Emergency laparoscopic surgery for ruptured pancreatic pseudocyst: Report of two cases and review of the literature

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Abstract
Pancreatic pseudocyst (PP) is a known complication of pancreatitis. When a rupture occurs, patients often become haemodynamically unstable and require emergency surgery for source control. Conventionally, such a procedure is carried out through open technique due to patient, surgeon and technical factors. We present two cases of emergency laparoscopic surgery performed for ruptured PP. Our first patient was a 53-year-old male with a ruptured 17.6 cm pancreatic body pseudocyst who underwent a laparoscopic washout, adhesiolysis, necrosectomy, distal pancreatosplenectomy and cholecystectomy. The second patient was a 66-year-old male with a ruptured 11 cm pancreatic body pseudocyst who underwent laparoscopic surgery, subsequently converted to hand-assisted surgery. We compare our cases with the existing literature and discuss pertinent management considerations. In conclusion, we demonstrated that emergency laparoscopic adhesiolysis, necrosectomy and distal pancreatosplenectomy are feasible and safe for the management of ruptured pseudocyst when performed by an experienced surgeon. However, further studies are needed to determine the advantages or limitations of the minimally invasive surgical approach for the management of these complicated cases.

Keywords: Laparoscopy, minimally invasive surgery, pancreatic pseudocyst, pancreatosplenectomy, rupture

INTRODUCTION
Pancreatic pseudocyst (PP) is a collection of pancreatic fluid which is surrounded by fibrous tissue wall that has escaped from the pancreatic ductal system.[1] It may result from acute pancreatitis, chronic pancreatitis or pancreatic trauma. Its prevalence has been estimated to be up to 40% in chronic pancreatitis and as per the current nomenclature, pancreatic pseudocyst would not exist in acute pancreatitis.[1] While a pseudocyst may occasionally spontaneously regress, it may also develop serious complications including infection, haemorrhage or rupture.[2] In particular, PPts may spontaneously rupture into the peritoneum, hollow viscus such as stomach, duodenum and colon, and even thorax.[3] PP rupture is an uncommon complication and has been reported in <5% of cases.[3] However, its consequences may be life-threatening and emergency treatment is often needed...
due to severe haemodynamic instability. This traditionally involves open laparotomy with high morbidity.

In recent years, minimally invasive surgery has been increasingly utilised as a modality in performing surgeries in the pancreato-biliary system. Complex surgeries, such as distal pancreatecto‑spleenectomy or pancreaticoduodenectomy, have been shown to be safely performed through the minimally invasive techniques including laparoscopy and robotic surgery with low conversion to open surgery. This has been performed in high‑risk patients with more complex pathologies with comparable outcome to open surgery.

We present two cases of emergency laparoscopic surgery performed for ruptured PP and review the literature concerning its management.

**CASE REPORTS**

**Case 1**
The first case is a 53-year-old male with a history of follicular lymphoma in remission and ischaemic heart disease post-coronary artery bypass grafting 2 years prior to presentation. He presented with a week's history of epigastric pain with vomiting and jaundice. On initial examination, he was noted to be icteric, with soft but mildly tender abdomen. Initial laboratory investigation revealed a white cell count of 14.84 × 10⁹/L, amylase of 244 U/L, bilirubin of 61 µmol/L, alanine aminotransferase of 102 U/L, aspartate aminotransferase of 161 U/L, alkaline phosphatase (ALP) of 1193 U/L and gamma‑glutamyl transferase of 1175 U/L. Chest radiograph did not show the presence of free subdiaphragmatic gas. Computed tomography (CT) scan of his abdomen and pelvis showed minimal normal pancreatic parenchyma in conjunction with a large rim enhancing fluid collection suggestive of pseudocyst on a background of necrotising pancreatitis. A follow-up magnetic resonance cholangiopancreatography showed a 17.7 cm pancreatic necrotic collection disrupting the pancreatic duct as well as causing portovenous and biliary obstruction. He was initially planned for interval endoscopic ultrasound guided drainage of the pseudocysts 1 week later. However, on the day before the planned drainage, he developed an episode of sudden-onset acute abdominal pain, where a repeat CT scan demonstrated free fluid in the bilateral subphrenic spaces and pelvis, suggestive of a rupture of the pseudocyst [Figure 1]. He underwent emergency laparoscopic necrosectomy, distal pancreaticoduodenectomy and cholecystectomy on the same day.

A 12-mm supraumbilical port was used for the laparoscopic camera. Another two 12 mm ports were placed at the left iliac fossa and epigastrium and two 5 mm ports at the right and left hypochondria. On entry into the abdomen, pancreatic ascites was noted, with necrotic tissue in the neck, body and tail of the pancreas. Severe dense adhesions were encountered, especially between the duodenum and stomach with the pancreas. Abdominal washout was performed, the pseudocyst drained and necrosectomy done. The pancreatic body and tail were resected. The tail was stapled with the splenic artery and vein and the pancreaticoduodenectomy completed. Cholecystectomy was also performed. A 3 cm incision was made for specimen extraction, and three Blake drains were placed along the pancreatic bed, right and left paracolic gutter. Total blood loss was 200 ml and no transfusion was needed. Total operative time was 290 min.

On the first post-operative day, his abdominal drain along the pancreatic bed was noted to be bilious, raising concern regarding duodenal perforation. He thus underwent a diagnostic laparoscopy on the same day. Some small amount of bile stained fluid was seen in the pseudocyst cavity behind the stomach and D1. No perforation was seen on laparoscopy and esophagogastroduodenoscopy, and gas leak test was negative. Copious washout was performed with no residual bilious content noted. He was monitored in high dependency ward and stepped down to general ward on the 4th post-operative day and commenced low-fat diet on the 6th post-operative day. There was no need for commencement of total parenteral nutrition (TPN). Interval CT scans on the 9th post-operative day showed interval reduction in size of the necrotic collection and decompression of the biliary tree. His recovery was also complicated by Grade B pancreatic fistula. He was given oral antibiotics from the 30th post-operative day onwards, and he was discharged.
on the 32\textsuperscript{nd} post-operative day with drains which were eventually removed in the outpatient setting.

\textbf{Case 2}

The second case was a 66-year-old male with known gallstone disease. He initially presented with 4 days of epigastric pain associated with nausea and vomiting. He was found to be icteric with tenderness over his epigastrium, and serum amylase of 1824 U/L with liver panel suggestive of obstructive jaundice (Bilirubin 113, ALP 136). CT of his abdomen and pelvis showed a common bile duct stone with upstream dilatation and a pancreatic neck suggestive of acute necrotising pancreatitis. There were no collections at this point. He underwent endoscopic retrograde cholangiopancreatography, sphincterotomy and stone retrieval successfully with no residual stones.

He subsequently developed recurrent bouts of pancreatitis, where interval CT showed development of a pseudocyst of up to 11 cm in maximal diameter. After discussion with the patient, plans were made to proceed with laparoscopic cystgastrostomy. However, on the day before his operation, he developed acute abdominal pain refractory to analgesia with hypotension and oliguria refractory to fluid resuscitation. On examination, there was guarding on abdominal palpation in all quadrants. He was diagnosed to have a ruptured pseudocyst and underwent emergent laparoscopic washout, necrosectomy distal pancreaticosplenectomy with cholecystectomy.

A 12 mm port was used for the periumbilical camera access as well as in the epigastrium and left iliac fossa. Five mm ports were used in the left and right hypochondria 5 mm. On entry into the abdomen, gross pancreatic ascites of 2.2 l was drained. Findings included a ruptured PP and necrosis in the retroperitoneal tissue. Dense adhesions were encountered which required extensive adhesiolysis. The cyst wall was dissected off the pancreas and the stomach. The short gastric artery was divided and spleen mobilised. We were unable to dissect the pancreas safely beyond the celiac axis due to dense adhesions, especially of the common hepatic artery to the pancreatic body and neck. The midline incision was extended to 6 cm and a Gelport inserted (Applied Medical, USA) to accommodate the surgeon's left hand for hand assistance. After necrosectomy and cholecystectomy, the pancreas body, splenic vein and splenic artery were stapled to complete the distal pancreatosplenectomy [Figure 2]. Three large Blake drains were placed to the lesser sac, pancreatic stump and splenic bed, respectively. Total operative time was 490 min and estimated blood loss was 1200 ml.

The patient was extubated on the post-operative day 1. Feeds were commenced on the 2\textsuperscript{nd} post-operative day and escalated to diet on the 4\textsuperscript{th} post-operative day. There was no need for commencement of TPN. Repeat CT on the 10\textsuperscript{th} post-operative day showed a collection at the distal pancreas surgical bed inferior to the surgical drain. Another drain was hence inserted through intercostal approach under CT guidance on the 14\textsuperscript{th} post-operative day. He was discharged on the 24\textsuperscript{th} post-operative day with his drains. The drain was left \textit{in situ} till 3 months after surgery and managed in the outpatient setting. However, after removal of the percutaneously placed drain in the outpatient setting 3 months post-operatively, it was noted that this was complicated by inadvertent entry through the pleural cavity resulting in hydropneumothorax and pancreato-pleural fistula. He was readmitted for the placement of chest tube and laparoscopic disconnection of the pancreato-pleural fistula. The procedure was uncomplicated and he was well on last review 7 months post-operatively.

\textbf{DISCUSSION}

The first surgical drainage of a PP was performed in 1841. The first open pseudocystogastrostomy was performed in 1921. This was first attempted laparoscopically in 1991. Today, endoscopic and laparoscopic options are the mainstay of treatment for elective non-ruptured PPs.[7] Endoscopic pseudocystogastrostomy may be performed under endoscopic ultrasound guidance and catheters placed to facilitate drainage of cystic content into the stomach. This has a higher rate of technical failure, stent blockage and inadequate drainage.[7] Laparoscopic pseudocyst-gastrostomy, pseudocyst-duodenostomy or pseudocyst-cystjejunostomy have the benefit of being able to accommodate concurrent necrosectomy and adjunctive procedures such as cholecystectomy.[7]
With regard to ruptured PP, the surgery has been largely performed through open techniques. This is due to a combination of factors, including haemodynamic instability in patients, technical difficulty to resect a large actively inflamed pseudocyst through minimally invasive approach, adequacy of washout and experience of surgeon in managing a relatively rare condition such as this. Indeed, a review of the literature found that surgery for ruptured PPs are few and far between, with only scattered case reports. With minimally invasive pancreatic surgery becoming the approach of choice in many centres globally, the use of laparoscopic techniques in this setting has the potential to decrease the operative morbidity such as pain and wound infection and improve the functional recovery.\[9\]

To the best of our knowledge, no cases of emergency laparoscopic surgery have been published for the treatment of ruptured PPs in the English language literature. Not unexpectedly, both cases were complicated, especially due to dense adhesions and inflammation associated with pancreatitis and rupture of large PPs. This resulted in our second case requiring conversion to hand assistance for safer dissection. Not surprisingly, both cases were complicated by post-operative Grade B pancreatic fistula. This was because in both cases, the pancreas could not be transected proximal to the disrupted pancreatic duct. The dense adhesions from pancreatitis made it hazardous to dissect the pancreas off the celiac axis and the hepatic artery to enable transection of the pancreas proximal to the site of disruption. In both cases, patients did not require post-operative parenteral nutrition. Diet was commenced within 6 days of operation and the patient was transferred to general ward within 5 days.

Table 1 summarises the existing cases of emergency surgery for ruptured PP in the literature [Table 1]. Four other cases were found in the literature from three studies\[2,3,8\] all of which were performed through open surgery. The size of the pseudocysts in our cases were of 11 and 17.6 cm in largest diameter, respectively, and occurred in the body of the pancreas, while the pseudocysts reported in the literature ranged from 11 to 23 cm and were located in the body and tail. While we performed necrosectomies, distal pancreatectomies and cholecystectomies for both our patients, two of the cases reported in the literature\[2,3\] underwent cyst-jejunostomies, one underwent external drainage to form a pancreatocutaneous fistula\[9\] and one underwent a distal pancreatectomy. None of the cases reported on the operative time. In one study\[2\] where a distal pancreatectomy was performed for a tail of pancreas pseudocyst of unreported size, 200 ml of blood loss was reported, comparable to our first case which was done laparoscopically. None of the cases reported any morbidity; length of stay ranged between 10 and 30 days. The only case which commented on nutrition\[9\] required TPN while both our cases did not.

The two cases demonstrate that emergency laparoscopic surgery is a feasible option for the treatment of ruptured PP. While the two cases presented had somewhat complicated recovery and prolonged hospital stay, they had early return to function and commencement of diet. It is important to note that these cases were technically extremely complex cases and should only be attempted by hepatopancreatobiliary surgeons with extensive experience with the minimally invasive surgery. The principal surgeon (Goh) in this study had prior experience with over 400 minimally invasive major hepatopancreatobiliary surgeries.

**CONCLUSION**

We demonstrated that emergency laparoscopic adhesiolysis, necrosectomy and distal pancreatectosplenectomy are feasible and safe for the management of ruptured pseudocyst when performed by an experienced surgeon. However, further studies are needed to determine the advantages or limitations of the minimally invasive surgical approach for the management of these complicated cases.

| Case | Author                      | MIS/ open | Size/location | Operation                           | Operative time (min) | Blood loss (ml) | Morbidity | Length of stay (day) | TPN |
|------|-----------------------------|-----------|---------------|-------------------------------------|----------------------|----------------|-----------|----------------------|-----|
| 1    | Current study               | MIS       | 17.6 cm Body  | Distal pancreatosplenectomy, washout, necrosectomy | 290                  | 200            | Grade B fistula | 32                   | No  |
| 2    | Current study               | MIS       | 11 cm Body    | Distal pancreatosplenectomy, washout, necrosectomy | 490                  | 1200           | Grade B fistula | 24                   | No  |
| 3    | Rocha et al.\[3\]           | Open      | 23 cm         | Cyst-jejunostomy                    | -                    | -              | No        | 10                   | -   |
| 4    | Rocha et al.\[3\]           | Open      | 11 cm         | External drainage and lavage        | -                    | -              | No        | 30                   | Yes |
| 5    | Mujer et al.\[3\]           | Open      | 21 cm Body    | Cyst-jejunostomy                    | -                    | -              | No        | -                    | -   |
| 6    | Okamura et al.\[2\]         | Open      | Tail          | Distal pancreatectomy               | -                    | 200            | No        | -                    | -   |

MIS: Minimally invasive surgery, TPN: Total parenteral nutrition.
Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
Dr. Goh has received travel grants and speaker fees from Johnson and Johnson.

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