

# Laparoscopic versus open surgical management of patients with chronic pancreatitis: A matched case–control study

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## Abstract

**Background:** The safety and feasibility of laparoscopic surgery in patients with chronic pancreatitis (CP) have been established, but its outcome has not been compared to that of open surgery.

**Patients and Methods:** This retrospective study was conducted on patients with CP who were treated by a single surgical team from 2012 to 2018. The medical records of patients with surgical treatment of CP were reviewed. Patients were divided into laparoscopic group (LG) and open group (OG). Both the groups were matched for age and procedures. The matched groups were compared.

**Results:** The total number of unmatched patients was 99 and post matching, there were 38 patients in each group. The demographic, aetiological, clinical and laboratory parameters were comparable. The number of each surgical procedure including bilio-enteric anastomosis was also similar. Lateral pancreaticojejunostomy was the most common surgical procedure in both the groups. An additional surgical procedure (bilio-enteric bypass) was required in 10.5% of the patients in LG and 21% of the patients in OG groups ( $P = 0.3$ ). Significantly lower blood loss (100 vs. 120 ml) and higher operation time (300 vs. 210 min) were observed in LG. The post-operative complication rate was 7.9% in LG group versus 10.5% in OG group. More than 85% of the patients in both the groups had a significant relief from pain. The impact of exocrine and endocrine insufficiency was not remarkable in both the groups. The requirement of an additional surgical procedure was associated with a high conversion rate.

**Conclusions:** The outcomes of laparoscopic surgery in patients with CP were similar to that of open surgery, and requirement of an additional surgical procedure is associated with a high conversion rate.

**Keywords:** Chronic pancreatitis, Frey's procedure, laparoscopic, lateral pancreaticojejunostomy, open, surgery

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## INTRODUCTION

Chronic pancreatitis (CP) is a chronic inflammatory condition of the pancreas which is associated with debilitating pain, impaired quality of life and occurrence of exocrine and/or endocrine insufficiency (EXI/ENI).<sup>[1]</sup> Medical treatment

is the first line of palliation, but a significant proportion of patients with CP require endoscopic and/or surgical treatment.<sup>[1,2]</sup> Endoscopic treatment is the preferred initial treatment in patients with obstructive type of CP.<sup>[2,3]</sup> However, two randomised controlled trials and one

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Cochrane review have demonstrated superior outcome of surgery than that of endotherapy.<sup>[4-6]</sup> The selection of the procedure is based on the size of the pancreatic duct (PD), extent of pancreatic calcification, size of the head, suspicion of Groove pancreatitis and/or malignant disorder.<sup>[1]</sup>

Open approach is traditionally employed to provide surgical care in patients with CP. The involved technical challenges led to underutilisation of laparoscopic approach in the management of CP. Gagner and Pomp (1994) reported the first laparoscopic pylorus-preserving pancreaticoduodenectomy in a patient with CP.<sup>[7]</sup> Kurian and Gagner (1999) performed the first Laparoscopic Lateral PancreaticoJejunostomy (LLPJ); they used intraoperative ultrasound (IOUS), stapling devices and direct suturing for the procedure.<sup>[8]</sup> Cushieri *et al.* (1996) reported safety, feasibility and enhanced recovery after laparoscopic distal pancreatectomy with splenectomy in CP.<sup>[9]</sup> Only a few centres have reported their experience about laparoscopic surgical management of CP.<sup>[9-14]</sup> The safety and feasibility of robotic surgical management of CP has also been reported.<sup>[15-17]</sup> A single case–control study compared robotic and open approach, but no studies have compared conventional laparoscopic approach to the open approach in CP.<sup>[18]</sup> The aim of this case–control study was to compare the outcome of conventional laparoscopic approach to that of open approach in the management of CP.

**PATIENTS AND METHODS**

This retrospective study included patients admitted at a single unit of a tertiary care centre in northern India from 2012 to 2018. Written informed consent was obtained from all the patients. The waiver for the study was obtained from the institutional review board. Medical records of the patients were reviewed for demographic characteristics, clinical presentation, laboratory investigations, radiological investigations, endoscopic interventions, operation details, complications and functional outcome. The pre-operative workup included blood haematology, blood chemistry, coagulation studies and tumour markers. The diagnosis of CP was based on contrast-enhanced computed tomography of the abdomen and histopathological examination of the pancreatic tissue. Endoscopic ultrasound plus/minus fine-needle aspiration cytology was performed if malignancy was suspected. Patients with confirmed malignancy were excluded from the study.

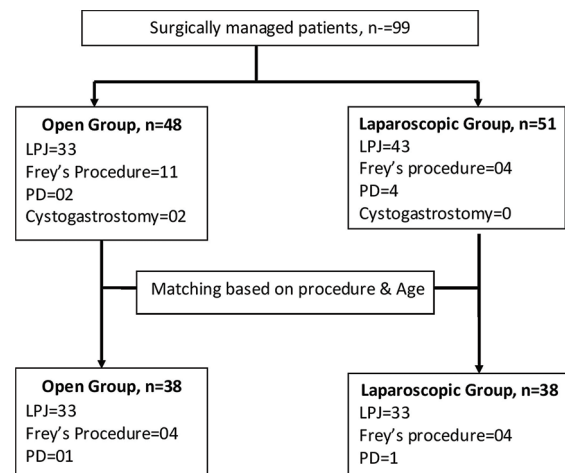
LPJ was performed in patients with dilated PD but no enlargement of the pancreatic head. Frey’s procedure was performed in patients with dilated PD and inflammatory

enlargement of the pancreatic head. Patients with Groove pancreatitis were offered pancreaticoduodenectomy (PD). No patient received distal pancreatectomy. Patients with biliary stricture required an additional bilio-enteric anastomosis. Initially, the patients with PD >8 mm and/or pancreatic calcification but without head enlargement were preferred for laparoscopic approach, but later on, the selection was random. The patients were classified into open group (OG) and laparoscopic group (LG) on intention-to-treat basis. The patients of both the groups were matched for age and procedures [Figure 1]. The severity of pain was recorded on the Numeric Rating Scale (NRS) ranging from 0 to 10.<sup>[19]</sup> Post-operative complications were recorded as described by Dindo *et al.*<sup>[20]</sup> Pancreatic fistulae were classified as per criteria laid down by the International Study Group on Pancreatic Fistula.<sup>[21]</sup>

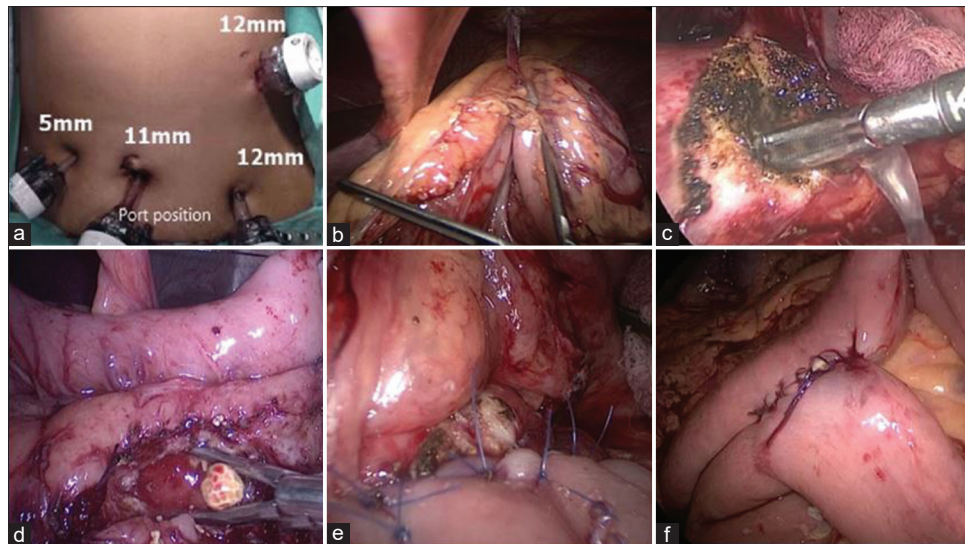
ENI was defined as diabetes mellitus requiring medical treatment and/or serum fasting glucose levels of more than 126 mg/dl.<sup>[22]</sup> Exocrine insufficiency (EXI) was defined as presence of fatty, frothy stools and/or requirement of pancreatic enzyme supplements. Hospital mortality was defined as death within 90 days of surgical procedure. The technique of LLPJ was the same as described by Nag *et al.*<sup>[11]</sup> Four access ports were used, as depicted in Figure 2a. The gastrocolic ligament was sacrificed to enter the lesser sac and the stomach was retracted, as depicted in Figure 2b. The diathermy current was applied to open PD and then it was laid open [Figure 2c and d]. The pancreaticojejunal anastomosis (PJA) and jejunojejunal anastomosis were fashioned in a side-to-side manner [Figure 2e and f].

**Follow-up**

Patients were followed up at every 3 months in the first 2 years and at every 6 months afterwards. The pain relief



**Figure 1:** Flow diagram



**Figure 2:** (a) Port Position; (b) Lifting of the stomach by an encircling tape; (c) Exposure of the pancreatic duct; (d) Retrieval of pancreatic duct stones; (e) Completed pancreaticojejunostomy anastomosis; (f) Completed jejunojejunostomy anastomosis

was recorded as complete (absence of pain), partial (NRS reduced by minimum 3 points) and none (when pain remained the same or worsened).<sup>14]</sup> The responses to ENI/EXI were recoded according to change in the requirement of hypoglycaemic agents/enzyme supplements, as follows: improved (requirement reduced), static (no change) and worsened (requirement increased).

### Statistics

The MedCalc Statistical Software version 19.1.5 (MedCalc Software by, Ostend, Belgium; <https://www.medcalc.org>; 2020) was used. Patients were matched for the type of surgical procedures and for age ( $\pm 5$  years). Parametric numerical data were reported as mean  $\pm$  standard deviation and non-parametric numerical data were represented as median (interquartile range). Ordinal and categorical parameters were represented as frequencies and percentages. Student's *t*-test and Mann–Whitney U-test were used to compare numerical variables. Chi-square test and Fisher's exact test were used to compare ordinal and categorical variables.  $P < 0.05$  was considered statistically significant.

### RESULTS

The total number of unmatched patients was 99 and post matching, each group had 38 patients [Figure 1]. The demographic, aetiological, clinical and laboratory parameters were comparable, as depicted in Table 1. The pre-operative pain score (NRS) was 7.5 (LG) versus 8 (OG). Tropical CP was the most common aetiological type. Pre surgery, four (10.5%) versus one (2.6%) had PD stenting in LG group versus OG group ( $P = 0.2$ ) [Table 1].

The surgical blood loss was lower (100 ml vs. 120 ml) in LG group ( $P = 0.009$ ). The duration of surgery was higher (300 vs. 210 min) in LG group ( $P = 0.000$ ) [Table 2]. The median hospital stay was 7 days in LG group versus 6 days in OG group ( $P = 0.107$ ) The complication rate was comparable. Two patients in the LG group required interventions for the complications: one required exploratory laparotomy for post-operative haemorrhage and disruption of PJA (primary repair done), and another required endotherapy to control bleeding from gastric ulcer (stress ulcer); both of them had a prolonged hospital stay. No patient in the OG group required any intervention post surgery. Follow-up in LG group versus OG group was 25 versus 30 months [Table 2].

In LG group versus OG group, pain relief was complete in 71% versus 65.7%, partial in 15.7% versus 18.4% and none in 13.1% versus 15.7% of patients [Table 2]. Endocrine functions were unaltered or improved in 13.1% of the patients in both the groups. Deterioration of endocrine functions or development of ENI was observed in 31.5% (LG) versus 34.1% (OG) of the patients. Exocrine functions were unaltered or improved in 7.8% (LG) versus 10.4% of the patients (OG). New onset or deterioration of EXI was observed in 42% (LG) versus 39.4% of the patients (OG) [Table 2]. There was no post-operative mortality (90 days) in both the groups. Eleven patients (28.9%) of the LG group required conversion to open approach. The reasons for conversion were need for additional procedures (five patients), non-localisation of PD (four), difficult head coring due to extensive calcification (one) and intraoperative haemorrhage (one). On univariate analysis, requirement

**Table 1: Comparison of clinical and demographic parameters**

Parameters	Open (n=38)	Laparoscopic (n=38)	P
Age, median (IQR)	31 (25-42)	32 (24-42)	0.827
Male, n (%)	24 (63.2)	24 (63.2)	1.000
Endocrine deficiency, n (%)	7 (18.4)	10 (26.3)	0.412
Exocrine deficiency, n (%)	16 (42.1)	11 (28.9)	0.233
Weight loss, n (%)	8 (21.1)	10 (26.3)	0.591
Chronic smoking, n (%)	4 (10.5)	7 (18.4)	0.331
Aetiology, n (%)			
Alcoholic chronic pancreatitis	5 (13.2)	8 (21.1)	0.364
Tropical chronic pancreatitis	33 (86.8)	30 (78.9)	
Pre-operative NRS for pain, median (IQR)	8.0 (7.0-9.0)	7.5 (7.0-8.0)	0.499
Symptoms duration in months, median (IQR)	18 (12.7-24.0)	20 (14.0-36.0)	0.237
Duct size in mm, median (IQR)	9 (8-10)	10 (9-12.0)	0.101
History of endotherapy, n (%)			
Pancreatic duct stenting	1 (2.6)	4 (10.5)	0.220
Celiac ganglion block	0 (0)	1 (2.6)	
Pancreatic duct calculi, n (%)	34 (89.5)	32 (84.2)	0.500
Hb (g/dl), median (IQR)	10.9 (10.2-11.8)	11.0 (9.8-12.0)	0.987
TLC (cells/mm <sup>3</sup> ), median (IQR)	7.4 (6.9-7.8)	7.3 (6.5-8.0)	0.778
RBS (g/dl), median (IQR)	99 (90.0-104.0)	101 (94-108.0)	0.532
HbA1c, median (IQR)	5.1 (5.0-5.6)	5.1 (5.0-5.6)	0.949
Serum creatinine (mg/dl), median (IQR)	0.6 (0.5-0.7)	0.7 (0.6-0.8)	0.123
Bilirubin (mg/dl), median (IQR)	0.6 (0.6-0.7)	0.6 (0.5-0.8)	0.505
ALP (IU/ml), median (IQR)	100 (79.0-118.5)	98.5 (78-109)	0.381
Albumin (g/dl), median (IQR)	4.0 (3.8-4.1)	3.9 (3.5-4.0)	0.132

IQR: Interquartile range, NRS: Numeric Rating Scale, Hb: Haemoglobin, HbA1c: Haemoglobin A1c, ALP: Alkaline phosphatase

**Table 2: Comparison of pre-operative and post-operative parameters**

Parameters	Open (n=38)	Laparoscopic (n=38)	P
Blood loss (ml), median (IQR)	120 (100-150)	100 (70-150)	0.009
Operation time (min), median (IQR)	210 (180-240)	300 (280-320)	0.000
Procedure done, n (%)			1.000
LPJ	33 (86.8)	33 (86.8)	
Frey's procedure	4 (10.5)	4 (10.5)	
Pancreaticoduodenectomy	1 (2.6)	1 (2.6)	
Additional procedure, n (%)			0.331
Biliary drainage	8 (21.0)	4 (10.5)	
Biliary and gastric drainage	0 (0.0)	1 (2.6)	
Hospital stay (days), median (IQR)	6 (6-7)	7 (6-8)	0.107
Complications, n (%)	4 (10.5)	3 (7.9)	0.693
Dindo Grade 1/Grade 2/Grade 3	4/0/0	01/0/2	0.076
Post-operative pain relief, n (%)			0.884
Complete relief	25 (65.7)	27 (71.0)	
Partial relief	7 (18.4)	6 (15.7)	
None	6 (15.7)	5 (13.1)	
Follow-up (months), median (IQR)	30 (15-52)	25 (9-40)	0.337
Post-operative endocrine deficiency, n (%)	18 (47.3)	17 (44.7)	0.953
Status quo	4 (10.5)	4 (10.5)	
Improved	1 (2.6)	1 (2.6)	
Worsened	3 (7.8)	4 (10.5)	
New onset	10 (26.3)	8 (21.0)	
Post-operative exocrine insufficiency, n (%)	19 (50)	19 (50)	0.951
Status quo	3 (7.8)	2 (5.2)	
Improved	1 (2.6)	1 (2.6)	
Worsened	12 (31.5)	12 (31.5)	
New onset	3 (7.8)	4 (10.5)	
Mortality (90 days), n (%)	0 (0)	0 (0)	

IQR: Interquartile range, LPJ: Lateral pancreatico jejunostomy

of an additional surgical procedure was associated with a high rate of conversion; other factors such as age, sex, pain score, duration of symptoms and PD size were not associated with conversion. On multivariate analysis, no significant association could be demonstrated [Table 3].

## DISCUSSION

The feasibility and safety of laparoscopic surgical management of CP have been established by several retrospective studies and one prospective study.<sup>[8-14,23]</sup> The

**Table 3: Univariate and multivariate analysis of laparoscopic group with and without conversion**

Parameter	No conversion (n=27)	Conversion (n=11)	P	
			Univariate analysis	Multivariate analysis
Age ≤21, n (%)	6 (22.2)	1 (9.1)	0.350	NS
Female, n (%)	9 (33.3)	5 (45.5)	0.488	NS
Additional procedure, n (%)	0 (0)	5 (45.5)	0.000	NS
Pain grade >7, n (%)	15 (55.6)	4 (36.4)	0.289	NS
Pain duration >20 months, n (%)	10 (37.0)	6 (54.5)	0.327	NS
Pancreatic duct ≥7 mm, n (%)	24 (88.9)	9 (81.8)	0.563	NS
Duct calculi presence, n (%)	22 (81.5)	10 (90.9)	0.475	NS

NS: Not significant

results of our study suggested that laparoscopic surgical management of CP has outcomes similar to that of conventional open surgery except lower blood loss and higher operation time in LG. In laparoscopic surgery, magnified vision and frequent use of energy devices help to achieve a better haemostasis, whereas inherent limitations usually prolong operation time. Surgical blood loss in LG was 100 ml which was comparable to the findings of Senthilnathan *et al.*<sup>[23]</sup> The mean duration of surgery in LG was 300 min, whereas Tantia *et al.* and Senthilnathan *et al.* reported an operation time of 220–277 min for LLPJ and 271–377 min for patients with additional surgical procedures.<sup>[10,23]</sup> However, Palanivelu *et al.* reported operation time from 110 to 225 min, which was lower than that of our study.<sup>[11]</sup> Relatively longer hospital stay in LG was mainly due to socioeconomic factors, and due to a prolonged stay in two patients with Grade 3 complications. The reported hospital stay in literature varies from 3 days to 14 days.<sup>[9-14,24]</sup>

Morbidity in LG (7.9%) was not higher than OG (10.5%); however, the reported morbidity rate for LG was >11% in some studies.<sup>[9-14,24]</sup> More than 85% of the patients in both the groups had complete/partial relief from the pain. Several authors have reported about 80% relief from the pain following laparoscopic surgery.<sup>[9-14]</sup> Sielezneff *et al.* reported relief from pain as excellent in 28%, good in 47% and fair in 16% following open surgery, whereas Tanaka *et al.* reported it up to 97%.<sup>[25,26]</sup> In our series, most of the patients did not show improvement in endocrine and exocrine functions of the pancreas, rather a significant proportion of patients showed deterioration of these functions. Similar to our study, Adolf *et al.* reported long-term pain relief in 93% of patients, but there was no improvement in endocrine and exocrine functions.<sup>[27]</sup> Schnellendorfer *et al.* reported the experience of 372 patients, out of which only 50% the patients had significant pain control, 62% of the patients returned to work and 29% and 35% of the patients developed endocrine and EXI, respectively.<sup>[28]</sup> However, Palanivelu *et al.* and Sielezneff *et al.* reported improved or static endocrine and exocrine functions following surgery.<sup>[10,24]</sup> Nealon *et al.* also reported

that operative drainage of PD delays functional impairment in patients with CP.<sup>[29]</sup> Most of the reports regarding improvement in ENI and EXI following pancreatic duct drainage procedure have preponderance of alcoholic pancreatitis, but tropical (idiopathic) pancreatitis is the most common aetiology of CP in the Asian region and natural history of tropical pancreatitis may be different than alcoholic pancreatitis.<sup>[30]</sup>

Limitations of the study were a high conversion rate (28.9%) and small sample size, especially low number of patients with Frey's procedure and PD. The high conversion rate was mainly due to requirement of additional surgical procedure (bilio-enteric bypass) and difficult duct localisation. Palanivelu *et al.* reported zero conversion rate; however, in their study, PD size was 9.8–22 mm and laparoscopic intraoperative ultrasound (LIOUS) was utilised. Tantia *et al.* and Senthilnathan *et al.* also reported conversion rates of 23.5% and 11%, respectively; both the groups have advocated the use of LIOUS.<sup>[10,23,30]</sup> Unfortunately, we do not have LIOUS facility at our centre and availability may reduce conversion rate in the future. Due to logistic reasons, the EXI was not measured quantitatively.

## CONCLUSIONS

The outcomes of laparoscopic surgery in patients with CP were similar to that of open surgery, and requirement of an additional surgical procedure is associated with a high conversion rate.

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## Conflicts of interest

There are no conflicts of interest.

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