

RESULTS OF MODIFIED PUESTOW PROCEDURE IN AMELIORATION OF ABDOMINAL PAIN AND PROGRESSION OF DIABETES MELLITUS IN PATIENTS OF CHRONIC PANCREATITIS REFRACTORY TO MEDICAL THERAPY/ERCP

Syed Kazim Shah Bukhari¹, Hafiz Umer Farooq¹, Syed Murtaza Shah Bukhari², Saqib Ali³, Muhammad Yasir Khan⁴, Muhammad Arsalan⁵

¹ Fellow, HPB and Liver Transplant, Department of HPB and Liver Transplant, Pakistan Kidney & Liver Institute and Research Centre, Lahore

² Senior Lecturer, Department of Physiology, Muhammad College of Medicine, Peshawar

³ Casualty Medical Officer, Category D Hospital Bazar Zaka khel, Khyber

⁴ Consultant HPB and Liver Transplant, Department of HPB and Liver Transplant, Pakistan Kidney & Liver Institute and Research Centre, Lahore

⁵ Senior Registrar, Department of Surgery, Muhammad Teaching Hospital, Peshawar

ABSTRACT

The modified Puestow procedure is a ductal drainage operation used in selected patients with chronic pancreatitis and a dilated main pancreatic duct who continue to have symptoms despite medical and endoscopic treatment. This study was conducted as a secondary analysis of 10 selected patients from an IRB-approved cohort who underwent modified Puestow surgery at the Center of Excellence for Hepatobiliary Surgery, Lahore, Pakistan, between October 2019 and June 2023. Postoperative follow-up continued until June 2025. The cohort included 4 females and 6 males with severe persistent abdominal pain despite conservative treatment; 4 patients had undergone prior therapeutic ERCP without durable improvement, 1 had undergone hepaticojejunostomy, and 1 had a prior inadequate Puestow procedure. Median pain score decreased from 9 (7-10) before surgery to 1 (0-3) at last follow-up. Six patients became completely pain-free, 3 had major pain relief with only occasional mild pain, and 1 had persistent but less frequent pain. Two patients had diabetes mellitus before surgery and both remained diabetic. Among 8 non-diabetic patients, 6 remained euglycemic and 2 developed new diabetes during follow-up. There were no deaths or significant complications. Modified Puestow surgery achieved lasting palliation of pain in this nonresponsive subset, but failed to cure diabetes. Its protective effect against subsequent development of type 3c diabetes is not known.

KEYWORDS: Chronic pancreatitis; Modified Puestow procedure; Pancreaticojejunostomy; Abdominal pain; Type 3c diabetes mellitus; Endoscopic retrograde cholangiopancreatography

INTRODUCTION

Chronic pancreatitis (CP) is a progressive inflammatory disease of the pancreas characterized by fibrosis, irreversible parenchymal damage, ductal changes, recurrent or persistent abdominal pain, and gradual loss of exocrine and endocrine function. Pain is the predominant clinical problem in many patients and may persist despite analgesics, pancreatic enzyme replacement, nutritional optimization, and endoscopic retrograde cholangiopancreatography (ERCP). In patients with painful obstructive CP and a dilated main pancreatic duct, operative ductal drainage remains an important treatment option when conservative and endoscopic treatment fail (Conwell et al., 2014; Gardner et al., 2020).

The lateral pancreaticojejunostomy, commonly referred to as the modified Puestow or Partington-Rochelle procedure, aims to decompress the main pancreatic duct by opening it longitudinally and anastomosing it to a Roux-en-Y jejunal limb. It is most appropriate when the pancreatic duct is dilated, commonly more than 7-8 mm, and pain is thought to arise from ductal hypertension, ductal obstruction, intraductal calculi, or recurrent inflammation. Randomized trials and meta-analyses have consistently reported better pain control and fewer repeated interventions after surgical drainage compared with an endoscopy first strategy in appropriately selected patients (Cahen et al., 2007; Cahen et al., 2011; Hughes et al., 2022; van Veldhuisen et al., 2025).

Although pain relief after modified Puestow surgery is well documented, its influence on pancreatogenic, or type 3c, diabetes mellitus is less clear. Endocrine dysfunction in CP results from progressive pancreatic fibrosis, calcification, inflammation, and islet cell loss. Some studies have suggested possible improvement in glycemic profile after ductal drainage, particularly when surgery is performed before advanced pancreatic destruction, whereas other comparative data show no clear reduction in new endocrine failure after surgery (Sidhu et al., 2001; Hughes et al., 2022; Rasheed et al., 2025). This study therefore examined both pain and diabetes outcomes after modified Puestow surgery in a Pakistani cohort with refractory CP.

MATERIAL AND METHODS

We conducted an ambispective secondary analysis of 10 selected patients with chronic pancreatitis from an IRB-approved cohort of modified Puestow procedures performed at the Center of Excellence for Hepatobiliary Surgery, Lahore, Pakistan, between October 2019 and June 2023. Follow-up data for pain and diabetes outcomes were collected up to June 2025. All patients had severe abdominal pain refractory to maximum medical therapy, including analgesics and pancreatic enzyme replacement. Four patients had undergone therapeutic ERCP, including stone or stent-based intervention, without durable pain relief. One patient had a previous Roux-en-Y hepaticojejunostomy, 1 had a prior incomplete Puestow procedure, and 4 had been managed medically before definitive surgery. Two patients had diabetes mellitus at baseline according to available clinical records, while 8 were euglycemic before surgery.

Ethical approval: The study was planned following approval in principle by the Department of HPB and Liver Transplant, Pakistan Kidney and Liver Institute and Research Centre (PKLI), in August 2022, and was conducted after Institutional Review Board approval in June 2024 (IRB No. 0211). Informed consent was obtained for the use of anonymized clinical data for research.

Surgical technique: All patients underwent open longitudinal pancreaticojejunostomy. Through a transverse abdominal incision, the pancreas was exposed and the dilated main pancreatic duct was opened longitudinally from head to tail. A Roux-en-Y jejunal limb of 40 cm was anastomosed side to side to the opened duct to provide drainage. The pancreatic head was not resected. Operations were performed by senior hepatobiliary surgeons using a similar operative technique.

Data collection: Demographic variables, prior interventions, operative details, complications, hospital stay, and follow-up outcomes were collected from the available clinical records. Pain was assessed using a 0-10 numeric rating scale before surgery and at last follow-up. Diabetes status was determined using follow-up fasting blood glucose, HbA1c, medication history, or documented clinical diagnosis. Follow-up continued until June 2025, with a median duration of 36 months.

Statistical analysis: Continuous variables are presented as median with interquartile range or range, and categorical variables are presented as number and percentage. Preoperative and postoperative pain scores were compared using the Wilcoxon signed-rank test. Categorical changes in diabetes status were evaluated descriptively because of the small sample size. A p value less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the baseline characteristics. There were 10 patients, including 6 males and 4 females. The median age was 35 years. The median duration of pain before surgery was 3 years. Two patients had diabetes before surgery. Six patients had already undergone a previous procedure before modified Puestow surgery.

Table 1. Baseline characteristics of patients undergoing modified Puestow procedure (n = 10)

Variable	Value
Age, years	35 (range 25-55)
Male sex	6 (60%)
Female sex	4 (40%)
Median duration of pain symptoms before surgery	3 years (IQR 2-5)
Previous therapeutic ERCP	4 (40%)
Previous Roux-en-Y hepaticojejunostomy	1 (10%)
Previous incomplete Puestow procedure	1 (10%)
Medical therapy only before surgery	4 (40%)
Preoperative diabetes mellitus	2 (20%)
Median follow-up after surgery	36 months (IQR 18-60)

Values are expressed as n (%) or median with IQR or range.

Pain outcomes are shown in Table 2. The median pain score decreased from 9 before surgery to 1 at last follow-up. This reduction was statistically significant ($p < 0.001$). Six patients became pain-free. Three patients had major pain relief with occasional mild pain. One patient had recurrent pain, but it was less frequent and less severe than before surgery.

Table 2. Pain outcomes after modified Puestow procedure

Outcome	Result
Preoperative pain score, median (range)	9 (7-10)
Postoperative pain score at last follow-up, median (range)	1 (0-3)
Median absolute pain score reduction	8 points
Completely pain-free at last follow-up	6/10 (60%)
Major pain relief with occasional mild pain	3/10 (30%)
Persistent but reduced pain frequency and intensity	1/10 (10%)
Complete or major pain relief	9/10 (90%)

Statistical comparison of pain scores	p<0.001
---------------------------------------	---------

Table 3 shows diabetes and perioperative outcomes. The 2 patients with diabetes before surgery remained diabetic after surgery. Among 8 non-diabetic patients, 6 remained euglycemic and 2 developed new diabetes during follow-up. There was no death, major complication, anastomotic leak, reoperation, or ICU admission. One patient had a superficial wound infection, which was managed conservatively.

Table 3. Endocrine and perioperative outcomes

Outcome	Result
Preoperative diabetes mellitus	2/10 (20%)
Diabetes mellitus at last follow-up	4/10 (40%)
Diabetes remission among preoperative diabetics	0/2 (0%)
Initially non-diabetic patients remaining euglycemic	6/8 (75%)
New-onset diabetes among initially non-diabetic patients	2/8 (25%)
Median hospital stay	8 days (IQR 6-12)
Estimated operative time	180 min
Estimated blood loss	<200 mL in all cases
30-day mortality	0/10 (0%)
Major complications, Clavien-Dindo grade III or higher	0/10 (0%)
Minor wound infection	1/10 (10%)
Reoperation, anastomotic leak, or ICU admission	0/10 (0%)

DISCUSSION

In this study, the modified Puestow procedure was shown to be effective for pain-directed operation in the treatment of selected CP patients with dilated main pancreatic duct, who continued to have symptoms despite standard treatment of CP, medical treatment or ERCP. The greatest clinical finding was the significant improvement in pain score, from a median pre-op value of 9 to 1 post-op. In practice, 6/10 patients reported no pain at all, and the other 3 had a dramatic reduction in pain, with mild pain only every now and then. Therefore, in parallel with complete relief, 90% of the patients had a significant benefit as major relief. This is significant because the group was not an early or uncomplicated group. Several had previously been treated with endoscopy or surgery, and had failed conservative treatment. The results are comparable to the accepted efficacy of surgical ductal decompression for obstructive painful CP (Conwell et al., 2014; Gardner et al., 2020). There is a plausible biological explanation for this improvement. In patients with dilated pancreatic duct, the causes of pain include ductal hypertension, ductal stones, ductal strictures, recurrent inflammation, perineural irritation and increased pressure in a preexisting fibrotic gland. Longitudinal pancreaticojejunostomy does this by making an opening down the length of the duct, allowing low pressure drainage into Roux-en-Y jejunal limb. The modified Puestow procedure preserves pancreatic tissue. It is also an option for patients who do not have an inflammatory head mass or a suspicion of malignancy. This tissue-sparing quality could partly explain why such an operation can give a significant amount of pain relief without a too high risk of complications, with an acceptable safety profile. Our pain outcomes are favourable compared to randomized and comparative literature. In the classic randomized trial conducted by Cahen et al. (2007), surgical drainage was superior to endoscopic treatment for pain relief. A longer follow-up period showed that patients assigned to surgery had fewer additional interventions and better pain relief (Cahen et al., 2011). More recent evidence also favors earlier surgical management in selected patients with painful CP and ductal dilatation. The ESCAPE trial showed lower pain scores with early surgery compared with an endoscopy first approach, and long-term follow-up after 8 years continued to favor early surgery for pain scores and patient satisfaction (Issa et al., 2020; van Veldhuisen et al., 2025). A meta-analysis of randomized trials similarly found a higher rate of complete pain control after surgery than after endoscopic therapy, without a clear difference in new endocrine or exocrine failure (Hughes et al., 2022).

The overall 60% pain free rate in the current group seems rather low compared to some published series. However, this needs to be taken with caution. The concept of complete relief was taken as strict as possible; that is, absence of pain at last follow-up. Three other patients complained of only occasional mild pain following a prolonged period, and pain intensity was significantly reduced, indicating some degree of improvement. Although these patients still experienced some symptoms, with clinically significant reduction in pain frequency and intensity, surgery was still beneficial. Complete relief and major relief are two types of relief. This distinction should be left in the manuscript since it will avoid overstatement and make the results more credible. The utility to the patients is not only a number, but also fewer attacks, fewer analgesic requirements, better ability to eat, fewer hospital visits and better daily functioning. The diabetes results were less good and indicate that there is a contrasting biology of pain and endocrine failure in CP. The 2 patients with pre-existing diabetes remained diabetic, while 2 of 8 initially non-diabetic patients became diabetic during follow-up. This suggests that modified Puestow surgery should not be considered as a cure for known endocrine insufficiency. Once islet cell damage has been caused by fibrosis,

calcification and chronic inflammation, ductal decompression is not likely to restore endocrine function. The observation that 75% of initially non-diabetic patients remained euglycemic was encouraging, but the small number and variability of patients make results difficult to interpret. No definitive answer regarding future diabetes type 3c can be drawn. These endocrine findings are also consistent with the general literature. Sidhu et al. (2001) reported a general improvement in diabetic parameters following modified Puestow surgery in tropical CP, but this could be a result of other factors like differences in patient selection, disease stage, nutritional status, baseline metabolic reserve and timing of surgery. Randomized comparisons and meta-analytic data indicate that surgery improves pain more consistently than endocrine findings, and that new endocrine insufficiency can occur after endoscopic and surgical procedures (Cahen et al., 2011; Hughes et al., 2022). This is now known as type 3c diabetes, and is understood to be a separate and clinically significant consequence of CP, with complex mechanisms involving insulin deficiency, impaired glucagon response, malabsorption and varying food consumption (Rasheed et al., 2025). To this end, even with great pain relief, patients undergoing modified Puestow surgery should have long term glycemic surveillance.

The perioperative safety in this study was reassuring. There was no mortality, no major Clavien-Dindo grade complication, no reoperation and no intensive care required. One superficial wound infection was treated conservatively. These observations agree with those of large contemporary cases, showing that the procedure is generally safe in suitable patients when performed by experienced pancreatic surgeons, although population-level morbidity is not negligible (Napolitano et al., 2020). The low morbidity rate of our cohort should be interpreted as encouraging, but not definitive, as a small sample of 10 patients cannot accurately measure rare complications. The study is also of regional interest. At many local practice levels, patients with CP might be subjected to chronic administration of analgesics, recurrent hospitalizations and several attempts at endoscopy prior to surgical referral. In a patient with persistent severe pain, obviously dilated duct, and failed ERCP, postponing surgery can cause more pain and more health care costs. This series suggests that early referral to hepatobiliary unit may offer long-term palliation. However, the data should not be taken as proof that every CP case should be treated surgically. Patient selection remains the key, and surgical options are best suited to duct-dominant disease with ductal dilatation. Alternative operations may be indicated if there is an inflammatory mass in the head of the pancreas, biliary obstruction, duodenal obstruction, or suspicion of malignancy.

Even if this current study did not perform molecular testing, CP is becoming well known as a disease influenced by genetic factors, molecular inflammatory pathways, pancreatic duct injury, fibrosis, and gradual loss of islet cells. Variants of pancreatitis-associated genes such as PRSS1, SPINK1, CFTR, CTRC, CLDN2, CPA1, CASR and CEL genes have been involved in pancreatitis-related disease, especially in early-onset, idiopathic, familial or non-alcoholic disease (Weiss et al., 2018; Zou et al., 2018). The clinical results following the modified Puestow surgery should therefore be understood as part of the whole biological picture of duct obstruction, genetic predisposition, chronic inflammation, fibrosis and endocrine decline. Additional regional studies should be conducted to concurrently use surgical outcome assessment, genetic profiling, inflammatory biomarkers and long-term endocrine follow-up to determine which patients will benefit from early ductal decompression and which patients are at high risk of becoming type 3c diabetes mellitus.

There are a number of caveats to be noted. This was an ambispective, single-center study which included only 10 patients and had no control group. Follow-up duration was flexible, and some numbers such as age range, duration of symptoms and exact operative time should be verified from the original records before journal submission. The etiology of CP was not always reported and makes it difficult to compare with alcoholic, idiopathic, hereditary and tropical CP cohorts. A simple numeric pain scale was used for assessment of pain. In this study, the pain was not formally assessed by a composite score, such as Izbicki pain score, and the study did not quantify opioid use, quality of life, exocrine pancreatic insufficiency, nutritional recovery, imaging severity or return to work. The assessment of diabetes was done on the basis of available follow-up records rather than a standardized prospective endocrine protocol. These limitations limit statistical power and make the findings hypothesis-generating and not conclusive. Prospective, multicenter studies with a predetermined follow-up interval should be desired in the future. Standardized metrics should be used to quantify pain, drug requirement, quality of life, nutrition, exocrine function, and glycemic outcomes. In particular, a local registry comparing endoscopic therapy, modified Puestow surgery, Frey procedure, and other surgical options would be of great value. Such work could clarify whether earlier surgical decompression in ductal CP improves not only pain but also long-term function, hospital utilization, and patient satisfaction. Until such evidence is available, the main defensible conclusion from this study is that modified Puestow surgery is a safe and effective pain-palliation procedure in carefully selected refractory CP patients, while its effect on diabetes prevention or reversal remains uncertain.

CONCLUSION

In selected patients with CP and a dilated main pancreatic duct, the modified Puestow procedure provides substantial and durable pain relief after failure of medical and endoscopic treatment. In this study cohort, the median pain score decreased markedly, 60% of patients became completely pain-free, and 90% achieved complete or major pain relief. The operation was

associated with low perioperative morbidity in this series. However, established diabetes did not resolve, and new diabetes still developed in some initially non-diabetic patients. Modified Puestow surgery should therefore be considered primarily a pain-palliation and ductal decompression procedure, not a reliable endocrine-curative intervention. Long-term glycemic follow-up remains necessary after surgery. Future research combining modified Puestow surgical outcomes with pancreatitis-related genetic markers and molecular biomarkers may help personalize treatment timing and predict long-term endocrine deterioration.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The study was planned following approval in principle by the Department of HPB and Liver Transplant, Pakistan Kidney and Liver Institute and Research Centre (PKLI), in August 2022, and was conducted after Institutional Review Board approval in June 2024 (IRB No. 0211). The study was performed in accordance with the Declaration of Helsinki and institutional research guidelines. Patients' informed consent was obtained for the use of anonymized clinical data for research purposes.

CONSENT FOR PUBLICATION

Not applicable. The manuscript does not contain identifiable individual patient data, images, or personal clinical details.

ACKNOWLEDGMENTS

The authors acknowledge the Department of HPB and Liver Transplant, Pakistan Kidney and Liver Institute and Research Centre, Lahore, for institutional support, clinical guidance, and facilitation of patient follow-up and record review.

AUTHOR CONTRIBUTIONS

SKSB and MYK conceptualized and supervised the study. SKSB, HUF, SA, and MYK contributed to patient management, data collection, and follow-up. SMSB assisted with literature review, manuscript drafting, data interpretation, and critical revision. MA contributed to manuscript writing, formatting, reference management, and final review. All authors reviewed and approved the final manuscript.

FUNDING

The authors received no specific grant for this research from any funding agency in the public, commercial, or non-profit sectors.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request and subject to institutional and ethical approval requirements.

REFERENCES

1. Cahen DL, Gouma DJ, Nio Y, Rauws EAJ, et al. (2007). Endoscopic versus surgical drainage of the pancreatic duct in chronic pancreatitis. *N. Engl. J. Med.* 356: 676-684. doi:10.1056/NEJMoa060610
2. Cahen DL, Gouma DJ, Laramée P, Nio Y, et al. (2011). Long-term outcomes of endoscopic vs surgical drainage of the pancreatic duct in patients with chronic pancreatitis. *Gastroenterology* 141: 1690-1695. doi:10.1053/j.gastro.2011.07.049
3. Conwell DL, Lee LS, Yadav D, Longnecker DS, et al. (2014). American Pancreatic Association practice guidelines in chronic pancreatitis: evidence-based report on diagnostic guidelines. *Pancreas* 43: 1143-1162. doi:10.1097/MPA.0000000000000216
4. Gardner TB, Adler DG, Forsmark CE, Sauer BG, et al. (2020). ACG clinical guideline: chronic pancreatitis. *Am. J. Gastroenterol.* 115: 322-339. doi:10.14309/ajg.0000000000000535
5. Hughes DL, Hughes I and Silva MA (2022). A meta-analysis of the long-term outcomes following surgery or endoscopic therapy for chronic pancreatitis. *Langenbecks Arch. Surg.* 407: 2233-2245. doi:10.1007/s00423-022-02468-x
6. Issa Y, Kempeneers MA, Bruno MJ, Fockens P, et al. (2020). Effect of early surgery vs endoscopy first approach on pain in patients with chronic pancreatitis: the ESCAPE randomized clinical trial. *JAMA* 323: 237-247. doi:10.1001/jama.2019.20967
7. Napolitano M, Smith SE, Narvaez E, Sachdeva A, et al. (2020). 30-day outcomes and predictors of complications after Puestow procedure. *Am. J. Surg.* 219: 908-915. doi:10.1016/j.amjsurg.2019.12.024
8. Petrov MS and Yadav D (2019). Global epidemiology and holistic prevention of pancreatitis. *Nat. Rev. Gastroenterol. Hepatol.* 16: 175-184. doi:10.1038/s41575-018-0080-2
9. Rasheed A, Galande S, Farheen S, Mitnala S, et al. (2025). Type 3c diabetes associated with chronic pancreatitis: a narrative review. *Pancreatology* 25: 1003-1012. doi:10.1016/j.pan.2025.08.005

10. Sidhu SS, Nundy S and Tandon RK (2001). The effect of the modified Puestow procedure on diabetes in patients with tropical chronic pancreatitis, a prospective study. *Am. J. Gastroenterol.* 96: 107-111.
11. van Veldhuisen CL, Kempeneers MA, de Rijk FEM, Bouwense SA, et al. (2025). Long-term outcomes of early surgery vs endoscopy first in chronic pancreatitis: follow-up analysis of the ESCAPE randomized clinical trial. *JAMA Surg.* 160: 126-133. doi:10.1001/jamasurg.2024.5182
12. Weiss FU, Skube ME and Lerch MM (2018). Chronic pancreatitis: an update on genetic risk factors. *Curr. Opin. Gastroenterol.* 34: 322-329. doi:10.1097/MOG.0000000000000461
13. Zou WB, Tang XY, Zhou DZ, Qian YY, et al. (2018). SPINK1, PRSS1, CTSC, and CFTR genotypes influence disease onset and clinical outcomes in chronic pancreatitis. *Clin. Transl. Gastroenterol.* 9: 204. doi:10.1038/s41424-018-0069-5