kimble RM, Cohen R, Williams S (1999) Successful endoscopic drainage of a posttraumatic pancreatic pseudocyst in a child. J Pediatr Surg 34(10):1518–1520
25. Jazrawi SF, Barth BA, Sreenarasimhaiah J (2011) Efficacy of endoscopic ultrasound-guided drainage of pancreatic pseudocysts in a pediatric population. Dig Dis Sci 56(3):902–908

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