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Early Experience with Minimally Invasive Surgery for Complications of Pancreatitis

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ABSTRACT

Introduction: Surgical management is usually reserved as the last resort treatment for complications of pancreatitis. These have traditionally been performed via open surgery due to the dense adhesions resulting from the surrounding tissue inflammation from pancreatitis. However, with recent advancements in minimally-invasive pancreatic surgery, increasing numbers of studies have reported the safety and feasibility of performing these procedures via laparoscopic or robotic-assisted surgery. In this study, we present our initial experience with 7 consecutive cases of minimally invasive pancreatic surgery (MIPS) performed for the management of pancreatitis.
Method: Retrospective review of 7 consecutive patients who underwent MIPS for pancreatitis between 2016-2020.
Results: There were 2 laparoscopic necrosectomies with distal pancreaticosplenectomies for ruptured pseudocysts, 1 laparoscopic ligation of pancreaticopleural fistula, 1 laparoscopic cyst-jejunostomy for pseudocyst, 1 laparoscopic cyst-gastrostomy for pseudocyst, 1 robotic modified Puestow procedure for chronic pancreatitis and one robotic-assisted distal pancreaticosplenectomy and drainage of necrosis for walled off necrosis. The overall, median operative time was 290 (range, 65-490) min, median blood loss was 50 (range, 0-1200) ml and median length of stay was 7 (range, 4-32) days. There were 2 grade 3 complications due to post-operative pancreatic fistulae.
Conclusion: This early experience demonstrated that MIPS is a safe and feasible alternative to open surgery for the treatment of complications of pancreatitis.
Key words: laparoscopic; minimally-invasive surgery, pancreatitis, robotic

INTRODUCTION

Pancreatitis, in both its acute and chronic forms, remain a common condition with a wide range of presentations and clinical course, with the potential for devastating morbidity and mortality (1). Its incidence has been increasing, and with a reported incidence between 4.9 to 73.4 cases per 100,000 worldwide (2).

While the vast majority of patients with acute pancreatitis fall into the category of the mild and moderately severe form, patients may develop severe acute pancreatitis with persistent organ failure (3). Local complications may also

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develop, such as acute necrotic collections (ANC), walled-off necrosis (WON) and pancreatic pseudocyst (PP). ANC result from pancreatic necrosis, and present in the first four week of the disease with fluid and solid components. WON results from reactive tissue developing around the ANC, and develop after four or more weeks after the initial onset of pancreatitis. PP results from peripancreatic fluid collection surrounded by a well-defined wall. Traditionally, the role of surgery in the treatment of acute pancreatitis lie in treating these local complications. ANC especially when infected is treated with necrosectomy, PP with either open drainage or open cyst-gastrostomy or cyst-jejunostomy. Should more extensive debridement be required, open subtotal pancreatectomy (SP), total pancreatectomy (TP) or pancreaticoduodenectomy (PD) are also alternative treatment options.

Surgical treatment is also an important management option in patients with chronic pancreatitis especially after failed medical or endoscopic therapy (4). Surgical procedures for chronic pancreatitis can be classified into resection procedures/ drainage procedures or both. Some of the commonly performed procedures include the Beger procedure, Frey's procedure and modified Pustow procedure. TP and PD are also performed for chronic pancreatitis especially when malignancy cannot be excluded.

In the past, surgical treatment for acute or chronic pancreatitis was almost exclusively performed via the open technique. This is due to the inherent complexity of the local anatomy, where retroperitoneal dissection is often required with the need to navigate major vascular and biliary structures, with the potential for debilitating morbidities such as post-operative pancreatic fistulas (POPF) (5). This especially so with pancreatitis whereby dense adhesions from the inflammation make surgical dissection especially difficult and frequently treacherous. However, over the past decade with minimally invasive surgery (MIS) being increasingly utilised for major pancreatic surgeries such as distal pancreatectomy, TP and PD (6-8), it is not surprising that there are increasing numbers of studies reporting the outcomes of the application of MIS for the treatment of acute and chronic pancreatitis (4-5). The application of MIS for major pancreatic surgery has been shown to confer patients with reduced surgical access trauma, resulting in less pain, earlier return to function and reduced length of stay. Non-surgical morbidity due to slow mobilisation as well as long term complications such as incisional hernias are reduced. In addition, the magnified view of MIS potentially allows for better identification of vessels and hence lower surgical blood loss (9).

Nonetheless, despite the advantages of MIS, studies reporting on the application of MIS for pancreatitis remains limited today. In this study, we present our early experience with 7 cases of MIS for complications of pancreatitis and discuss the current literature.

METHOD

Six consecutive patients who underwent 7 MIS procedures for complications of pancreatitis from August 2016 to January 2020 were identified. All surgery was performed by a single surgeon (Goh BK). Patient's data, clinical, radiological and pathological records were obtained. All clinical data were retrieved from a computerised clinical database (Sunrise Clinical Manager, Eclipsys Corporation, Atlanta, GA, USA). All cases in this study employed either the use of laparoscopic surgery or robotic surgery. All robotic-assisted surgery was performed using the Da Vinci Si (Intuitive Surgical) platform. Two of these cases have been reported in a previous publication (10) and our surgical technique for laparoscopic and robotic pancreatic surgeries have been reported previously (6, 11). Relevant perioperative outcomes including operation time, blood loss, postoperative morbidity and post-operative hospitalization were recorded.

Definitions

Postoperative complications were classified according to the Clavien-Dindo grading system (12). All postoperative morbidity was recorded as up to 30 days from surgery or within the same inpatient admission regardless of length of stay including 30-day readmissions. 30-day and 90-day mortalities were also recorded. POPF was defined and graded according to the updated International Study Group (ISG) for Pancreatic Fistula system (13).

RESULTS

Over the study period, a total of seven cases of MIS for complication of pancreatitis performed in six patients were identified. The demographic, operative and perioperative data are summarized in *table 1*.

Five cases of laparoscopic pancreatic surgery (cases 2,4,5,6,7) and two cases of robotic pancreatic surgery were performed (cases 1,3). Of the laparoscopic procedures, there was 1 cystgastrostomy (case 2), 1 cystjejunostomy (case 3) and 2 necrosectomies with DPS

Table 1 - Details of the 7 cases of minimally invasive pancreatic surgery for pancreatitis in 6 patients

Case	Age (sex)	Diagnosis	Procedure	Operative time (min)	Blood loss (ml)	Length of Stay (days)	Complication	Clavien-Dindo Grade
1	71M	WON	Robotic assisted laparoscopic distal pancreatosplenectomy	335	200	4	Nil	-
2	45M	PP	Laparoscopic cystgastrostomy	95	0	6	Nil	-
3	16F	Chronic pancreatitis	Robotic Puestow procedure	295	50	5	Nil	-
4	45M	PP	Laparoscopic Roux-en-Y cystjejunostomy	275	25	7	Nil	-
5	53M	Ruptured PP	Laparoscopic distal pancreatosplenectomy and necrosectomy	290	200	32	Grade B fistula Diagnostic laparoscopy for high drain output	3
6	66M	Ruptured PP	Laparoscopic distal pancreatosplenectomy and necrosectomy	490	1200	24	Grade B fistula requiring radiological guided drain insertion	3
7.		Pancreatopleural fistula	Laparoscopic disconnection of pancreatopleural fistula	65	0	10	Nil	-

WON, walled off necrosis; PP, pseudocyst

(case 5,6). The patient in case 6 subsequently developed a pancreatopleural fistula, requiring laparoscopic disconnection at a later date. Of the robotic procedures, one was a case of DPS for WON (case 1) and one was a case of chronic pancreatitis with atrophy requiring Puestow procedure (case 3).

The median operative time was 290 min (range: 65 - 490min) and the median blood loss was 50ml (range: 0 - 1200ml). The median postoperative length of stay was 7 days (range: 4 - 32 days). This is summarised in *table 2*. Of the seven cases, two cases developed Grade B POPF (case 5 and 6). The patient in case 5 had bilious drain output on his first post-operative day, raising concerns regarding duodenal perforation. Diagnostic laparoscopy with oesophagogastroduodenoscopy did not detect any sites of leakage. His drains were removed in the outpatient setting post-discharge due to POPF Grade B. The patient in case 6 required image-guided drainage of his abdominal collection. This was performed via the intercoastal approach, which inadvertently traversed the pleural cavity resulting in a pancreatopleural fistula. The patient subsequently underwent a laparoscopic disconnection of the fistula, and has remained well since.

DISCUSSION

The first use of MIS in pancreatic surgery came in the form of laparoscopy as a staging tool for pancreatic neoplasm, reported in 1911. It was only in 1994 was the first laparoscopic pancreatic resection was reported (9). Today, the MIS approach has been described for all the different types of procedures performed for the treatment of complications of acute and chronic pancreatitis. Nonetheless, most of these have been reported only in relatively small surgical series (15-23) or case reports (*table 3*).

Surgery for complications of acute pancreatitis

Laparoscopic and robot-assisted necrosectomy

Minimally invasive necrosectomy can be performed via various approaches including transmesolic, retroperitoneal or transgastric. The latest American Gastroenterological Association Clinical Practice Update has recommended that minimally invasive techniques are preferred over open necrosectomies in managing pancreatic necrosis (14). Retrospective studies have demonstrated it to be a safe alternative to open necrosectomy with no major wound related complications. It has been touted to provide better exposure of the local anatomy including the lesser sac and head of pancreas. However, most of these studies are limited by the lack of direct comparison with open techniques, and complications such as POPF have occasionally been reported (15). Minimally invasive necrosectomy have been used in conjunction with the step-up approach, which advocates for initial control of septic foci and delayed definitive treatment if the patient still requires further source control (16).

Pancreatic resections

The need to perform PD for pancreatitis is relatively rare compared

Table 2 - Summary of the 7 cases of minimally invasive pancreatic surgery for pancreatitis

Median age (years)	53 (16 to 71)
Sex (male)	6
Median operation time (min)	290 (65 to 490)
Blood loss (ml)	50 (0-1200)
Morbidity (Clavien Dindo grade)	2
I	-
II	-
III	2
IV	-
V	-
Median length of stay (days)	7 (4 to 32)

to the other interventions. Literature of PD being performed via minimally invasive surgery is scant. However, it has been shown that in a large volume centres which perform above 22 cases of minimally invasive PD a year, laparoscopic PD has been safely performed in patients for treatment of pancreatitis (17). Laparoscopic TP has also been shown to be another feasible option. Blair et al (18) reported a series of 20 patients who underwent laparoscopic TP for chronic pancreatitis with no peri-operative mortality.

Both DPS and PD have also been reported to be safely performed via robotic platforms. One high volume centre (19) reported performing 6 robotic PD and 10 DP for patients with pancreatitis safely, with average length of stay of six and five days respectively, with complications of respiratory failure and POPF reported in two separate patients.

Cystgastrostomy and cystjejunostomy

Laparoscopic cystgastrostomies have been a well-established treatment for PP since the early 2000s. A review of over 40 published cases of laparoscopic cystgastrostomies demonstrated a median length of stay of four days, with just one case of subsequent infection and one recurrence (20). Similarly, laparoscopic cystjejunostomies for PP have also been shown to compare favourably with its open counterpart, with no major complications, conversion to laparotomy and no recurrence (21). Cystgastrostomy has also been reported to be performed with robot-assistance. Morelli (22) described a case of robot-assisted cystgastrostomy for WON. Enlisting the additional dexterity of the robotic system, they were able to debride the solid component of the WON after performing a stapled anastomosis of the posterior gastric wall to the WON. Their patient recovered uneventfully.

Surgery for chronic pancreatitis

Puestow and Frey procedure

Senthilnathan et al (23) reported in an observational cohort study of patients with chronic pancreatitis, 39 of whom underwent Puestow procedure and 15 of whom underwent Frey procedure. In total, 10 patients required conversion to open surgery for various reasons including suspicion for malignancy and intraoperative bleeding. One patient developed POPF post-operatively

Table 3 - Summary of clinicopathological outcomes of our 7 cases and of 6 previous case series (>5 cases) reporting on minimally invasive surgery (robotic or laparoscopic) for complications of pancreatitis

Author	n	Procedure	Sex (male)	Median(range)/ mean±SD operative time (min)	Median(range)/ mean ±SD intraoperative blood loss (ml)	Median(range)/ mean ±SD Length of stay (day)
Kilburn et al (4)	4	Laparoscopic Frey procedure	2	130 (100-160)	60 (50-100)	7 (3-40)
Matthew et al (15)	28	Laparoscopic necrosectomy	20	100.8 (60-120)	-	10-18
Blair et al (18)	20	Laparoscopic total pancreatectomy	8	430±98	-	11 (5-27)
Hamad et al (19)	39	Robotic total pancreatectomy (11) Robotic Puestow procedure (8) Robotic Frey procedure (4) Robotic Pancreaticoduodenectomy (6) Robotic Distal pancreatectomy (10)	23	324 (204-523)	240 (100-450)	7 (5-9)
Teixeira et al (21)	8	Laparoscopic Roux-en-Y cystjejunstomy	5	150 (100-215)	78	4 (2-10)
Senthilnathan et al (23)	54	Laparoscopic Puestow procedure (39) Laparoscopic Frey procedure (15)	34	220.6 ± 32.0 290.0 ±34.5	271.0 ± 18.8 6.4 ± 1.1	184.5 ±16.4 7.8 ± 1.8
Present study	7	Robotic distal pancreatosplenectomy (1) Laparoscopic cystgastrostomy (1) Robotic Puestow procedure (1) Laparoscopic Roux-en-Y cystjejunostomy (1) Laparoscopic distal pancreatosplenectomy and necrosectomy (2) Laparoscopic disconnection of pancreatopleural fistula (1)	6	290 (65 to 490)	50 (0-1200)	7 (4 to 32)

and one developed haemorrhage. They reported mean operative time of 220 minutes for Puestow and 271 for Frey procedures and length of stay of 6.4 and 7.8 days respectively. Complete pain relief was reported in 88 and 90 percent of patients who underwent Purstow and Frey procedures after five years respectively.

Puestow and Frey procedures have also been reported to be performed via robotic approach. Hamad (19) reported 8 Puestow and 4 Frey procedure in their retrospective cohort study. Median operative time was 210 and 372 minutes for Puestow and Frey procedure, blood loss was 45 and 163 ml, length of stay was 7 and 6 days respectively. One patient developed post-operative haemorrhage from the jejunojenunal anastomosis and one patient had a POPF.

Our cases correspond with the existing literature in demonstrating that pancreatic surgery for complications of pancreatitis may be performed safely via MIS. Our patients had comparable operative times, intraoperative blood loss and length of stay as previously reported in the literature. Of note, two of our patients who underwent emergency laparoscopic necrosectomy and DPS for ruptured PP had prolonged length of stay and both developed POPF (10). This may be attributable to patient and disease factors as both patients were acutely unwell at the time of surgery due to the pancreatic pseudocyst rupture. Both these cases developed POPF unsurprisingly, as in both cases the pancreas could not be transected proximal to the disrupted pancreatic duct.

Most of the literature surrounding MIS has been limited by less than ideal numbers and the nature of study being largely retrospective cohort studies. This render it difficult to fairly compare the outcomes of MIS versus open surgery for specific procedures for pancreatitis. However, these studies demonstrate that in the hands of experienced surgeons, outcomes of minimally invasive pancreatic surgeries for pancreatitis is a feasible and safe alternative to open surgery. It is important to note in this study, good outcomes could be obtained despite this being our early surgical experience as the principal surgeon (Goh) in this study had concomitant experience with approximately 500 minimally invasive major hepatopancreatobiliary(HPB) surgeries such as major pancreato-biliary surgeries and liver resections (24,25).

CONCLUSION

In conclusion, this early experience demonstrates that the minimally-invasive approach is a safe and feasible treatment modality for complications of pancreatitis when performed by HPB surgeons experienced with MIS. Further comparative studies with a larger sample size are needed to determine if the MIS approach is superior to the traditional open approach.

Conflict of interest

Dr Brian Goh has received travel grants and honorarium from Johnson and Johnson, Olympus and Transmedic the distributor of the Da Vinci system in Singapore

Ethical approval

This manuscript met the institution criteria and received a waiver from institution board review

REFERENCES

1. Bollen TL. Acute pancreatitis: international classification and nomenclature. Clinical Radiology. 2015. E1-13.
2. Tenner S, Baillie J, DeWitt J, Vege SS. American college of gastroenterology guideline: management of acute pancreatitis. American Journal of Gastroenterology. 2013;108:1400-15.
3. Sarr MG. 2012 revision of the Atlanta Classification of acute pancreatitis. Pol Arch Med Wewn. 2013. 123(3):118–24.
4. Kilburn DJ, Chiow AKH, Leung U, Siriwardhane M, Cavallucci DJ, Bryant R, et al. Early experience with laparoscopic Frey procedure for chronic pancreatitis: a case series and review of literature. J Gastrointest Surg. 2017; 21(5):904-909. Epub 2016 Dec 26.
5. Rossidis G, Hughes SJ. Minimally invasive treatment of pancreatic disease. Curr Gastroenterol Rep. 2012;14(2):125–30.
6. Goh BKP, Zeng G, Low TY, Chua DW, Koh YX, Lim KI. Changing trends and outcomes associated with the adoption of minimally-invasive pancreato-biliary surgery: Contemporary experience of a 'self-taught' early adopter in Southeast Asia. J Minim Access Surg. 2020;16(4):341-347.
7. Goh BKP, Low TY, Kam JH, Lee SY, Chan CY. Initial experience with laparoscopic and robotic surgery for the treatment of periampullary tumours: single institution experience with the first 30 consecutive cases. ANZ J Surg. 2019;89(4):E137–41.
8. Kabir T, Tan ZZ, Syn N, Chung AY, Ooi LL, Goh BK. Minimally-invasive versus open enucleation for pancreatic tumours: A propensity-score adjusted analysis. Ann Hepatobiliary Pancreat Surg. 2019;23(3):258-64.
9. Alsfasser G, Hermeneit S, Rau BM, Klar E. Minimally Invasive Surgery for Pancreatic Disease - Current Status. Dig Surg. 2016. 33(4):276–83.
10. Linn YL, Wang ZK, Goh BKP. Emergency laparoscopic surgery for ruptured pancreatic pseudocyst: Report of two cases and review of the literature. J Minim Access Surg. 2021;17(1):108-112.
11. Goh BKP, Low TY, Lee SY, Chan CY, Chung AYF, Ooi LPJ. Initial experience with robotic pancreatic surgery in Singapore: single institution experience with 30 con-secutive cases. ANZ J Surg. 2019; 89(3):206-210. Epub 2018 May 24.
12. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240(2):205–13.
13. Bassi C, Marchegiani G, Dervenis C, Sarr M, Hilal MA, Adham M, et

al. The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years After. Surgery. 2017;161(3):584-591. Epub 2016 Dec 28.
14. Baron TH, DiMaio CJ, Wang AY, Morgan KA. American Gastroenterological Association Clinical Practice Update: Management of Pancreatic Necrosis. Gastroenterology. 2020; 158(1):67–75.
15. Mathew MJ, Parmar AK, Sahu D, Reddy PK. Laparoscopic necrosectomy in acute necrotizing pancreatitis: Our experience. J Minim Access Surg. 2014;10(3):126–31.
16. Morató O, Poves I, Ilzarbe L, Radosevic A, Vázquez-Sánchez A, Sánchez-Parrilla J, et al. Minimally invasive surgery in the era of step-up approach for treatment of severe acute pancreatitis. Int J Surg. 2018;51:164-169.
17. Adam MA, Thomas S, Youngwirth L, Pappas T, Roman SA, Sosa JA. Defining a Hospital Volume Threshold for Minimally Invasive Pancreaticoduodenectomy in the United States. JAMA Surg. 2017. 152(4):336–42.
18. Blair AB, Burkhart RA, Hirose K, Makary MA. Laparoscopic total pancreatectomy with islet autotransplantation for chronic pancreatitis. J Vis Surg. 2016;2:121. eCollection 2016.
19. Hamad A, Zenati MS, Nguyen TK, Hogg ME, Zeh HJ 3rd, Zureikat AH. Safety and feasibility of the robotic platform in the management of surgical sequelae of chronic pancreatitis. Surg Endosc. 2018. 32(2):1056–65.
20. Bhattacharya D, Ammori BJ. Minimally invasive approaches to the management of pancreatic pseudocysts: review of the literature. Surg Laparosc Endosc Percutan Tech. 2003. 13(3):141–8.
21. Teixeira J, Gibbs KE, Vaimakis S, Rezayat C. Laparoscopic Roux-en-Y pancreatic cyst-jejunostomy. Surg Endosc. 2003;17(12):1910–3.
22. Morelli L, Furbetta N, Gianardi D, et al. Robot-assisted trans-gastric drainage and debridement of walled-off pancreatic necrosis using the EndoWrist stapler for the da Vinci Xi: A case report. World J Clin Cases. 2019;7(12):1461–6.
23. Senthilnathan P, Subrahmaneswara Babu N, Vikram A, Sabnis SC, Srivatsan Gurumurthy S, Anand Vijai N, et al. Laparoscopic longitudinal pancreatojejunostomy and modified Frey's operation for chronic calcific pancreatitis. BJS Open. 2019;3(5):666-671. eCollection 2019 Oct.
24. Goh BK, Prieto M, Syn N, Koh YX, Lim KI. Critical appraisal of the learning curve of minimally invasive hepatectomy: experience with the first 200 cases of a Southeast Asian early adopted. ANZ J Surg. 2020;90(6):1092-1098.
25. Low TY, Goh BK. Initial experience with minimally invasive extended pancreatecotmies for locally advanced malignancies: report of 6 cases. J Minim Access Surg. 2019;15:204-9.