

Puestow procedure: results in 19 years of institutional experience

Procedimiento de Puestow: resultados en 19 años de experiencia institucional

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ABSTRACT

Introduction: Chronic pancreatitis comprises a chronic progressive inflammatory syndrome of the pancreas, with irreversible damage and loss of exocrine and endocrine function. Pain is the most frequent symptom. Surgical treatment is superior compared to conservative or endoscopic therapies. **Objective:** To know the results obtained in the performance of a Puestow procedure for the management of chronic pancreatitis. **Material and methods:** All patients who underwent a Puestow procedure at the Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán" in Mexico City, Mexico, between 2000 and 2019 were included. **Results:** We found 45 patients operated for a lateral pancreato-jejunal-anastomosis. The mean age was 46 years. There were 24 (53%) men and 21 (47%) women. In 42.2% of the patients there was a history of alcoholism and/or smoking. The most frequent indications for surgery were pain (46.7%) and recurrent acute pancreatitis (37.8%). Eighteen (40%) patients had recurrence of pain with a mean follow-up of 4.4 years. **Conclusions:** At present, there is no ideal surgical procedure for patients with chronic pancreatitis, the type of intervention to choose should reflect the balance between the success of the procedure and the inherent risks.

RESUMEN

Introducción: La pancreatitis crónica comprende un síndrome inflamatorio progresivo crónico del páncreas, con daño irreversible y pérdida de la función exocrina y endocrina. El dolor es el síntoma más frecuente. El tratamiento quirúrgico es superior en comparación con terapias conservadoras o endoscópicas. **Objetivo:** Conocer los resultados obtenidos en la realización de un procedimiento de Puestow para el manejo de pancreatitis crónica. **Material y métodos:** Se incluyeron todos los pacientes que fueron sometidos a un procedimiento de Puestow, en el Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán" en la Ciudad de México, México, entre los años 2000 a 2019. **Resultados:** Se encontraron 45 pacientes operados por una pancreatoyeyunoanastomosis lateral. La edad media fue de 46 años. Fueron 24 (53%) hombres y 21 (47%) mujeres. En 42.2% de los pacientes había antecedente de alcoholismo y/o tabaquismo. Las indicaciones más frecuentes para la cirugía fueron: dolor (46.7%) y pancreatitis aguda de repetición (37.8%). Dieciocho (40%) pacientes cursaron con recurrencia del dolor con un seguimiento medio de 4.4 años. **Conclusiones:** En la actualidad, no existe un procedimiento quirúrgico ideal para pacientes con pancreatitis crónica, el tipo de intervención a elegir debe ser el reflejo del equilibrio entre el éxito del procedimiento y los riesgos inherentes.

INTRODUCTION

Chronic pancreatitis (CP) comprises a set of clinical manifestations secondary to a persistent inflammatory process of the pancreas.¹⁻³ The American Pancreas Association

(AAP) defines CP as: "a chronic progressive scarring and inflammatory syndrome of the pancreas, with irreversible damage and loss of exocrine and endocrine function".⁴

CP shows an overall annual incidence of four to 23 cases per 100,000 population, and

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Table 1: General features of the study population. N = 45.

Variable	n (%)
Age (years)	46.44 ± 14.59
Male sex	24 (53.3)
Weight (kg)	61.83 ± 12.29
Body mass index kg/m ²	22 ± 4.11
Background history	
Type 2 diabetes mellitus	5 (11.1)
Alcohol consumption	19 (42.2)
Smoking	19 (42.2)
Tobacco rate	22.7 ± 30.35
Acute pancreatitis	37 (82.2)
Number of episodes of acute pancreatitis	5.2 ± 5.38
Pancreatic insufficiency	
Endocrine	14 (31.1)
Exocrine	9 (20.0)
Diarrhea	19 (40.0)
Previous imaging studies	
Transendoscopic ultrasound	20 (44.4)
Magnetic resonance imaging	18 (40.0)
Computerized tomography scan	44 (97.8)
Preoperative findings	
Calcifications	32 (71.1)
Location	
Head	16 (50.0)
Neck	1 (3.1)
Body	2 (6.2)
Uncinate process	1 (3.1)
Multiple	12 (37.5)
Stones	15 (33.3)
Location	
Head	11 (73.0)
Neck	1 (7.0)
Multiple	3 (20.0)
Atrophy	14 (31.0)
Duct diameter	8.03 ± 3.94
Previous interventions	
Endoscopy	15 (33.3)
Type of procedure	
Lithotripsy	2 (13.33)
Pancreatic stent	4 (26.66)
Failed	2 (13.33)
Pain management	1 (6.66)
Sphincterotomy	3 (20.00)
Combined	3 (20.00)
Drainage of pancreatic pseudocyst	4 (8.90)
Pancreatic necrosectomy	2 (4.40)
Use of pancreatic enzymes	23 (51.10)
Chronic opioid use	4 (8.90)

Data are presented as mean ± standard deviation or median (p25-p75).
Categorical variables are presented as frequencies and percentages.
Study data.

a prevalence of 13 per 100,000.⁵ Patients have a four times higher mortality risk compared to the general population, and a ten times higher probability of pancreatic malignancy.⁶ Multiple etiologies are attributed to the development of CP. In the United States, alcohol consumption is responsible for 45% of reported cases. Other causes are included in the acronym TIGAR-O (toxic/metabolic, idiopathic, genetic, autoimmune, recurrent severe acute pancreatitis, obstructive).⁷

One hypothesis linked to hereditary pancreatitis suggests that CP begins with an episode of acute pancreatitis. This model is known as SAPE (sentinel acute pancreatitis event).⁸ Abdominal pain is the most frequent symptom of CP. Different causal mechanisms of pain have been proposed including inflammation, increased pressure within the duct or parenchyma, ductal stenosis and/or obstruction by calculi, complications such as pseudocysts or phlegmons, or extra-pancreatic complications such as portal thrombosis, biliary or duodenal stenosis and peptic ulcers.⁹ It has been demonstrated that there are also central and peripheral sensitization mechanisms that cause changes at the level of pancreatic innervation.¹⁰

The World Health Organization (WHO) recommends, for pain management, to start with non-opioid medications, and if there is no improvement move upwards to weak opioids such as tramadol followed by stronger opioids.¹¹ Some groups suggest that endoscopic or interventional treatment is the first step in the treatment of patients with CP; however, not all patients are candidates for this type of approach.^{12,13}

Recently, the surgical approach has been shown to be superior for the treatment of CP compared to conservative or endoscopic therapies.¹⁴⁻¹⁶

The Puestow procedure was first described in 1958 by Partington and Rochelle. It consists of a drainage procedure performing a longitudinal latero-lateral pancreato-jejunal-anastomosis. This type of surgery is the one of choice when the main pancreatic duct is dilated (5 mm minimum diameter),¹⁷ in the absence of an inflammatory mass in the head of the pancreas or obstruction of the bile duct.¹⁸

Table 2: Perioperative and follow-up features.

	n (%)
Indication of Puestow procedure	
Pain	21 (46.7)
Conduit disconnected	3 (6.7)
Pancreatic insufficiency	2 (4.4)
Episodes of acute pancreatitis	17 (37.8)
Intraoperative findings	
Hard consistency of the pancreas	14 (31.1)
Stone extraction	20 (44.4)
Location	
Head	9 (45)
Neck	2 (10)
Tail	2 (10)
Multiple	7 (35)
Atrophy	16 (35)
Duct diameter	8.19 ± 2.29
Postoperative evolution	
Restart of oral feeding	
≥ 48 hours	12 (27)
≥ 72 hours	18 (40)
4 to 7 days	14 (31)
> 7 days	1 (2)
Use of drainage	45 (100)
Pancreatic fistulae	0 (0)
Days of postoperative hospitalization	7 (5-9)
Complications due to ACCORDION	14 (31.1)
Grade	
Mild	8 (58)
Moderate	3 (21)
Severe	3 (21)
Follow-up	
Recurrence of pain	18 (40)
Use of opioids	5 (11)
<i>De novo</i> pancreatic insufficiency	20 (44)
Endocrine insufficiency	8 (18)
Exocrine insufficiency	17 (38)
Use of pancreatic enzymes	33 (73)
Hospital readmission	4 (9)
Follow-up (years)	4.44 ± 2.29

Data are presented as mean ± standard deviation or median (p25-p75). Categorical variables are presented as frequencies and percentages. Study data

It has been described as technically safe and efficient procedure, with low morbidity (20%) and operative mortality (1%).¹⁹ Pancreatic leaks develop in less than 5% of cases.²⁰ Endocrine and exocrine functions are usually

not compromised because there is no major resection of pancreatic tissue. In Mexico, González and collaborators described in 1996 the results obtained in 49 patients submitted to a pancreato-jejunal-anastomosis because of CP. With a mean follow-up of 6.5 years, they found that 98% were pain free.²¹

Dite and colleagues demonstrated in the first randomized controlled trial that there is better pain control at five years in patients who underwent surgery (34-52%) compared to those who received endoscopic treatment (15-46%).²² Currently, there is no consistency in the different guidelines regarding the timing and choice of CP treatment.

The main objective of this study is to know the results obtained in the performance of a Puestow procedure for the surgical management of CP, in 19 years of experience in a high-volume center in Mexico City.

MATERIAL AND METHODS

All patients who underwent a Puestow type surgical procedure for the treatment of CP at the Instituto Nacional de Ciencias Médicas y Nutrición “Salvador Zubirán” between 2000 and 2019 were included. For the selection of subjects, a list of patients who had undergone pancreatic duct to small bowel bypass surgery with open or laparoscopic approach, according to the ICD-10 procedure code, was requested to the Statistics Department.

A review of the physical and electronic files was carried out and filtered data that met the inclusion criteria in an electronic database, which included the proposed variables were collected. A descriptive and comparative statistical analysis was performed depending on the type of variable. For the continuous variables of age, weight, body mass index (BMI), smoking rate, episodes of acute pancreatitis (AP), pancreatic duct diameter and follow-up in years of the operated patients, the mean, median, standard deviation and 95% confidence intervals were calculated.

Frequency values and percentages for categorical variables such as male sex, type 2 diabetes mellitus (T2DM), alcohol consumption, smoking, AP, endocrine and exocrine pancreatic insufficiency, and imaging study results such as

transendoscopic ultrasound (USTE), magnetic resonance imaging (MRI) and computed axial tomography (CT) scan were obtained. Other categorical variables included preoperative and intraoperative findings such as pancreatic calcifications, presence of stones, pancreatic atrophy, as well as previous interventions such as endoscopy, pancreatic pseudocyst drainage, necrosectomy, and use of pancreatic enzymes.

Variables related to postoperative evolution were analyzed, such as the use of drains, development of pancreatic fistulas, days of hospitalization and complications according to the ACCORDION scale, and follow-up variables such as recurrence of pain, use of opioids, development of de novo pancreatic insufficiency, hospital readmissions and follow-up in years were also analyzed. In the bivariate Mann-Whitney U analysis, the IBM SPSS Statistics v24 program was used. A p-value of less than 0.05 was considered statistically significant.

All those patients who had been operated by the Puestow procedure for a cause other than chronic pancreatitis were excluded from the study, as well as those who were operated in combination with any other type of pancreatic resection surgical procedure. Patients who

were not operated on at the Instituto Nacional de Ciencias Médicas y Nutrición “Salvador Zubirán” and who did not have a complete physical or electronic file for data collection were eliminated from the study database.

RESULTS

We found 45 patients operated on by a Puestow procedure, secondary to the diagnosis of CP. The mean age was 46 years. There were 24 (53%) men, 21 (47%) women, and the mean body mass index was 22.71 kg/m². Of the patients with CP, five had a diagnosis of T2DM (11.1%). Regarding episodes of acute pancreatitis prior to surgery, 37 (82.2%) had presented at least one episode, and the overall mean episodes was 5.2 (*Table 1*).

Of the patients (19 of 45), 42.2% had a history of alcohol consumption or a history of alcoholism, and 42.2% had a history of smoking, with a mean smoking index of 22.7 (*Table 1*). Regarding endoscopic procedures prior to surgery, at least 15 patients (33.3%) underwent some type of intervention for the treatment of CP. Fourteen cases (31.1%) were detected with endocrine insufficiency, characterized by T2DM following the diagnosis of CP, while 19

Table 3: Bivariate analysis of postoperative pain recurrence.

Parameters	Recurrence of pain (N = 18)	No recurrence of pain (N = 27)	p
	n (%)	n (%)	
Age (years)	49.39 ± 11.96	44.48 ± 16.02	0.274
Male	12 (66.7)	12 (44.4)	0.143
Body weight (kg)	63.59 ± 10.63	60.65 ± 13.35	0.439
Previous acute pancreatitis	16 (88.9)	21 (77.8)	0.350
History of smoking	9 (50.0)	10 (37.0)	0.388
History of alcoholism	10 (55.6)	9 (33.3)	0.139
History of endoscopic surgery	6 (33.3)	9 (33.3)	0.999
Atrophic pancreas*	7 (38.9)	8 (29.6)	0.600
Hard pancreas	6 (33.3)	8 (29.6)	0.999
Post-surgical pancreatic insufficiency	11 (61.1)	9 (33.3)	0.066

Data are presented as median (p25-p75). Bivariate Mann-Whitney U analysis. * Intraoperative findings. Study data.

Table 4: Bivariate analysis of postoperative de novo pancreatic insufficiency.

Parameters	<i>De novo</i> pancreatic insufficiency (N = 20)	<i>Non de novo</i> pancreatic insufficiency (N = 25)	p
	n (%)	n (%)	
Previous acute pancreatitis	17 (85)	20 (80)	0.67
Atrophic pancreas*	6 (30)	9 (36)	0.71
Hard pancreas	8 (40)	6 (24)	0.90
Pancreatic duct diameter	3 (3-10)	4 (3-12)	0.47
Stone extraction	7 (35)	13 (52)	0.26

Data are presented as median (p25 -p75). Bivariate Mann-Whitney U analysis. * Intraoperative findings. Study data.

patients (40%) reported diarrhea; however, only nine (20%) had a diagnosis of exocrine insufficiency.

In the imaging studies, 32 (71.1%) patients with calcifications were considered as pathognomonic findings of CP, most of them located in the head of the pancreas (n = 16.50%), 12 (37.5%) within multiple localizations and the rest presented a modal distribution in the neck (n = 1, 3.1%), body (n = 2, 6.2%) and uncinata process (n = 1, 3.1%), respectively. The mean duct diameter reported was 8.03 mm (Table 1).

In 15 (33.3%) patients, the presence of lithiasis was reported, located in the head (n = 11, 73%), neck (n = 1, 7%) and in multiple parts of the pancreas (n = 3, 20%). Fourteen (31%) of the subjects presented atrophy of the pancreatic gland (Table 1). The most frequent indications for performing a Puestow procedure reported included pain in 21 patients (46.7%), repeated episodes of AP in 17 (37.8%) cases, three (6.7%) because of a disconnected duct and two (4.4%) for pancreatic insufficiency. Among the intraoperative findings, the pancreas was described as having a hard consistency in 14 patients (31%). The average diameter of the pancreatic duct reported was 8.19 mm and in 20 (44.4%) patients stones were extracted from the duct. Pancreatic atrophy was described in 16 cases (35%) (Table 2).

The average hospital stay was seven days, no pancreatic fistulas were reported, and no patient required intensive care. All patients (100%) underwent some type of drainage during surgery. Regarding complications, 14 (31%) patients in total were characterized according to the ACCORDION surgical complication severity classification system as mild in eight (58%) patients, moderate in three (21%) and severe in three (21%) (Table 2).

In the follow-up of the patients, 18 (40%) had recurrence of pain; due to this, five (11%) patients reported regular use of opioids despite the surgical procedure. On the other hand, 20 (44%) patients presented de novo pancreatic insufficiency, among which eight (18%) developed endocrine symptoms such as serum glucose alterations and 17 (38%) presented exocrine insufficiency manifesting diarrhea or steatorrhea. Secondary to these symptoms, 33 (73%) required pancreatic enzymes administration (Table 2). The hospital readmission rate was 9% (n = 4). The mean follow-up of patients was 4.4 years.

In the bivariate analysis against recurrence of pain, age showed a p-value = 0.274, male sex a p = 0.143 and weight a p = 0.439 (Table 3). Regarding patient history, the relationship with a history of alcoholism was p = 0.139 and smoking was p = 0.388, as well as in those with a history of acute pancreatitis and endoscopic procedures, the p-value was 0.350

and 0.999, respectively. The development of de novo pancreatic insufficiency after surgery showed a $p = 0.67$ against the history of acute pancreatitis, while according to the intraoperative findings, the presence of atrophy showed a $p = 0.71$, a hard consistency of the pancreas with a $p = 0.90$, diameter of the duct $p = 0.47$ and finally compared to the extraction of stones a $p = 0.26$ (Table 4). However, no significant values were obtained in the bivariate analysis.

DISCUSSION

Chronic pancreatitis (CP) is a complex disease that involves a physical, emotional, and financial burden for the patient, physicians, and the health care system. Our retrospective series included 45 patients who underwent a Puestow procedure as a surgical treatment described in CP. This review analyzed the results obtained over 19 years of experience, and despite being a retrospective analysis, there is no other current series described in Mexico that analyzes the experience in relation to this type of procedure. Different surgical techniques of drainage, resection or combined techniques have been published;²³⁻²⁵ however, the Puestow procedure seems to offer lower morbidity and mortality rates by sparing pancreatic tissue and preserving functional organs such as the duodenum.

Alcohol consumption and smoking have been strongly identified as factors capable of altering the genetic-environmental relationship of patients, playing an important risk role in the evolution and development of CP. It is known that people with a history of alcoholic pancreatitis have a 12.5% risk of developing CP, but to date only in animal models attempts have been made to understand the pathophysiological and genetic mechanisms that predispose to the development of CP, including the SAPE model described above.⁸ An important finding in our series was that 42.2% of patients had a history of smoking and/or alcohol consumption. However, it was not possible to directly relate these factors to the development of CP.

The choice of patient to undergo a Puestow procedure as part of the treatment of CP

should consider the anatomic context, with a dilated pancreatic duct (> 5 mm) and absence of an inflammatory mass of the pancreatic head or bile duct obstruction.^{11,18} The pathognomonic radiological findings of CP and the intraoperative findings in our series are in agreement with what has been suggested in other studies, since the mean diameter of the pancreatic duct between both findings was 8.11 mm, added to the presence of calcifications in the gland and stones in the pancreatic duct.

Another important aspect to highlight was the absence of pancreatic fistulas as a postoperative complication, and when analyzing that the consistency of the gland was hard in all the operative notes evaluated, it is suggested that this variable may play an important predictive role in the development of pancreatic fistulas; however, randomized studies are needed to validate this hypothesis.

Risk factors for developing pancreatic fistulae have been described with significant results in patients undergoing pancreatoduodenectomy. Zunxiang et al, based on the International Study Group on Pancreatic Surgery (ISGPS) definition, described that 39.1% of patients with soft pancreas developed grade B or C fistulae, versus patients who had a hard pancreas ($p < 0.0001$).²⁶

Success rates for short-term pain relief after a Puestow procedure have been reported in 80-85% of patients and in the long term in 70-80% during five to 10 years of follow-up.^{9,27} However, higher rates of pain recurrence (50%) have been described in those patients with a pancreatic duct diameter < 7 mm.⁵

In one of the largest series included in the review by Gouma DJ and his colleagues,¹⁹ and described by Sakorafas GH and colleagues,²⁸ on the results obtained at the Mayo Clinic in the surgical treatment of CP, in 120 patients who underwent lateral pancreato-jejunal-anastomosis, the group described that the pain relief rate was 81% with a follow-up of up to eight years. In our study, 60% had no recurrence of pain, with a mean pain recurrence time of up to 102 weeks and an average follow-up of 4.4 years after surgery.

In the bivariate analysis of the recurrence of this symptom against demographic variables such as age, sex and body weight, as well as

against the history of smoking, alcoholism and the performance of endoscopic procedures prior to surgery, no statistically significant differences were seen that could prove the relationship of these variables as predictors of recurrence of postsurgical pain after a Puestow procedure. However, as evidenced in our results, 46.7% were taken to surgery under the indication of pain, followed by the history of repeated acute pancreatitis (37.8%), so this means that there may be a bias in the description of pain as a presurgical indication, due to the subjectivity of this symptom that is part of the clinical manifestations during any episode of acute pancreatitis.

The development of pancreatic insufficiency, manifested by T2DM and/or de novo diarrhea/steatorrhea in the postoperative course of a decompressive procedure such as Puestow's, are lower compared to that reported with other resection procedures, and in relation to our results it was like that reported in the series of Sakorafas and his group²⁸ although at a lower rate (diabetes 18 vs. 33% and steatorrhea 38 vs. 40%, respectively). However, there were no statistically significant results when we compared the development of de novo pancreatic insufficiency versus the intraoperative findings of the pancreas that could predispose to the development of this complication.

CONCLUSIONS

It is clear then that two of the goals in the treatment of CP are pain relief and improvement in the quality of life of patients. If medical treatment fails to mitigate pain, current literature suggests that surgical treatment has shown better results compared to medical-endoscopic therapies. These types of surgeries, such as the Puestow procedure and others that include pancreatic resection, are performed with low morbidity and mortality in high volume centers such as the Instituto Nacional de Nutrición y Ciencias Médicas "Salvador Zubirán" (National Institute of Nutrition and Medical Sciences "Salvador Zubirán").

At present, there is not an ideal surgical procedure for patients with CP, and the type of intervention chosen should reflect the balance

between the success of the procedure and the inherent risks. Although pain relief was not achieved in 40% of the cases, which is comparable to that reported in other series, the success achieved should be considered in the context of the preoperative status of the patients, mostly in those who have failed medical, radiological and/or endoscopic treatment, in addition to the fact that chronic pain is disabling and affects the quality of life of people diagnosed with CP.

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