Laparoscopic lateral pancreaticojejunostomy: an evolution to endostapled technique

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Abstract

Background Chronic pancreatitis (CP) is a debilitating condition resulting in severe pain with progressive deterioration of pancreatic function. "Tropical" pancreatitis represents a variant of the disease with widely dilated ducts, numerous calculi, and few strictures. Traditionally, modified Puestow's procedure has been the treatment of choice for a dilated pancreatic ductal system. However, it has only recently been adapted to laparoscopic approach which is a technically demanding procedure primarily due to need for extensive intra-corporeal suturing.

Methods Symptomatic cases of CP presenting at our center with minimum 8 mm mean ductal diameter at body and head were selected for laparoscopic modified Puestow's procedure. Those with prior pancreatic surgery, pancreatic head masses, endoscopic pancreatic stenting, and portal hypertension were excluded. Twenty-eight cases meeting selection criteria underwent a laparoscopic procedure.

Results Seven patients (25%) underwent a stapled pancreaticojejunal anastomosis, 17 (60.7%) received a sutured anastomosis. Four patients (14.3%) were converted to open surgery due to failure to localize the pancreatic duct with percutaneous needle aspiration. Of those patients who underwent a successful laparoscopic procedure, a single patient developed a pancreatic fistula which resolved spontaneously; another patient had a difficult post-operative course with prolonged intensive care. We suffered no mortality within the series and no patient had any long-term disability. Anastomotic patency rates of 100% were achieved by the third post-operative month.

Conclusion Lateral pancreaticojejunostomy is an effective surgical management for CP with a dilated ductal system. Its laparoscopic adoption is the rational next surgical step. It allows effective duct decompression with low mortality and morbidity. The procedure demands an advanced surgical skill set with an emphasis on intra-corporeal suturing. Those patients suffering from tropical CP with wide ductal dilatation greater than 12 mm are suited to an endostapled anastomosis which helps significantly reduce operative time without any corrosion of outcomes.

Keywords Chronic pancreatitis · Lateral pancreaticojejunostomy · Puestow's procedure · Tropical pancreatitis · Endostapler

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Chronic pancreatitis (CP) implies longstanding inflammation of the pancreatic parenchyma. While alcohol is the most common etiological factor in the west, Asian patients are often diagnosed with "tropical pancreatitis" with genetic & dietary risk factors. Tropical CP has been postulated to occur secondary to cassava toxicity, micro-nutrient deficiency, and genetic inheritance [1]. However, lifestyle changes including an increase in alcohol intake [2] are beginning to tilt the scales towards alcohol-induced CP in south–east Asia [1, 3, 4].

The clinical course of both varieties of the disease is similar—patients develop intra-ductal calcium depositions, which together with fibrosis within the duct wall, obstruct the flow

of pancreatic secretions into the duodenum. This upstream obstruction produces increased intra-ductal pressures, leading to pre-mature activation of pancreatic proenzymes within the gland itself, further worsening parenchymal destruction. Clinically, the afflicted patient presents with frequent attacks of upper abdominal pain with radiation to the back. Biochemistry reveals elevated serum enzymes. Imaging reveals a fibrotic pancreatic parenchyma with irregular duct & multiple calcific depositions within.

Pain is the primary complaint in CP, irrespective of etiology; it is the most frequent cause of hospitalization. It contributes to a poor quality of life, often causing malnutrition [3]. The mechanisms responsible for pain in CP are many, including the release of pro-inflammatory cytokines, production of substance P, ischemia of visceral nerve fibers, with development of "pain memory" in the central nervous system which is independent of peripheral nociceptive input [5, 6].

Both alcoholic & tropical CP produce a similar clinical presentation, culminating in exocrine and endocrine pancreatic insufficiency. They primarily appear to differ only in etiology & demographic factors. A closer look at the afflicted gland, though, reveals marked differences between alcoholic CP & tropical CP. Alcoholic CP produces a fibrotic gland with a markedly irregular duct; ductal strictures are striking with few intra-ductal calculi. In contrast, a "tropical" pancreas possess ducts which are more widely dilated, with fewer strictures and multiple large calculi within [1, 7].

Study setting

Laparoscopic lateral pancreaticojejunostomy is an uncommonly performed procedure. We began performing it at our center in 2009. Considering the prevalence of tropical CP in our country with wide pancreatic ducts, we were intrigued by Glaser's use of endostaplers in the procedure [8]. However, our search did not reveal any other researcher's experience with the same, and therefore, no guidelines concerning its use. Our primary aim was to successfully identify patients who are suited to laparoscopic pancreaticojejunostomy and describe our experience of the same. Secondary aims were to assess the feasibility of a stapled pancreatico-jejunal anastomosis in tropical pancreatitis, describe the technique employed, assess any special difficulties or complications when compared with standard sutured anastomosis and formulate recommendations for their use.

Materials and methods

Patients

They were selected from the surgical clinic at our hospital which is a tertiary referral center for the state of Maharashtra. Patients 18 years or older, with a confirmed diagnosis of CP with recurrent pain for 2 years or more were included. Written, informed consent was obtained from each patient at commencement. Those with prior pancreatic surgery were excluded (Table 1).

Imaging results

All cases underwent a routine triphasic abdominal computed tomography (CT) and a magnetic resonance cholangio-pancreaticogram (MRCP). Patients with a minimum pancreatic ductal diameter of 8 mm in body/head on MRCP were included within the study. Those found to have a pancreatic head mass, ducts smaller than 8 mm across, were considered for open surgery. The patency of anastomosis was reassessed using MRCP 3 months after surgery, or earlier if patient suffered an acute exacerbation.

Timing of surgery

It was determined in relation to the following:

Table 1 Selection criteria of patients for laparoscopic lateral pancreaticojejunostomy

Selection criteria of patients
Inclusion criteria
18 years of age or older
Consenting to be a part of the study
Diagnosed with CP
Pain for two or more years, not responding to conservative management
CT & MRCP demonstrate pancreatic duct larger than 8 mm
Smoking & alcohol cessation at least 3 months prior to surgery
Exclusion criteria
Age less than 18 years
Not consenting to be a part of the procedure
Unfit for general anesthesia
Previous pancreatic surgery
Prior endoscopic pancreatic duct endoscopic dilatation or stent insertion
Pancreatic head mass or a suspicion of pancreatic malignancy on imaging
Previous acute exacerbation was at least 6 weeks prior to surgery. Acute exacerbation defined as:
Worsening of symptoms requiring hospitalization
Recent shift to opioid analgesia
Elevated serum enzymes higher than 200 U/L
Continued smoking or alcohol consumption
Portal Hypertension
Pregnancy

1. Patients should have been symptomatic with chronic abdominal pain for at least 2 years
2. Patients should not have had an acute exacerbation for a period of 6 weeks prior to surgery. An acute attack was defined as an exacerbation of symptoms requiring hospitalization, recent shift to opioid analgesia or an elevation of serum enzymes greater than 200 U/L.
3. Past endoscopic procedures, if any, should have a gap of 6 weeks prior to surgery
4. Patients with history of alcohol consumption or smoking were required to discontinue the same for a period of 3 months prior to surgery. This was done with assistance of clinical psychologists and psychiatrists.

Data collection

All patient features, medical, and surgical history were collected retrospectively. Disease duration was calculated from first point of contact with a general surgeon or physician for symptoms classical of CP. A detailed drug history was obtained for those found to suffer from endocrine or exocrine insufficiency. Suboptimal medication was titrated to achieve relief or symptoms and/or glycemic control.

Surgical technique

Position

All patients were placed in a leg-split "French" position. A four-port foregut arrangement was employed, as depicted in Fig. 1 (a—camera port, b—5-mm working port, c—12-mm working port for endostapler insertion, d—5-mm retraction/ working port).

### Preparing a wide operative field

After a diagnostic laparoscopy, the lesser sac is entered through the gastrocolic ligament using ultrasonic shears. To ensure a wide operative space, a "stomach hanging technique" [9] is employed, where a few seromuscular sutures taken on the posterior gastric wall are hitched to the abdominal wall using a suture passing needle (Fig. 2). Adhesions between the stomach and pancreas are taken down with a judicious mix of sharp dissection with scissors and ultrasonic shears.

MPD identification & ductotomy

The most challenging part of the procedure is the identification of the main pancreatic duct. In the absence of laparoscopic ultrasound probe at our center, this was achieved by using a lumbar puncture needle introduced
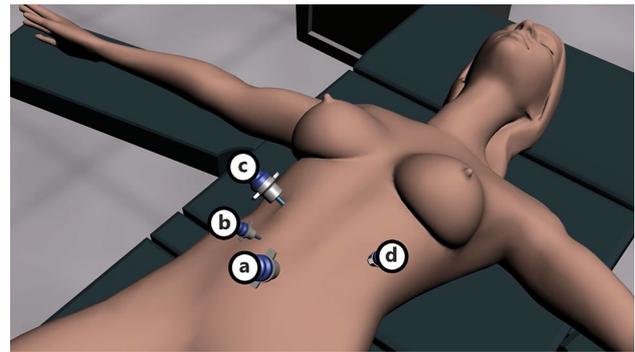
Fig. 1 Port positions for laparoscopic lateral pancreaticojejunostomy; (a) camera port, (b) 5-mm working port, (c) 12-mm working port for endostapler insertion, (d) 5-mm retraction/working port
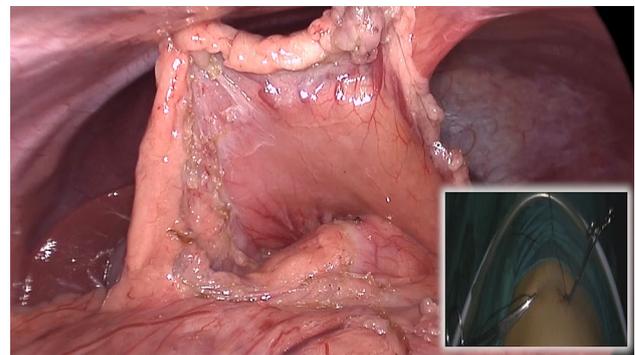

Fig. 2 "Stomach hanging technique" with seromuscular sutures on posterior gastric wall hitched to anterior abdominal wall. Inset: external view

transcutaneously. The patient's MRCP helps choose the site of initial ductal entry. In an evenly dilated duct, entry was attempted at the pancreatic head (Fig. 3).

Aspiration of pancreatic contents via the needle reveals the duct location; it is then opened with a hook or ultrasonic shears. This usually results in rapid spillage of ductal contents which were under pressure due to distal obstruction. After suctioning the secretions, the ductal mucosa comes into view. An effort is made to keep visualizing the ductal mucosa as the MPD is laid open further towards the tail. A failure to do so may lead to erroneously dividing only the parenchyma superficial to the duct, leaving the duct intact.

All calculi within the duct are retrieved within an endobag. Copious irrigation of the ductotomy with saline helps dislodge smaller concretions. Pancreaticodochoscopy with a 5-mm zero-degree scope confirms clearance beyond the ductotomy. A roux-en-Y jejunal limb is fashioned, which is passed retro-colic, to the left of the middle colic vessels. A stapled jejunojejunostomy re-establishes bowel continuity.
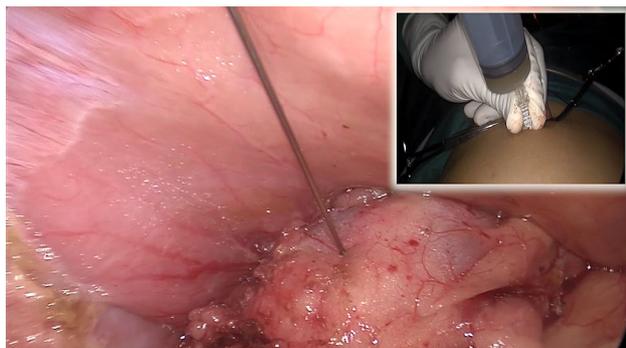
Fig. 3 Transabdominal insertion of spinal needle to aid duct localisation. Inset: transcutaneous aspiration of pancreatic secretions

The pancreaticojejunostomy

The principle of a wide, longitudinal anastomosis as laid down by Partington & Rochelle were followed [10]. Almost all descriptions of the laparoscopic procedure mentioned a sutured anastomosis. This is demanding due to the length of anastomosis desired, the variable fibrotic consistency of the pancreas, and difficult ergonomics. At our center, an initial attempt at endostapler anastomosis was made in all cases with ducts wider than 10 mm. The anvil is the narrowest and thinnest part of the endostapler, measuring 9.55×3.12 mm. It is inserted into the pancreatic duct while the opposing cartridge end of the jaw is inserted into the roux limb via an enterotomy (Fig. 4). Successful firing results in a wide, secure pancreaticojejunostomy, which can be further extended towards the tail. The final defect is closed with absorbable sutures.

If an endostapler could not be maneuvered into the pancreatic duct, it was laid open with ultrasonic shears along its length and a corresponding enterotomy was created in the roux limb. The anastomosis was completed using one of two techniques. The first involves an inner layer of continuous

polydioxanone 3–0 sutures with an outer layer of interrupted stitches using 3–0 braided polyester. In the second technique, the roux limb was sutured to the pancreatic surface using intermittent polyester of silk suture with a continuous inner layer with 3–0 absorbable barbed sutures (Fig. 5).

The roux limb of jejunum was secured in all cases to the transverse mesocolic window with nonabsorbable sutures. The procedure ends with a drain placed in the lesser sac.

Results

Patient demography

Between 2008 and 2017, 28 patients with CP meeting our selection criteria were taken up for laparoscopic pancreaticojejunostomy at our center. Of these, nine were women; the male-to-female ratio was 2.11. Average age of the patients was 41.18 years. Seven patients (25%) had a history of chronic alcohol consumption with six chronic smokers (21.4%) and two tobacco chewers (7.14%). A single patient (3.6%) had a family history of CP in a first degree relative in the absence of other risk factors, suggestive of a hereditary etiology. Twenty patients (71.4%) were deemed to suffer from Idiopathic or tropical CP.

Symptoms

As per selection criteria, all patients suffered from chronic pain secondary to CP. Three patients (10.7%) exhibited both endocrine and exocrine insufficiency. Five patients (17.8%) had only diabetes mellitus while four (14.28%) had exocrine insufficiency with good glycemic control.

Imaging

At the inception of this study, we retrospectively reviewed MRCP imaging of patients of CP at our center. The findings

Fig. 4 Endostapled pancreatico-jejunal anastomosis with anvil of stapler negotiated into pancreatic duct with cartridge end in the jejunal roux limb

Fig. 5 Sutured pancreatico-jejunal anastomosis in a case with MDD of 8 mm

were correlated with operative notes and a threshold of 8 mm ductal diameter was deemed amenable for laparoscopic intervention. The mean duct diameter (MDD) for every case was calculated by using the average of duct width at head and body, as seen on MRCP (Fig. 6). Ductal width at the tail was intentionally omitted while calculating the MDD as it was found to skew the results. The average MDD for the 28 patients was 10.89 mm.

Operative Outcomes

Of the 28 patients within the study group, seven patients (25%) successfully underwent a stapled pancreaticojejunostomy, 17 (60.7%) received a sutured anastomosis after an unsuccessful initial attempt with an endostapler, while four patients (14.3%) underwent a conversion to open surgery due to failure to identify the pancreatic duct. Mean hospital stay for the laparoscopic group was 5.85 days, while it was 8.5 days for those who underwent a conversion.

The mean operative time was 170.7 min for the stapled group, 213.5 min for the sutured group, and 185 min for those who underwent a conversion.

Complications

We suffered no mortality in our series. Twenty patients (71%) had an uneventful post-operative course without any complication. Complications, when present, were graded according to classification put forward by Dindo et al. [11].

Three patients (10.7%) suffered from grade I complication of surgical wound gape, stitch abscess or urinary retention. Of the two patients (7.14%) who developed grade II complications, one suffered from atelectasis needing antibiotics, the

Fig. 6 MRCP of a case of tropical chronic pancreatitis highlights maximal dilatation within the head with the diameter steadily decreasing towards the pancreatic tail

other suffered from a hemorrhagic drain output on the third post-operative day. A CT angiography was performed for the same which failed to demonstrate any active bleeding. The patient's anaemia was corrected with a blood transfusion with an uneventful clinical course thereafter.

Two patients (7.14%) developed a pancreatic fistula postoperatively. The first had undergone a laparoscopic sutured LPJ and presented with amylase-rich fluid extravasation from drain site on the 9th post-operative day which was managed conservatively (grade IId). One patient who had undergone a conversion suffered from a high-output pancreatic fistula which was treated with somatostatin analogues with endoscopic sphincterotomy and pancreatic duct stenting (grade IIIb). Fistula resolution occurred by the sixth post-operative week.

A single patient suffered a grade IVb complication—a 62-year-old hypertensive female who had a tumultuous post-operative recovery with hemodynamic instability necessitating ICU stay for 4 days. No repeat surgical or endoscopic intervention was required, and she was deemed to be suffering from systemic inflammatory response syndrome (SIRS). Her pleural effusion was aspirated under sonographic guidance. She was discharged on the 13th post-operative day without any long-term disability.

An anastomotic patency rate of 100% was demonstrated by MRCP performed 3 months post-operatively (Fig. 7). Of the 24 patients who successfully underwent a laparoscopic LPJ, 21 (87.5%) had complete pain relief after 1 year with the rest claiming partial pain relief necessitating intermittent analgesic use. One of these patients eventually underwent a Frey's procedure 3 years after surgery on discovery of pancreatic head enlargement.

Discussion

Every pancreas is as unique as the person to which it belongs. Surgery should be tailored to the morphology of the gland and the problems the patient presents with. Glands with diffuse parenchymal fibrosis, strictured ductal tree, or with pancreatic head masses should undergo some form of resectional procedure. Early identification of patients who may be candidates for surgery helps avoid extensive resections and improve outcomes. Those with obstructive symptoms should be planned for drainage procedures. A problem-centric approach with a stress on organ preservation is key [12].

Patients with tropical CP are prime candidates for surgical drainage procedures due to the morphology of the gland. A wide pancreatic duct with multiple concretions within is amenable to drainage into a jejunal limb. The modified Puestow's procedure as described by Rochelle and Partington is particularly suited to a laparoscopic approach in such
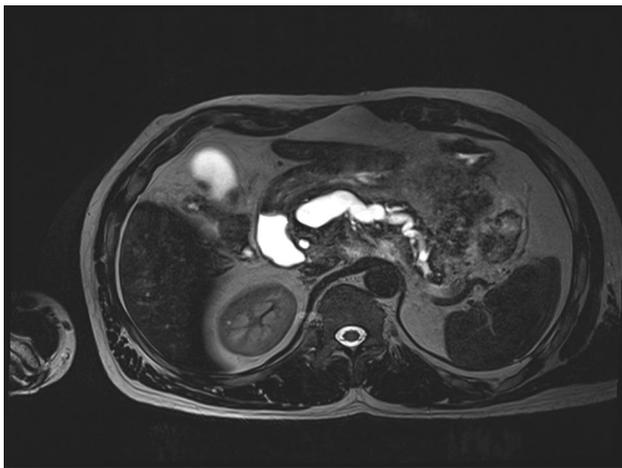
Fig. 7 Effective decompression of the pancreatic ductal system is evident in post-operative MRCP

Pre-operative MRCP   Post-operative MRCP
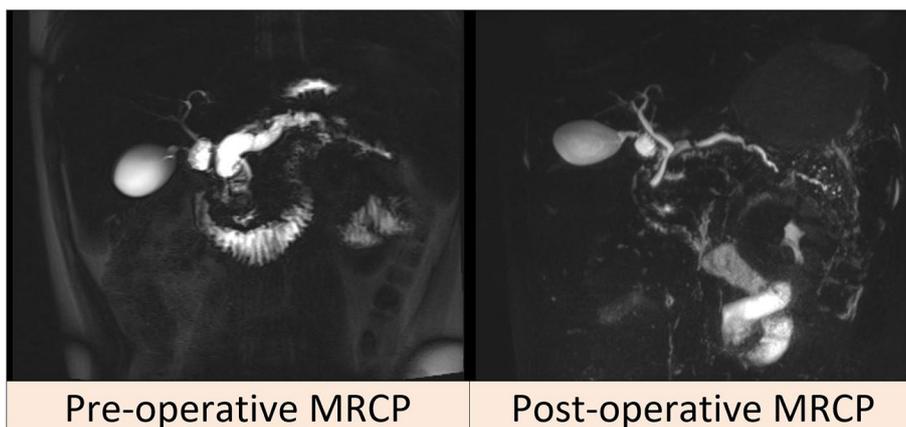
patients. Like most other surgical procedures, laparoscopic modified Puestow's procedure has also evolved into a laparoscopic avatar in the late 1990s. The first such procedure was described by Kurian and Gagner in 1999 [13]. Given the advanced nature of the procedure, difficulties in locating the pancreatic duct and performing the subsequent anastomosis, reports of the procedure remained infrequent [13–18]. However, resourceful surgical researchers have managed to adapt the technique to single-incision laparoscopic surgery [19], using intra-operative basketing to achieve ductal clearance [20], as well as using robotics [21, 22] to possibly aid ease of the procedure. Glaser et al. performed the first documental stapled pancreaticojejunostomy [8].

However, wide adoption of the procedure has been lethargic due to certain impediments, the first of which is attaining a wide operative field within the lesser sac. We have found the "stomach hanging method" [9] to the anterior abdominal wall to be quite effective, particularly when the gastric seromuscular sutures are taken higher on the posterior gastric wall.

The next hurdle lies in correctly locating the pancreatic duct. In the absence of laparoscopic ultrasound at our center, we have relied on transabdominal spinal needle insertion into the pancreatic substance with aspiration of secretions helping localize the duct. The first point of needle insertion must be guided by the patient's MRCP images. Failure to locate the main pancreatic duct was the cause of the four conversions within our series. The average MDD in these four patients was 8.6 mm, compared to 9.8 mm in patients who underwent a successful laparoscopic sutured anastomosis and 14.7 mm in the stapled group. Previously published descriptions of the procedure have stated that laparoscopic ultrasound is a valuable tool [13, 15, 16, 18], and we feel availability of the same could have perhaps helped us avoid conversion to an open procedure.

Proficient intra-corporeal suturing is an essential part of any minimal access surgeon's skill set. But the sutured laparoscopic pancreaticojejunostomy places significant strains on one's competence. The lack of triangulation and the axis of desired anastomosis with an immobile retroperitoneal organ necessitates sectorization of working instruments. Anastomotic suturing constitutes a significant fraction of operative time. One simple workaround is the use of absorbable barbed sutures which have been found to be as effective as traditional sutures in pancreatic surgery, helping reduce operative times, without any increase in complication rates [23, 24]. Another novel option is the use of endostaplers to perform the anastomosis. First described by Glaser [8], an endostapled anastomosis seemed ideal in the surgical treatment of tropical CP. The dilated duct permits insertion of the narrow anvil into the MPD, while the broader cartridge side of the jaw is easily accommodated into the roux limb via an enterotomy. The fact that only 25% of our cases received a stapled anastomosis is testament to the fact that this variation of the procedure is not universally applicable in CP. The single greatest patient factor limiting use is duct morphology. A duct with multiple strictures in an otherwise dilated system, or a narrow duct calibre to begin with were the usual culprits. Another factor was the physical limitation of the stapler being used. While the width of the commercially available endostapler anvil (Medtronic Ltd, Dublin, Ireland) is 9.55 mm, we have found that it is best suited for ducts larger than 12 mm. This disparity can be explained by the obtuse angle of entry into the ductotomy and a duct calibre made irregular with multiple strictures. The presence of large calculi within the duct may also impede anvil insertion, necessitating retrieval with laparoscopic graspers via the ductotomy. Pancreaticodochoscopy using a zero-degree 5-mm laparoscope helps confirm duct clearance. An abundant lavage with normal saline is also useful. When successful, an endostapled anastomosis is wide, secure, with prompt hemostasis, while being time-efficient (Fig. 8).

In our series, the smallest duct that was successfully operated laparoscopically had a MDD of 8 mm. With increasing
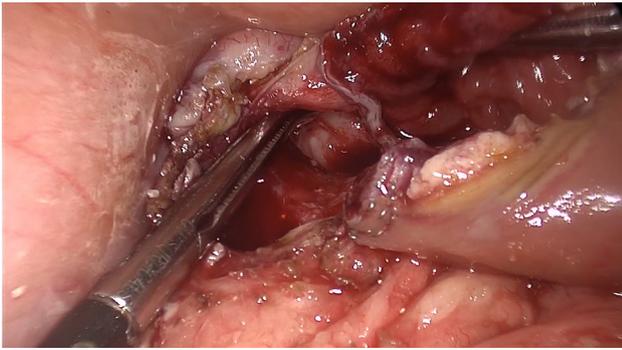
Fig. 8 After endostapler firing, the staple line is evaluated through the ductotomy/enterotomy to reveal a hemostatic and secure anastomosis

Table 2 Grading of main pancreatic ductal dilatation

Grade	Mean duct diameter (MDD)[a]	Preferred anastomosis
I	< 8 mm	Sutured
II	8–12 mm	Sutured > endostapler
III	> 12 mm	Endostapler

[a]Mean duct diameter = average of duct diameter at head and body

duct size, the operative times reduce with increasing ease of surgery. It is the MDD which also guides the type of anastomosis to be performed (Table 2).

All patients who underwent a laparoscopic procedure sans conversion were afforded the inherent benefits of minimal access approach—they were ambulated sooner with early resumption of oral intake by the second post-operative day. Barring a single patient with post-operative SIRS, the post-operative course was uneventful. Pancreatic fistula in a single patient within this group who received a sutured anastomosis, resolved by the second month. We did not note any untoward post-operative event in patients who received the stapled anastomosis. No patient suffered any long-term morbidity because of the procedure. Average follow-up for the patients was 42 months.

Pain is the central parameter in CP, as its presence is a precondition for intervention and is the yardstick by which the treatment is judged. 87.5% patients within the laparoscopic group reported a significant improvement in pain scores at 1-year follow-up. 75% had sustained pain relief at 3 years.

With time, comes greater familiarity with an otherwise uncommon procedure. The favorable surgical outcomes can be partly attributed to stringent selection criteria applied. We do not need convincing regarding the benefit of laparoscopic LPJ and feel that the benefits of minimally invasive approach can be extended to patients with pancreatic head masses in

need of Frey's procedure [25, 26]. Others are finding success in laparoscopic pancreatic resection [27]. All recent research points to early surgical intervention for CP and we firmly believe in the same. Surgery should be planned within 3 years of symptomatic CP [28]. A gland that is less further along its disease course is more amenable to laparoscopy, with infrequent need for organ resections. An effective and timely drainage helps decompress the gland, preventing further parenchymal damage.

Conclusion

Lateral pancreaticojejunostomy is an effective surgical management for CP with a dilated ductal system. Its laparoscopic adoption is the rational next surgical step. It allows effective duct decompression with low mortality and morbidity. The procedure demands an advanced surgical skill set with an emphasis on intra-corporeal suturing. Those patients suffering from tropical CP with wide ductal dilatation are suited to an endostapled anastomosis which helps significantly reduce operative time without any corrosion of outcomes. Looking forward, laparoscopic management of CP can be extended to those in need of resectional procedures like Frey's procedure.

Compliance with ethical standards

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