Diabetes Status After Lateral Pancreaticojejunostomy and Frey’s Procedure in Chronic Calcific Pancreatitis: An Observational Study

Ashok Kumar Sahoo 1,2, Narendranath Swain 1, Arun Kumar Mohanty 1, Sibabrata Kar 3, Nagendra Kumar Rajasamant 1, Santosh Kumar Behera 1

1. Surgery, S.C.B. Medical College & Hospital, Cuttack, IND 2. Surgery, Jawaharlal Institute of Postgraduate Medical Education & Research, Puducherry, IND 3. General Surgery, S.C.B. Medical College & Hospital, Cuttack, IND

Corresponding author: Sibabrata Kar, drshk75@yahoo.com

Abstract

Introduction

Diabetes secondary to pancreatic diseases is commonly referred to as pancreatogenic diabetes or type 3c diabetes mellitus. This study was conducted to determine the status of diabetes mellitus after Frey’s procedure and lateral pancreaticojejunostomy (LPJ) in diabetic and nondiabetic patients with chronic calcific pancreatitis (CCP) and to discuss the clinicopathological course as well as diabetes in CCP.

Materials and methods

This study was designed as a retrospective observational study consisting of 27 patients with CCP who were surgically treated either with the pancreatic head coring Frey’s procedure or with LPJ. Surgeries were performed in a tertiary care hospital of Eastern India by a team of surgeons following the same surgical principle. The diagnosis of CCP was made by clinical and radiological evaluations. Visual Analog Scale (VAS) scoring was used peroperatively to assess pain. Postoperatively, all the patients were monitored clinically; pain scoring and relevant investigations were done depending upon subjective and objective indications. Special attention was paid to diabetic patients through frequent follow-ups and tight glycemic control. All 27 patients were followed up with at least two outpatient follow-ups.

Results

The trends in fasting blood sugar values in the LPJ group showed a small spike in the early postoperative period (two weeks) with a p-value of >0.05, and later on, it improved over 18 months of follow-up, reaching below the preoperative values (mean 109.38). On the contrary, the fasting blood glucose levels in Frey’s procedure revealed a significant spike in the early postoperative period (two weeks) with a mean sugar value of 148 mg/dl and a p-value of 0.01. The levels stayed well above the preoperative values over 18 months of follow-up. The trends in HbA1c showed marginal improvement in the LPJ group in a six-month follow-up period (p-value 0.008) from the preoperative levels. In Frey’s procedure group, postoperative HbA1c levels at three months revealed an increase, which can be attributed to the minor but significant loss of pancreatic tissue from the head, which continued to be on the higher side at the six-month follow-up. Trends in mean insulin dosage showed a significant spike in the early postoperative period (two weeks) both in the LPJ (p-value 0.01) and Frey’s procedure group (0.01); however, in the LPJ group, the insulin dose showed a reduction over the 18-month follow-up, reaching below the mean preoperative insulin dose. While in the Frey’s procedure group, the postoperative insulin dose remained higher throughout the 18-month follow-up period (p-value <0.05).

Conclusions

LPJ has got a little effect on the diabetic status of nondiabetic patients. Frey’s procedure leads to marginal deterioration of the diabetic status and increases in insulin dosage in both diabetic and nondiabetic patients.

Introduction

Chronic calcific pancreatitis (CCP) is a common condition encountered in the eastern parts of India. It is a disease characterized by pancreatic inflammation and fibrotic injury, resulting in irreversible parenchymal damage. Diabetes secondary to pancreatic diseases is commonly referred to as pancreatogenic diabetes or type 3c diabetes mellitus [1]. It is a clinically relevant condition with a prevalence of 5-10% among all diabetic subjects in the Western population. In nearly 80% of all type 3c diabetes mellitus cases, CCP seems...
to be the underlying disease [2].

The causes of diabetes in CCP are multifactorial and include atrophy of the pancreas, beta-cell destruction, exocrine insufficiency, and role of incretin [3]. Surgical management for pancreatitis is reserved for patients with complications of CCP or suspected underlying carcinoma. The choice of surgery for CCP is decided based on anatomical variants of the disease, which are distinguished by the size of the main pancreatic duct [4].

In CCP, the most common surgical procedure done is drainage. Recently it has been found that the incidence of carcinoma in CCP is about 15-40% [5]. This suspicion of malignancy may require resection procedures and most of the patients with symptoms are diabetic at the time of surgery and are on insulin for the control of diabetes mellitus.

During Whipple’s or pylorus-preserving pancreaticoduodenectomy, the head of the pancreas is removed. Pancreatic tissue provides insulin, which is required for blood sugar control. When pancreatic tissue is removed, the body releases less insulin, and the risk of developing diabetes mellitus is high. Patients who are diabetic at the time of surgery or who have had an abnormal blood sugar level that was controlled on diet or insulin prior to surgery have a higher chance of diabetes getting worse after surgery [6].

Head resection removes about 40% of the pancreas. Whether this resection leads to diabetes or worsening of diabetes is controversial. There are reports from various parts of the world that resection worsens diabetic status. However, these studies were based on CCP patients [7].

Many patients with CCP manifest some degree of fat malabsorption, regardless of the presence of symptoms [8]. In patients with type 3c diabetes mellitus, exocrine pancreatic insufficiency is ubiquitously present. The incretin system may play a crucial role in the metabolic control of type 3c diabetes mellitus. The regulation of the beta-cell mass and the physiological incretin secretion are directly dependent on normal exocrine pancreatic function and fat hydrolysis. Drainage procedures improve the exocrine function and may favor the betterment of diabetic status and insulin use [9].

However, so far, there have been no reported studies in CCP in the tropics to prove whether there is a deterioration of diabetes following resection/drainage procedure. Hence, this study was conducted to determine the status of diabetes mellitus after Frey’s procedure and lateral pancreaticojejunostomy (LPJ) in diabetic and non-diabetic patients with CCP and to discuss the clinicopathological course of CCP and management of diabetes in CCP.

**Materials And Methods**

This study was designed as a retrospective observational study consisting of 27 patients of CCP who were surgically treated either with the pancreatic head coring Frey’s procedure or with LPJ from July 2014 to December 2016. The surgeries were performed in a tertiary care hospital of Eastern India by a team of surgeons following the same surgical principle. The diagnosis of CCP was made by clinical and radiological evaluations, which include a plain x-ray of the abdomen, ultrasound scan (USG), computed tomography scan (CT scan), and magnetic resonance cholangiopancreatogram (MRCP). Various radiological investigations were used to determine the pancreatolithiasis, main pancreatic duct (MPD) contour, any alteration in the parenchymal architecture like fibrosis, atrophy, and mass lesions. Visual Analog Scale (VAS) scoring was used perioperatively to assess pain [10]. The score was reported on the scale of ‘no pain’ to ‘mild to moderate pain’ to ‘intolerable or worst pain’. The patients who were excluded from the study were those who had undergone endoscopic retrograde cholangiopancreatography (ERCP) or those requiring Whipple’s or lateral pancreaticojejunostomy or Beger’s procedure.

**Surgical techniques**

The indications of surgery were unbearable pain due to pancreatolithiasis, dilated MPD, suspicion of malignancy, failure of medical treatment, or any associated complications. The surgery aimed to remove all ductal stones, strictures, and the diseased segment of the pancreas, followed by a wide pancreaticojejunal anastomosis. The patients undergoing Frey’s procedure had to undergo opening of the MPD, removal of all calculi, andenucleation of the diseased pancreatic head in contiguity with a strictured segment of the duct of Wirsung. A rim of the pancreatic head closed to the duodenum was spared along with posterior parenchyma, with or without excising both ducts of Wirsung and Santorini. This technical modification spares the pancreatic neck and preserves the posterior capsule of the pancreatic head along with the body and tail. In both original and modified Frey’s procedures, the depths of pancreatic tissue that was cored were different. Second-generation ducts stones were also removed. Roux-en-Y longitudinal/lateral pancreaticojejunostomy ensured wide pancreatic drainage. The tissues were histopathologically studied to exclude malignancy.

**Postoperative care**

All the patients were monitored clinically and through pain scoring and relevant investigations depending
upon subjective and objective indications. All the patients were started on oral feeding between the fifth and seventh postoperative days and were discharged between the 10th and 23rd days. Special attention was paid to diabetic patients through frequent follow-ups and tight glycemic control.

**Follow-up**

All 27 patients were followed up till July 2017 with at least two outpatient follow-ups. All patients gave written informed consent for surgical treatment according to the institutional guidelines. Long-term follow-up was obtained by: a telephonic interview with the patient, a written questionnaire that was sent to the patient. In cases of rehospitalization, medical records were obtained and reviewed. Most patients needed a proton pump inhibitor or H2 receptor blocker, a pancreatic enzyme supplement. Variables examined were fasting blood sugar (FBS), postprandial blood sugar (PPBS), HbA1c and dose of insulin, the occurrence of diabetes, and the date of initiation of insulin treatment.

**Statistical analysis**

Data analysis was done with IBM SPSS Statistics for Windows, Version 20.0 (Released 2011. IBM Corp., Armonk, New York). Chi-square test and paired two-tailed t-test were used for data analysis. A p-value of <0.05 was considered statistically significant.

**Results**

Out of a total of 27 patients, 13 patients had undergone Frey’s procedure, and the remaining 14 patients went through LPJ. The demographic characteristics of the patients are given in Table 1.

| Qualitative Variables                  | LPJ Group (14)(%) | Frey’s Group (13)(%) | P-value |
|----------------------------------------|------------------|----------------------|---------|
| Sex                                    |                  |                      |         |
| Male                                   | 9(64.3)          | 8(61.5)              | 0.883   |
| Female                                 | 5(35.7)          | 5(38.5)              |         |
| Socioeconomic status                   |                  |                      |         |
| Low                                    | 11(78.6)         | 8(61.5)              |         |
| Medium                                 | 3(21.4)          | 5(38.5)              | 0.333   |
| High                                   | 0                | 0                    |         |
| Alcoholism                             |                  |                      |         |
| Yes                                    | 7(50)            | 4(30.8)              | 0.310   |
| No                                     | 7(50)            | 9(69.2)              |         |
| Smoking                                |                  |                      |         |
| Yes                                    | 4(28.6)          | 6(46.2)              | 0.345   |
| No                                     | 10(71.4)         | 7(53.8)              |         |
| Hyperlipidemia                         |                  |                      |         |
| Yes                                    | 4(28.6)          | 8(61.5)              | 0.085   |
| No                                     | 10(71.4)         | 5(38.5)              |         |
| Recurrent acute pancreatitis           |                  |                      |         |
| Yes                                    | 10(71.4)         | 10(76.9)             | 0.745   |
| No                                     | 4(28.6)          | 3(23.1)              |         |
| Cambridge score                        |                  |                      |         |
| Moderate                               | 11(78.6)         | 9(69.2)              | 0.580   |
| Severe                                 | 3(21.4)          | 4(30.8)              |         |
| Preoperative Oral Hypoglycemic Agents use |                  |                      |         |
| Yes                                    | 1(7.1)           | 1(7.7)               | 0.957   |
| No                                     | 13(92.9)         | 12(92.3)             |         |
| Postoperative Oral Hypoglycemic Agents dosage change |                  |                      |         |
| Yes                                    | 1(7.1)           | 2(15.4)              | 0.496   |
| No                                     | 13(92.9)         | 11(84.6)             |         |

**TABLE 1: Demographic Characteristics**

LPJ: lateral pancreatojejunostomy
Among the 14 LPJ patients, nine were males and five were females. The Frey’s group comprised eight males and five females. Both groups were comparable regarding sex, with a p-value of 0.883. In total, 11 out of 14 patients belonged to a low socioeconomic background in the LPJ group, while eight out of 13 in the Frey’s procedure group were in the low-income group. Also, three out of 14 in LPJ and five out of 13 in the Frey’s procedure group belonged to the middle-income group. Both groups were comparable as there was no statistical difference in socioeconomic status (p-value 0.333). Alcohol addiction was among 50% and 30% of patients in the LPJ group and the Frey’s procedure group, respectively. Among the LPJ group and the Frey’s procedure group, 72% and 77% had a history of recurrent acute pancreatitis, respectively. Severity was assessed using the Cambridge severity score; 79% of patients in the LPJ group were categorized as moderate and 21% as severe. In the Frey’s procedure group, 69% were classified as moderate and 30.8% as severe. The baseline characteristics of both groups are depicted in Table 2.

| Quantitative Variables | LPJ Group | Frey’s Group | T-Value | P-value |
|------------------------|-----------|--------------|---------|---------|
| Weight                 | Mean 58.5 | 60.77        | 0.577   | 0.569   |
|                        | SD 9.558  | 10.872       |         |         |
| BMI                    | Mean 22.60| 23.2         | 0.794   | 0.434   |
|                        | SD 3.79   | 3.25         |         |         |
| Serum amylase          | Mean 40.43| 61.23        | 1.728   | 0.096   |
|                        | SD 27.046 | 35.235       |         |         |
| Serum lipase           | Mean 40.14| 59.46        | 1.322   | 0.198   |
|                        | SD 41.757 | 33.293       |         |         |
| Preop FBS              | Mean 125.93| 122.46      | 0.188   | 0.853   |
|                        | SD 51.53 | 43.714       |         |         |
| Preop HbA1c            | Mean 6.829 | 6.623       | 0.445   | 0.660   |
|                        | SD 1.1384 | 1.2597       |         |         |
| Preop insulin          | Mean 15.79 | 10          | 1.084   | 0.288   |
|                        | SD 15.423 | 11.916       |         |         |
| FBS 2 weeks            | Mean 131.14| 148         | 1.166   | 0.255   |
|                        | SD 37.554 | 11.916       |         |         |
| FBS 3 months           | Mean 123.14| 135.62      | 1.248   | 0.224   |
|                        | SD 24.507 | 27.421       |         |         |
| FBS 6 months           | Mean 114.23| 134.77      | 1.892   | 0.071   |
|                        | SD 22.5  | 32.037       |         |         |
| FBS 12 months          | Mean 110.77| 132.38      | 2.318   | 0.029   |
|                        | SD 25.2  | 22.262       |         |         |
| FBS 18 months          | Mean 109.38| 126.31      | 1.726   | 0.97    |
|                        | SD 25.695| 24.274       |         |         |
| HbA1c 3 months         | Mean 6.871 | 6.908       | 0.100   | 0.921   |
|                        | SD 0.8905 | 0.9987       |         |         |
| HbA1c 6 months         | Mean 6.631 | 6.946       | 0.976   | 0.338   |
|                        | SD 0.7941 | 0.8491       |         |         |
| Postop insulin 3 months| Mean 20.371| 16          | 0.799   | 0.432   |
|                        | SD 15.6520| 12.4633      |         |         |
| Postop insulin 6 months| Mean 16   | 16.77        | 0.123   | 0.903   |
The mean weight in the LPJ group was 58.5 kg with a standard deviation (SD) of 9.558, while in the Frey’s procedure group, it was 60.77 kg, with an SD of 10.87. The mean BMI was 22.6 and 23.2 in the LPJ and Frey’s procedure groups, respectively. The mean preoperative fasting blood sugar (FBS) in the LPJ group was 125.93 mg/dl, with 10 out of 14 being diabetic on insulin or oral hypoglycaemic agents (OHA). The mean preoperative FBS in the Frey’s procedure group was 122.46 mg/dl, with seven out of 13 being known as diabetic. The mean preoperative insulin dose in the LPJ group was 15.79 units and 10 units were the mean preoperative insulin dose in the Frey’s procedure group. The trends in FBS values in the LPJ group showed a small spike in the early postoperative period (two weeks) with a p-value of >0.05, and later on, it improved over 18 months of follow-up, reaching below the preoperative values (mean 109.38) (Table 3). It may be attributed to the reduction in ductal hypertension and the role of incretin. On the contrary, the FBS levels in the Frey’s procedure group revealed a significant spike in the early postoperative period (two weeks), with a mean sugar value of 148 mg/dl and a p-value of 0.01 (Table 4).

| Pair | Preop FBS | Postop FBS 2 weeks | T-Value | P-Value |
|------|-----------|--------------------|---------|---------|
| 1    | 125.93    | 131.14             | 0.845   | 0.413   |
| 2    | 125.93    | 123.14             | 0.287   | 0.779   |
| 3    | 129.15    | 114.23             | 1.370   | 0.196   |
| 4    | 129.15    | 110.77             | 1.537   | 0.150   |
| 5    | 129.15    | 109.38             | 1.689   | 0.117   |

**TABLE 3: Paired T-Test of Mean Pre- and Postoperative FBS for the LPJ Group**

FBS: fasting blood sugar; LPJ: lateral pancreatojejunostomy; Preop: preoperative; Postop: postoperative
TABLE 4: Paired T-Test of Mean Pre- and Postoperative FBS for Frey's Procedure Group

FBS: fasting blood sugar; Preop: preoperative; Postop: postoperative

| Pair  | Preop FBS | T-Value | P-Value |
|-------|-----------|---------|---------|
| 1     | 122.46    | 4.219   | 0.01    |
| 2     | 122.46    | 1.689   | 0.117   |
| 3     | 122.46    | 1.370   | 0.196   |
| 4     | 122.46    | 1.097   | 0.294   |
| 5     | 126.31    | 0.393   | 0.698   |

The levels stayed well above the preoperative values over 18 months of follow-up. A trend of regaining the endocrine function was found but not going below the preoperative levels over 18 months and needed a longer duration of follow-up, which was beyond the scope of this study. The trends in HbA1c showed marginal improvement in the LPJ group over a six-month follow-up period (p-value 0.008) from the preoperative levels (Table 5).

TABLE 5: Paired T-Test for Pre- and Postoperative HbA1c for the LPJ Group

LPJ: lateral pancreateojejunostomy; Preop: preoperative; Postop: postoperative

| Pair  | HbA1c  | T-Value | P-Value |
|-------|--------|---------|---------|
| 1     | 6.829  | 0.346   | 0.735   |
| 2     | 7.008  | 3.172   | 0.008   |

It needed further follow-up as data at 12 and 18 months were not uniformly available and hence not statistically analyzed. This may be attributed to the improved drainage, reduction in ductal hypertension, and possible incretin interplay. In Frey's procedure group, postoperative HbA1c levels at three months revealed an increase, which can be attributed to the minor but significant loss of pancreatic tissue from the head, which continued to be on the higher side at the six-month follow-up (Table 6). Statistical significance cannot be established for this as the p-value was >0.05. Trends in mean insulin dosage showed a significant spike in the early postoperative period (two weeks) both in the LPJ (p-value 0.01) and Frey's procedure group (0.01) (Tables 7-8). However, in the LPJ group, the insulin dose showed a reduction over the 18 months of follow-up, reaching below the mean preop insulin dose. While in the Frey's procedure group, the postoperative insulin dose remained higher throughout the 18-month follow-up period (p-value <0.05).
**Table 6: Paired T-Test for Pre- and Postoperative HbA1c for the Frey’s Procedure Group**

Preop: preoperative; Postop: postoperative

| Pair  | Preop HbA1c | Postop HbA1c 3 months | T-Value | P-Value |
|-------|-------------|------------------------|---------|---------|
| 1     | 6.623       | 6.908                  | 2.047   | 0.063   |
| 2     | 6.623       | 6.946                  | 1.376   | 0.194   |

**Table 7: Paired T-Test for Pre- and Postoperative Insulin Dose in the LPJ Group**

LPJ: lateral pancreatojejunostomy; Preop: preoperative; Postop: postoperative

| Pair  | Preop insulin dose | Postop insulin dose 3 months | T-Value | P-Value |
|-------|--------------------|-------------------------------|---------|---------|
| 1     | 15.79              | 20.371                        | 4.196   | 0.01    |
| 2     | 16.46*             | 19.23                         | 1.720   | 0.111   |
| 3     | 16.46*             | 17.23                         | 2.941   | 0.660   |
| 4     | 16.46*             | 15.08                         | 5.122   | 0.435   |

**Table 8: Paired T-Test for Pre- and Postoperative Insulin Dose in the Frey’s Procedure Group**

LPJ: lateral pancreatojejunostomy; Preop: preoperative; Postop: postoperative

| Pair  | Preop insulin dose | Postop insulin dose 3 months | T-Value | P-Value |
|-------|--------------------|-------------------------------|---------|---------|
| 1     | 10                 | 16                            | 4.544   | 0.01    |
| 2     | 10                 | 16.77                         | 4.879   | 0.001   |
| 3     | 10                 | 15.69                         | 4.086   | 0.002   |
| 4     | 10                 | 15.08                         | 3.518   | 0.004   |

**Discussion**

This study was focused on the endocrine outcome of two surgical treatment modalities employed for the management of CCP: LPJ and Frey’s procedure. Both procedures are similar but differ in the amount of...
pancreatic tissue removed and indications. Frey’s procedure is useful in clinical scenarios where the head of the pancreas is studded with calculi along with ductal hypertension and removes a variable amount of pancreatic tissue amounting to almost 20-25 % while LPJ focuses on ductal decompression through ductal deroofing [11,12].

Classically, it was proved that the drainage procedures do not alter the diabetic status either in the early postoperative or late follow-up stages [13]. Distal pancreatectomy will compromise the endocrine function without affecting the exocrine functions at an earlier stage, and proximal pancreatectomy precipitates exocrine but not endocrine insufficiency [14]. The difference is attributable in part to the relative preponderance of islet cells in the body and tail of the pancreas.

A recent study has shown that even without an operation, all patients with alcoholic (calcific) chronic pancreatitis develop both exocrine and endocrine failure within 5-10 years of the onset of disease [15]. The onset and progression of endocrine insufficiency closely parallel those of exocrine failure [16,17]. Clearly, the resection of the functionally compromised pancreas has the potential to adversely affect pancreatic function [18].

Various investigations were employed to estimate the pancreatic endocrine function, including the estimation of serum insulin, C-peptide and 24-hour urine C-peptide, and abnormal intravenous and oral glucose tolerance tests [19]. In this study, we had employed inexpensive and convenient investigation metrics like FBS and HbA1c and found that these tests adequately reflected the clinical status of the patients.

Reflecting on earlier experiences, the exocrine function remains unchanged by drainage procedures (LPJ), with there being neither deterioration nor significant improvement (p-value >0.05) [20]. Contrary to the earlier belief that procedures in the head of the pancreas do not affect the endocrine function [21], patients in the Frey’s procedure group showed a statistically significant worsening of FBS in the early postoperative period and continued to be worse over 18 months of follow-up. Their HbA1c levels also corresponded to the observation. Insulin requirement was also increased over the follow-up period. Although the trend was falling, we need close observation over later years to find out the outcome, which is beyond the scope of this study. This may be attributed to the worsened exocrine function post-Frey’s procedure influencing the glycemic control of the patient. Out of six nondiabetic patients, four required insulin postoperatively to control their glycemic levels, strongly complementing the results. Out of four nondiabetic patients who underwent LPJ, all four did not require insulin therapy at a 1.5-year follow-up.

Conclusions

LPJ has got a minimal effect on the diabetic status of nondiabetic patients. While Frey’s procedure leads to the marginal deterioration of diabetic status and increases in insulin dosage over the initial 18 months of follow-up in both diabetic and nondiabetic patients, LPJ provides marginal improvement of diabetic status and reduction in insulin dosage over 18 months of follow-up.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Ewald N, Kaufmann C, Raspe A, Kloer HU, Bretzel RG, Hardt PD: Prevalence of diabetes mellitus secondary to pancreatic diseases (type 3c). Diabetes Metab Res Rev. 2012, 28:338-42. 10.1002/dmrr.2260
2. Roy A, Sahoo J, Kamalanathan S, Naik D, Mohan P, Pottakkat B: Islet cell dysfunction in patients with chronic pancreatitis. World J Diabetes. 2020, 11:280-92. 10.4239/wjd.v11.i17.280
3. Hart PA, Bellin MD, Andersen DK, et al.: Type 3c (pancreatogenic) diabetes mellitus secondary to chronic pancreatitis and pancreatic cancer. Lancet Gastroenterol Hepatol. 2016, 1:226-37. 10.1016/S2468-1253(16)30106-6
4. Nealon WH, Walser E: Main pancreatic ductal anatomy can direct choice of modality for treating pancreatic pseudocysts (surgery versus percutaneous drainage). Ann Surg. 2002, 235:751-8. 10.1097/00000658-200206000-00001
5. Barry K: Chronic pancreatitis: diagnosis and treatment. Am Fam Physician. 2018, 97:585-93.
6. Mezza T, Gelfo CM, Cinti F, et al.: Endocrine and metabolic insights from pancreatic surgery. Trends Endocrinol Metab. 2020, 51:760-72. 10.1016/j.tem.2020.07.005
7. Schäfer M, Müllhaupt B, Clavien PA: Evidence-based pancreatic head resection for pancreatic cancer and chronic pancreatitis. Ann Surg. 2002, 236:137-48. 10.1097/00000658-200208000-00001
8. Semrad CE: Approach to the patient with diarrhea and malabsorption. Goldman’s Cecil Medicine. 2012, 895-915. 10.1056/NEJMoa0901424
9. Ewald N, Hardt PD: Diagnosis and treatment of diabetes mellitus in chronic pancreatitis. World J Gastroenterol. 2015, 19:7276-81. 10.3748/wjg.v19.i42.7276
10. Hafeli M, Ellering A: Pain assessment. Eur Spine J. 2006, 15:S17-24. 10.1007/s00586-005-1044-x
11. Roch A, Teysedou J, Mutter D, Marescaux J, Pessayre J: Chronic pancreatitis: a surgical disease? Role of the Frey procedure. World J Gastrointest Surg. 2014, 6:129-35. 10.4240/wjgs.v6.i7.129
12. Gestic MA, Callejas-Neto F, Chaim EA, Utrini MP, Cazzo E, Pareja JC: Surgical treatment of chronic pancreatitis using Frey’s procedure: a Brazilian 16-year single-centre experience. HPB (Oxford). 2011, 13:263-71. 10.1111/j.1477-2574.2010.00281.x
13. Kumar R, Sahoo JP, Potakat B, et al.: Effect of Frey’s procedure on islet cell function in patients with chronic calcific pancreatitis. Hepatobiliary Pancreat Dis Int. 2018, 17:358-62. 10.1016/j.hbpd.2018.06.001
14. Speicher JE, Traverso LW: Pancreatic exocrine function is preserved after distal pancreatectomy. J Gastrointest Surg. 2010, 14:1006-11. 10.1007/s11605-010-1184-9
15. Pham A, Forsmark C: Chronic pancreatitis: review and update of etiology, risk factors, and management. F1000Res. 2018, 7:10.12688/f1000research.12852.1
16. Rickels MR, Norris AW, Hull RL: A tale of two pancreases: exocrine pathology and endocrine dysfunction. Diabetologia. 2020, 63:2030-9. 10.1007/s00125-020-05210-8
17. Picciucchi M, Capurso G, Archibugi L, Delle Fave MM, Capasso M, Delle Fave G: Exocrine pancreatic insufficiency in diabetic patients: prevalence, mechanisms, and treatment. Int J Endocrinol. 2015, 2015:595649. 10.1155/2015/595649
18. Patankar AM, Attard IA, Bradley E, et al.: Pancreatic exocrine insufficiency after pancreaticoduodenectomy: current evidence and management. World J Gastrointest Pathophysiol. 2020, 11:20-31. 10.4291/wjg.v11.i2.20
19. Katta S, Desimone ME, Weinstein RS: Pancreatic islet function tests. Endotext [Internet]. Feingold KR, Anawalt B, Boyce A, et al. (ed): MDText.com, Inc., South Dartmouth (MA); 2021.
20. Angelopoulou N, Dervenis C, Goula A, et al.: Endocrine pancreatic insufficiency in chronic pancreatitis. Pancreatology. 2005, 5:122-31. 10.1159/000085264
21. Jalleh RP, Williamson RC: Pancreatic exocrine and endocrine function after operations for chronic pancreatitis. Ann Surg. 1992, 216:64-62. 10.1097/00000658-199212000-00007

2022 Sahoo et al. Cureus 14(2): e21855. DOI 10.7759/cureus.21855