



## Cross-sectional Study

## Outcome of Whipple's procedure for Groove pancreatitis: A retrospective cross-sectional study

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## ABSTRACT

**Background:** Groove pancreatitis (GP) is a rare form of chronic pancreatitis primarily affecting the pancreatoduodenal groove. Very few studies have been published from India. The aim of the present study is to report our experience with Whipple's procedure for GP.**Methodology:** In this cross-sectional study, data of all patients who underwent Whipple's procedure for GP between August 2007 and July 2021 were retrospectively reviewed.**Results:** Of the total 504 Whipple's procedures, histopathologically proven GP was identified in 9 patients. All of them were male. Mean age at presentation was  $42.66 \pm 4.35$  years. All of them had history of alcohol abuse. Eight (88.8%) of them had history of smoking. Postprandial abdominal discomfort and pain ( $n = 9$ , 100%) was the most common presenting symptom. Three (33.3%) patients had solid variety and six (66.6%) patients had cystic dystrophy of the duodenal wall. Two (22.2%) patients had mass in the head of the pancreas which was thought to be malignant. None of the patients underwent prior endoscopic management (stenting). Duration of surgery and blood loss was 330 (range, 300–379) minutes, and 250 (range, 200–750) ml respectively. There was no postoperative mortality. Postoperative complications developed in 5 (55.5%) patients. All the complications were managed conservatively. Median postoperative hospital stay was 10 (range, 9–16) days. Over a median follow-up of 41 (range, 12–120) months, complete remission of symptoms was achieved in 7 (78%) patients.**Conclusion:** Whipple's procedure is safe with acceptable perioperative outcomes and good long-term symptom control.

## 1. Introduction

Groove pancreatitis (GP) is a rare form of chronic pancreatitis which involves the pancreatoduodenal groove area bounded by the pancreatic head, common bile duct and C-loop of the duodenum [1]. The entity was first described by Becker in 1973 in German term as Rinnenpankreatitis [2]. The term Groove pancreatitis was coined by Stolte et al., in 1982 [3]. Later on, Becker and Mischke classified GP into pure form and segmental form [1]. In pure form, the disease is limited to the groove zone without involvement of the pancreas. In segmental or diffuse form, both the groove and head of the pancreas are involved with upstream dilatation of the main pancreatic duct. Owing to its rarity, the true incidence of GP is unknown and the reported incidence varies from 2.7%

to 24.5% cases of pancreaticoduodenectomies performed for chronic pancreatitis [2–4]. It is mostly seen in men at their 4th to 5th decade of life. Most of the patients had history of alcohol abuse. Differentiation between GP and pancreatic head malignancy is sometimes difficult on preoperative evaluation. However, with an increasing understanding of the radiological findings, preoperative diagnosis is often possible. Younger age at clinical onset and history of alcohol abuse may suggest the diagnosis of GP. If a definitive diagnosis can be made preoperatively, conservative treatments should be the first line of management. Surgery is warranted where the initial conservative management has failed, or complicated by duodenal obstruction, or there is a suspicion of malignancy. Most commonly performed operation for GP is pancreaticoduodenectomy (PD) with an overall symptom relief that varies

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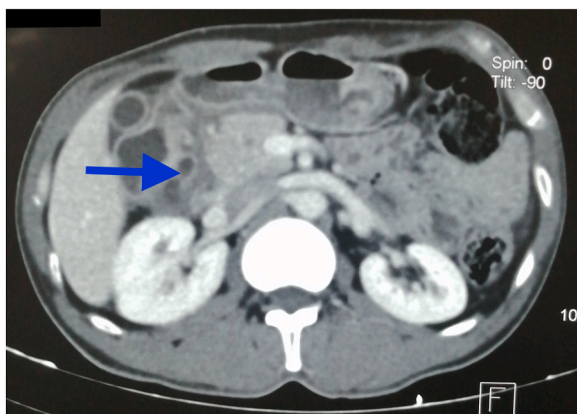
from 76% to 79% of patients [5]. Available data on GP from India is scarce. The aim of the present study is to report our experience with PD for GP.

## 2. Methodology

This is a retrospective cross-sectional study. Data of all patients who had undergone Whipple's procedure (WP) at the Institute of Post-graduate Medical Education and Research, Kolkata, a tertiary care teaching hospital in Eastern India, between August 2007 and July 2021 were retrieved from our prospectively maintained G I Surgery database. All patients who had confirmatory histopathological diagnoses of groove pancreatitis were included in the present study. Demographic details, clinical history, and relevant investigations were collected. Patients who had other histopathological diagnoses (pancreatic adenocarcinoma,  $n = 2$ ; pancreatic neuroendocrine tumor,  $n = 1$ ) in spite of having clinical and radiological features of GP were excluded. This study was approved by the institutional ethics committee (Memo number: IPGME&R/RAC/318, dated- 10/5/2022). Informed patient consent was waived of by the ethics committee as the data was anonymized and retrospective nature of the study. This study is registered at Thai Clinical Trials Registry and was conducted in accordance with the Declaration of Helsinki (TCTR20220510002). The study has been reported in line with the STROCSS criteria [6].

### 2.1. Diagnosis

Preoperative diagnosis of GP was made on the basis of clinical features and identification of characteristic radiological findings. Pancreas protocol CT scan (Fig. 1) was performed in all the patients. Presence of hypodense cystic changes in the thickened duodenal wall, large fiber fibrotic bands in the paraduodenal groove, and loss of fat plane between pancreatic head and duodenum pointed toward the diagnosis of GP. Magnetic resonance imaging (MRI), and Endoscopic ultrasound (EUS) were performed in patients where characteristic radiological features were absent in CECT imaging. Hypointense sheet-like lesions in the groove area, duodenal mural cyst, and thickening of the wall of duodenum on T1-weighted MRI images were appreciated. EUS (Fig. 2) detected stenosis of 2nd part of duodenum with intramural cysts, smooth tapering of common bile duct, and a heterogeneous hypoechoic mass at the pancreatic head with or without dilatation of the main pancreatic duct. Pseudocyst and calcification were also well visualized with EUS. In cases of suspicion of malignancy, a EUS guided fine needle aspiration was done. Final confirmatory diagnoses were obtained from



**Fig. 1.** Contrast enhanced computed tomography showing a hypodense lesion (blue arrow) between the medial aspect of the proximal duodenum and the uncinate process of pancreas with associated inflammatory stranding of the paraduodenal area. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the histopathological evaluation of the surgically resected specimen which showed chronic inflammation with or without cystic dystrophy, hyperplasia of the Brunner's gland, and heterotopy of pancreatic tissue in the duodenum (Fig. 3).

### 2.2. Treatment

Treatment was individualized for each patient and was discussed in a multidisciplinary pancreas board comprising of Gastroenterologists, GI surgeons, GI radiologists and GI pathologists. Initially, conservative management was advocated.

### 2.3. Surgical technique

We performed the WP by a bilateral subcostal incision. Self-retaining Thompson retractor was routinely used. All patients underwent a standard Whipple pancreaticoduodenectomy. Intraoperative bile culture was obtained in all the patients. We routinely use falciform ligament flap to protect the gastroduodenal artery (GDA) stump from post-operative pseudoaneurysm formation. In cases of carcinoma, we routinely performed standard lymphadenectomy and removal of soft tissue to the right side of the first 3–4 cm of the superior mesenteric artery. GDA stump was routinely transfixed with 4-0- polypropylene sutures. After removal of the specimen, hemostasis was achieved meticulously. Bleeding from the pancreatic stump was controlled with 5-0- polypropylene sutures. Reconstruction was done with end-to-side pancreaticojejunostomy with 4-0- polypropylene sutures, hepaticojejunostomy with 4-0- vicryl, and gastrojejunostomy on the same jejunal loop at approximately 50 cm distal to the hepaticojejunostomy site. We then brought the falciform ligament flap to the operative field and wrap it around the exposed hepatic artery and GDA stump. This procedure allowed complete separation of these vessels from the pancreatic stump. Closed system suction drains (Jackson-Pratt drains) were placed adjacent to pancreaticojejunostomy and hepaticojejunostomy. The final position of the flap was checked before the closure of the abdomen. Feeding jejunostomy was performed in all the patients for post-operative alimentation. Prophylactic octreotide was not routinely used. All patients received cefoperazone/sulbactam-based antibiotics for about 5 postoperative days.

### 2.4. Definitions

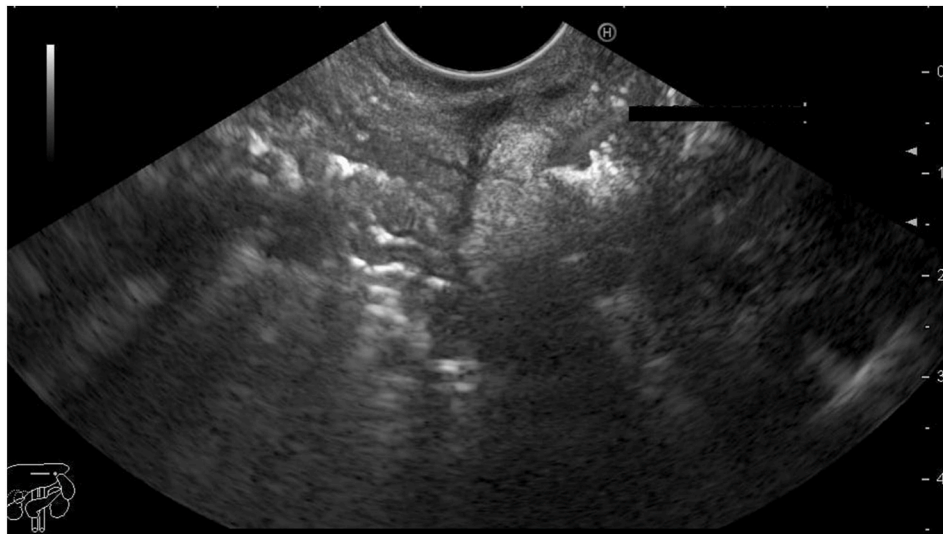
Death during the hospital stay, or within 90 days after intervention was the definition of perioperative mortality utilized. Postoperative complications were graded using the Clavien-Dindo classification [7]. Pancreatic fistulae, post pancreatectomy hemorrhage, and delayed gastric emptying were defined and classified according to the criteria of International Study Group on Pancreatic Surgery (ISGPS) guidelines [8–10]. Diabetes mellitus (DM) was defined in fasting blood sugar was more than 126 mg/dL and serum glycosylated hemoglobin A1c (HbA1c) was more than 6.5%.

### 2.5. Statistical analysis

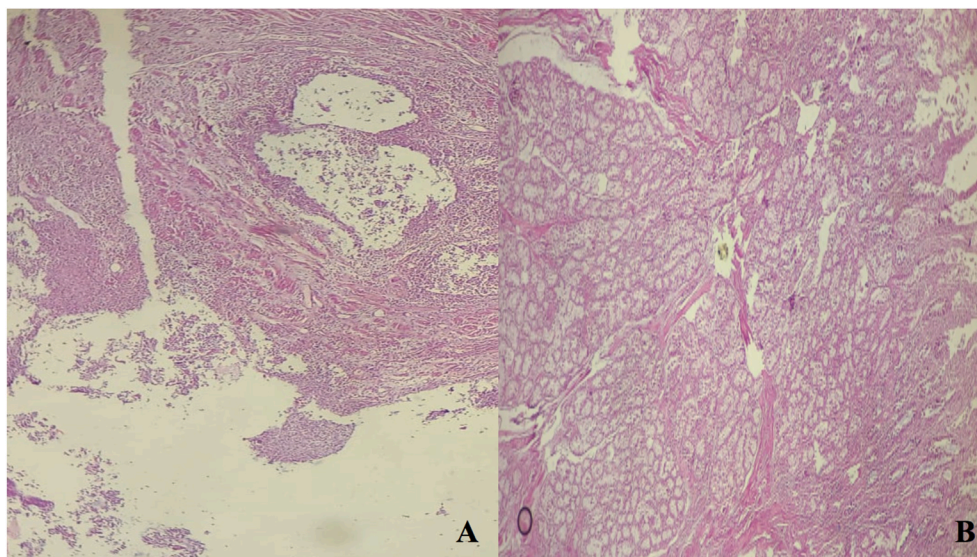
Quantitative variables were expressed as mean  $\pm$  standard deviation or median with range. Dichotomous variables were expressed as a percentage. All statistical analysis was done with SPSS version 22 (Chicago Inc.).

## 3. Results

During the study period, 504 patients underwent WP. The preoperative evaluation was suggestive of a GP in 11 patients. Three patients were excluded from these 11 patients based on histopathological reports. Histopathological examination of these 3 patients showed adenocarcinoma ( $n = 2$ ) and neuroendocrine tumor ( $n = 1$ ). One patient with a preoperative suspicion of pancreatic head malignancy showed



**Fig. 2.** Endoscopic ultrasound showing hypoechoic pancreatic parenchyma with multiple hyperechoic foci, and strands suggestive of groove pancreatitis.



**Fig. 3.** H&E image showing A: cystic dystrophy of the duodenal wall, B: Brunner's gland hyperplasia.

features of GP on histopathological examination. Thus, our study population comprises 9 patients with histopathologically proven groove pancreatitis (9/504, 1.78%). Demographic details, comorbidities, peri-operative and follow-up data are presented in [Table 1](#). All 9 (100%) patients were male. Mean age at presentation was  $42.66 \pm 4.35$  years. Mean body mass index was  $19.5 \pm 2.6$  kg/m<sup>2</sup>. All (100%) of them had history of alcohol abuse. Eight (88.8%) patients had history of smoking. Co-morbidities were identified in 4 patients. Two (22.2%) patients had pre-existing diabetes mellitus. No patient had symptoms of exocrine pancreatic insufficiency preoperatively.

Postprandial abdominal discomfort and pain (n = 9, 100%) was the most common presenting symptom followed by vomiting (n = 5, 55.5%), weight loss (n = 4, 44.4%), and jaundice (n = 1, 11.1%). One (11.1%) patient had a history of recurrent acute pancreatitis. The median duration of symptoms before WP was 24 (range, 3–60) months.

CT scan abdomen was performed in all patients. CT findings suggestive of GP were found in 7 (77.7%) patients. Endoscopic ultrasound (EUS) and Magnetic resonance imaging (MRI) were performed in 7 (77.7%) and 2 (22.2%) patients respectively. Three (33.3%) patients had solid variety of lesions with an edematous wall of the duodenum. Six

(66.6%) patients had cystic dystrophy of the duodenal wall. Two (22.2%) patients had mass of the head of the pancreas which was thought to be malignant. The main pancreatic duct was dilated in 5 (55.5%) patients. Calcification of the pancreatic parenchyma was picked up in 2 (22.2%) patients. Left-sided portal hypertension was present in one (11.1%) patient. EUS guided fine needle aspiration biopsy was performed for two (22.2%) patients who had suspicion of malignancy. One of them had cytological features of GP. None of the patients underwent prior endoscopic management (stenting).

Eight patients (89%) had grade II American Society of Anesthesiologists (ASA) physical status classification. Mean preoperative hemoglobin, albumin, and bilirubin level were  $11.73 \pm 1.20$  g/dL,  $3.87 \pm 0.36$  g/dL, and  $0.63 \pm 0.12$  mg/dL respectively. All (100%) of the patients underwent open pancreatoduodenectomy (PD). The main indication for surgery was abdominal pain in 6 patients, pain with duodenal obstruction in 2 patients, and suspicion of malignancy in one patient. Intraoperatively, firm pancreas was identified in 6 (66.6%) patients and soft in 3 (33.3%) patients. Vascular anomaly was identified in 2 (22.2%) patients. One of them had an accessory right hepatic artery arising from the superior mesenteric artery and the other patient had both his right



**Table 1**  
Patient characteristics and post-pancreatoduodenectomy outcome.

Patient	Gender	Age (years)	BMI (kg/m <sup>2</sup> )	ETOH	Smoking	HTN	DM	Presentation	Duration of symptoms (months)	ASA	Operative time (min)	EBL (mL)	LOS (days)	Complication	Follow-up (months)	Symptom relief
1	Male	47	20.1	+	+	-	-	1,2,3	12	III	300	750	16	SSI	120	Complete
2	Male	46	24.2	+	+	-	-	1,3	3	II	330	250	10	-	110	Complete
3	Male	39	21.4	+	+	-	-	1,2,3	36	II	330	200	9	-	96	Partial
4	Male	44	17.8	+	+	-	-	1,2	60	II	326	200	12	-	52	Complete
5	Male	40	20.2	+	-	-	-	1	36	II	315	300	16	Chyle leak	41	Complete
6	Male	35	20.3	+	+	-	+	1,2	24	II	300	300	9	-	40	Complete
7	Male	42	14.8	+	+	-	-	1,2	12	II	369	400	10	DGE-B	27	Complete
8	Male	42	17.9	+	+	-	-	1,3	48	II	379	250	10	POPF-B	29	Complete
9	Male	49	19.68	+	+	+	+	1,4	6	II	344	250	10	POPF-A	12	Partial

BMI: Body mass index in kg/m<sup>2</sup>, ETOH: alcohol abuse, HTN: hypertension, DM: Diabetes mellitus, ASA: American society of anesthesiologists physical status classification, EBL: estimated blood loss, LOS: length of stay, +: present, -: absent, Presentation: 1: abdominal pain, 2: vomiting, 3: weight loss, 4: jaundice, SSI: surgical site infection, DGE: delayed gastric emptying, POPF: postoperative pancreatic fistula.

and left hepatic artery arising from the abdominal aorta. Bile sample was collected in all the patients and 2 (22.2%) of them were reported to have bactobilia. Median operative time was 330 (range, 300–379) minutes. Median operative blood loss was 250 (range, 200–750) ml. Two (22.2%) patients required perioperative blood transfusion. Five post-operative complications (Clavien Dindo grade I in 3, grade II in 2 patients) developed in 5 (55.5%) patients. Postoperative pancreatic fistula (Type A = 1, 11.1%; Type B = 1, 11.1%) was the most common complication identified in 2 (22.2%) patients. One (11.1%) patient developed type B delayed gastric emptying, one (11.1%) patient developed chyle leak, and one (11.1%) patient developed surgical site infections. There was no operative mortality. Brunner’s gland hyperplasia (n = 8, 88.8%) was the most common histopathological finding, followed by cystic dystrophy of the duodenal wall (n = 6, 66%), and heterotopic pancreatic tissue in the duodenum (n = 4, 44.4%). Median postoperative hospital stay was 10 (range, 9–16) days.

Median postoperative follow-up was 41 (range, 12–120) months. Complete remission of symptoms was achieved in all the patients in the initial 6 months after operation. Pain recurred in 2 patients at 9 months and 48 months respectively. Both of them had continued alcohol consumption after the operation. So, 7 patients (78%) had complete pain relief at the last follow-up. Weight gain was achieved in 7 patients (78%). One patient developed incisional hernia requiring prolene mesh repair. One (11.1%) patient developed exocrine pancreatic insufficiency and was advised life-long pancreatic enzyme supplementation. Two patients (22%) developed new-onset diabetes mellitus after surgery. One patient with recurrence of pain required 3 episodes of pancreatitis-related hospitalization over the last 2 years. The other patient with incomplete pain control has to take analgesic medication (Tramadol hydrochloride) intermittently.

#### 4. Discussion

This retrospective study showed that pancreaticoduodenectomy is a safe and effective procedure with acceptable short-term surgical outcomes and good long-term symptom control. Preoperative clinical evaluation can diagnose GP in about 72% (8/11) of patients. GP is seen most commonly in men in the 4th or 5th decade of life. The exact pathogenesis of GP remains unclear. It is thought to be resulting from primary or secondary obstructive mechanisms [2]. Alcohol and smoking are considered as the most common associated risk factors which cause alteration of pancreatic secretion through the duct of Santorini [2,11]. When this flow is hampered, the pancreatic juice is diverted through the Wirsung’s duct, which forms an acute angle, and causes accumulation of the secretion in the head of pancreas [12]. The overall intraductal hypertension in the duct of Santorini facilitates the leakage of pancreatic juice into the paraduodenal groove which in turn causes GP [13,14]. Similarly, in our study all 9 patients had history of chronic alcohol consumption and 8 patients were chronic smokers. Other causative factors may be Brunner’s gland hyperplasia, ectopic pancreas, and duodenal bud [15]. Moreover, fibrous scarring secondary to biliary disease, gastroduodenal ulcer, or gastrectomy may be associated with the pathogenesis of GP [16].

Usual symptoms are similar to that of chronic pancreatitis and include nausea, early satiety, postprandial abdominal pain, vomiting, and weight loss [2,17,18]. Abdominal pain is the most common symptom [19]. Abdominal pain was a major complaint for all 9 patients in our study. Some patients may present with recurrent episodes of acute pancreatitis. Pain and pancreatitis are due to inflammation and pancreatic ductal obstruction. Whereas, vomiting and jaundice are likely due to ingrowth of the intraduodenal inflammatory pancreatic tissue [20]. Although rare, jaundice is seen if there is stenosis of the common bile duct [21]. Unlike pancreatic adenocarcinoma which has painless progressive jaundice, in case of GP jaundice is usually fluctuating. The symptoms last for few months to more than a year before a clinical diagnosis is made. In our study, it varied from 3 to 60 months.

Clinical course of the disease is often debilitating and sometimes it is associated with features of pancreatic exocrine and endocrine insufficiency [22]. Biochemical investigations may show normal to slightly elevated pancreatic enzymes. Liver enzymes and tumor markers are rarely elevated [23].

Preoperative diagnosis of GP is often a challenge. The main differential diagnosis is pancreatic adenocarcinoma, autoimmune pancreatitis, and neuroendocrine tumor of the pancreas [2,24–26]. Moreover, there is evidence of pancreatic adenocarcinoma arising from GP [27]. Similarly in our study, preoperative diagnosis was correct in 72% (8/11) of patients where there was a suspicion of GP. On the other hand, GP was found on histopathological examination in one patient who had a preoperative diagnosis of pancreatic head malignancy.

Involvement of the pancreatoduodenal groove is the hallmark of all forms of GP. The pure form is less frequent compared to the segmental form (18.3% vs 81.7%) [28]. On contrast-enhanced computed tomography, GP appears as a sheet of hypodense mass in the groove area, and on T1 weighted magnetic resonance imaging (MRI) it appears hypointense. T2 weighted MRI is used to demonstrate intraduodenal wall cyst. Cystic dystrophy and stenosis of the duodenum are best picked up by endoscopic ultrasound (EUS). Additionally, in the segmental form of GP, dilatation of the pancreatic duct and upstream dilatation of the common bile duct due to smooth stenosis at the distal end can also be visualized in EUS. EUS-guided fine needle aspiration (FNA) biopsy offers the benefit of preoperative pathological diagnosis. This is even more important where malignancy is suspected or characteristic radiological features of GP are lacking. The only drawback is that results may vary depending on the area of sampling. In the presence of Brunner's gland hyperplasia, multiple giant cells, GP is considered. Many times, the sampling is done from areas of dense fibrosis. This finding can be deceptive as desmoplastic reaction is a common finding in case of pancreatic adenocarcinoma.

There is two therapeutic options for patients with GP: (1) Conservative medical or endoscopic management and (2) surgical intervention. Conservative treatments include abstinence from alcohol and smoking, pancreatic rest, and analgesics. Isayama et al. [14] and Casetti et al. [29] had reported endoscopic stenting of minor papilla for the treatment of GP. In both the series, definitive surgical intervention was required in the long run. Contrary to these, Arvanitakis et al. had shown a stepwise approach in the management of GP is feasible and effective, where 80% of the patients achieved complete clinical response [30]. A recent retrospective population-based study [31] showed that conservative treatment was successful in nearly half of their patients. With a better understanding of the disease, clinical course, more confident preoperative diagnosis and a reasonable success rate of medical and endoscopic management make conservative treatments as the first-line option. Surgery is indicated for failure of conservative treatment to control abdominal pain, presence of duodenal obstruction, and where there is a suspicion of malignancy. Different surgical procedures have been described for GP which include gastrojejunostomy, pancreaticoduodenectomy (PD), pancreas-preserving duodenectomy, and duodenum-preserving pancreatic head resection [32]. Nevertheless, a duodenum-preserving pancreatic head resection and gastrojejunostomy seem to be inefficient in patients with GP, which is probably explained by incomplete resection of groove area. Pancreaticoduodenectomy is the most commonly performed surgery. Casetti et al. [29] in their study had shown that 76% of the patients achieved complete pain relief following surgery. De Pretis et al. [28] reported that after a mean 6.6 years of follow-up, lesser number of patients who underwent surgery, developed recurrence of abdominal pain compared to the ones who underwent conservative therapy (19% vs 59%). In the present study, 78% of patients achieved complete pain control. Although PD results in complete relief of symptoms in majority of the patients (>75%), it has considerable morbidity (35%–60%) and mortality (1%–5%). Although there was no postoperative mortality, 55% of our patients developed postoperative complications.

The study has some strengths and limitations. The strength is that it is one of the largest single institution surgical case series with no perioperative mortality and good short-term and long-term outcome. To the best of our knowledge, this is the only study reported from India. The drawbacks are: 1) it is a retrospective study spanned over a period of 14 years; 2) it is purely a surgical series: no comparison was made between surgery and other modalities of management; 3) all patients underwent PD: no comparison could be made between other forms of surgery. Our experience only showed that PD can be performed with acceptable perioperative morbidity and mortality. Future studies, preferably multicenter studies with different modalities of management are warranted to assess the superiority of one modality over others.

## 5. Conclusion

It is difficult to differentiate GP from pancreatic head malignancy preoperatively in a substantial proportion of patients. However, with increased availability and understanding of radiological investigations, it is often possible. In the experienced hand, Whipple's procedure can be performed with acceptable perioperative morbidity and mortality and long-term good results.

## Ethical approval

This study was approved by the institutional ethics committee of Institute of Postgraduate Medical Education and Research, Kolkata (Memo number: IPGME&R/RAC/318, dated- 10/5/2022).

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Nil.

## Author contribution

A.D. and S.R. wrote the main manuscript. D.M., R.G., and G.K.D. performed the data collection and review of the literature. All the authors have gone through the final version of the manuscript.

## Consent

Not applicable.

## Registration of research studies

This study is registered at Thai Clinical Trials Registry and was conducted in accordance with the Declaration of Helsinki (TCTR20220510002). <https://www.thaiclinicaltrials.org/show/TCTR20220510002>.

## Guarantor

Dr. Sukanta Ray acts as guarantor for the article.

## Provenance and peer review

Not commissioned, externally peer-reviewed.

## Declaration of competing interest

Nil.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2022.104008>.

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