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30-Day outcomes and predictors of complications after Puestow procedure

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ABSTRACT

Background: A lateral pancreaticojejunostomy, or a Puestow procedure, is used in chronic pancreatitis with ductal dilation and pain. The current literature on the Puestow is sparse. This study examines outcomes of Puestow procedures nationwide.

Methods: Using ACS-NSQIP database, patients who underwent a Puestow procedure from 2010 to 2016 were identified. Univariate analysis and multivariable regression models were used to identify predictors of mortality and morbidities. Covariates included in the regression models were chosen based on clinical significance.

Results: The cohort included 524 patients. The 30-day mortality rate was 1.2%(n = 6). At least one major complication occurred in 19.1% of patients including death (1.2%), major organ dysfunction (8.2%), pulmonary embolism (1.3%), and surgical site infections (13.0%). Diabetes, COPD, and transfusions were the strongest predictors of complications.

Conclusions: The Puestow procedure is an acceptable treatment modality with low rates of morbidity and mortality. Minimizing transfusions and optimizing pulmonary status may improve 30-day outcomes.

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Introduction

Chronic pancreatitis (CP) is a progressive fibroinflammatory disorder that affects approximately 50 per 100,000 people in the United States (US). Long-standing and recurrent inflammation of the pancreas leads to damage and fibrosis of the pancreatic parenchyma, with loss of acinar, islet and ductal cell function which ultimately results in exocrine and endocrine dysfunction.[1,2] The most common and prominent clinical manifestation of this disease is chronic intractable abdominal pain[1,3]. The burden of this debilitating disease is extensive and results in significantly decreased quality of life, increased healthcare resource utilization, decreased attendance at work, and lost income. Overall the direct and indirect costs associated with CP are approximately $638 million annually in the US.[4–7]

Management options for CP start with lifestyle modifications, including dietary changes and eliminating risk factors for pancreatitis such as smoking and alcohol.[3] Medical therapies include various non-narcotic analgesics and pancreatic enzyme replacement.[3] Unfortunately these measures may fail in 50–60% of patients and necessitate endoscopic or surgical interventions.[8,9] The most common indication for both endoscopic and surgical intervention for CP is pain[10,11]. The pathophysiologic pathway of CP related pain remains poorly understood. Multiple pathways are implicated including pancreatic ductal distension, increased parenchymal pressure, local neural inflammatory infiltration and damage, and abnormal peripheral and central neuropathic alterations.[12–15] The underlying premise of interventional treatment entails mechanical resolution of the obstructed pancreatic duct. Endoscopic methods are employed more frequently and are typically performed first, based on their less invasive nature; however evidence suggests that endoscopic interventions for CP are less effective than surgical modalities.[10]

Multiple surgical procedures have been developed for CP, and these can roughly be classified as either parenchymal resection, decompressive, or a combination of the two.[15–18] Each respective procedure is chosen based on patient anatomy, underlying pathology and etiology, and surgeon experience.[19] The lateral

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pancreaticojejunostomy, or Puestow procedure, has emerged over the past 60 years as the most commonly performed decompressive operation.[17,20] A Puestow is performed for patients with main duct or duct of Wirsung obstruction associated with ductal dilatation. While several variations are described, the main steps of the operation include a longitudinal incision along the pancreas and main pancreatic duct, followed by an anastomosis to a portion of jejunum.[21]

Unfortunately there are very little data to guide the optimal choice or timing of surgical intervention based on patient factors.[16] Due to a relatively low number of these procedures throughout the US, the outcomes after a Puestow operation are lacking. There are several single institution studies from larger centers but with limited numbers of patients.[21,22] The purpose of this study is to better characterize the type of patient undergoing the Puestow procedure and analyze preoperative risk factors predictive of early postoperative morbidity and mortality using the American College of Surgeons National Surgical Quality Improvement Program Database (ACS-NSQIP) database to evaluate a large sample of patients.

Methods

This is a retrospective study of prospectively collected data from the ACS-NSQIP database. Patients who underwent a lateral pancreaticojejunostomy as the primary procedure from 2010 to 2016 were identified using the CPT code 48548. Relevant patient demographics and preoperative variables can be found in Table 1. All postoperative outcomes were followed up to 30 days after surgery. The primary endpoint was 30-day mortality. Secondary endpoints were 30-day postoperative complications including cardiac (myocardial infarction, cardiac arrest), pulmonary (reintubation, failure to wean from ventilator 48 h after surgery, pneumonia), renal (acute kidney injury, acute renal failure), wound complications (superficial, deep, and organ space infection, fascial dehiscence), and hospital length of stay. Univariate analysis and multivariable regression models were used to find predictors of mortality and morbidities. Covariates included in the regression models were chosen with purposeful selection based on clinical significance. P-values of <0.05 were used to determine statistical significance.

Table 1
Patient demographics.

Patient Variable	% (No.) or mean ± SD
Age	52.5 ± 12.8
Body Mass Index (Kg/m^2)	24.3 ± 5.7
Obesity	5.0% (26)
Male Sex	52.5% (275)
Race - Black	15.4% (80)
Race- White	75.1% (390)
Smoker	53.8% (282)
Insulin Dependent Diabetes	21.0% (110)
Non-Insulin Dependent Diabetes	10.5% (55)
Functional Independence	97.9% (513)
COPD	5.9% (31)
CHF	0.2% (1)
Hypertension	46.4% (243)
Dialysis/Renal Failure	0.4% (2)
Cancer	1.0% (5)
Chronic Steroid Use	2.3% (12)
Unintentional Weight Loss	14.3% (75)
ASA Classification III - IV	74.2% (389)

ASA = American Society of Anesthesiologists.

Results

The total cohort consisted of 524 patients with a mean age of 52.5 ± 12.8 years, and 275 patients were men (52.5%). A majority of patients were Caucasian (75.1%), with 15.4% African American and 9.5% of another race. More than half of patients (53.8%) were smokers. Diabetes mellitus (DM) was present in 165 patients (31.5%) and 110 patients (21.0%) were insulin dependent diabetics. Chronic obstructive pulmonary disease (COPD) was noted in 5.9% of the cohort and nearly half of patients (46.4%) had a diagnosis of hypertension (Table 1).

The relevant postoperative outcomes are detailed in Table 2. At least one clinically significant complication occurred in 19.7% of patients, and these are listed as composite outcomes. The composite outcomes include mortality, all major organ system complications (pulmonary, renal, cardiac, and neurological), deep vein thrombosis (DVT) and pulmonary embolism (PE), and surgical site infections (SSI).

The 30-day mortality rate was 1.2% (n = 6). Pulmonary complications, which includes incidence of ventilator greater than 48 h, reintubation events, and pneumonia, occurred in 6.1% of patients (n = 32). SSIs occurred in 68 patients (13.0%). Of note, SSI consisted of several categories: Superficial wound infections were 47.1% (n = 32) of the total SSI's, and 35.3% of SSI's were organ space infections (n = 24). Overall, 4.6% of the total cohort suffered from an organ space SSI. Deep wound infections (n = 6) and wound dehiscence (n = 6) contributed a smaller proportion of SSIs. The readmission rate was 10.5%.

The calculated adjusted odds ratio according to composite event showed that diabetes, COPD, and perioperative transfusion were the strongest predictors of a post-surgical complication (Table 3). Diabetic patients were more likely to suffer a composite event with an odds ratio of 1.74 (95% Confidence Interval (CI) 1.07–2.83, p = .03). COPD patients also showed an increased tendency to have a composite event with an odds ratio of 2.4 (CI 1.02–5.66, p = .04). Perioperative blood transfusions also correlated with an increased risk of an event, with an odds ratio of 1.99 (CI 1.01–3.91, p < .05).

Table 2
Composite outcomes after Puestow Procedure.

Outcome Variable	% (No.) or mean ± SD
Mortality	1.2% (6)
Cardiac Complication	0.8% (4)
Neurologic Complication	0% (0)
Pulmonary Complication	6.1% (32)
Renal Complication	1.3% (7)
DVT/PE	1.3% (7)
Surgical Wound Complication	13.0% (68)
Urinary Tract Infection	2.9% (15)
Perioperative Transfusion	10.1% (53)
Return to Operating Room	3.2% (17)
Unplanned Readmission	10.5% (55)
Operative Time	241.1 ± 112.0
Median Hospital Length of Stay, [CI]	10.5 [9.4–11.7]
Composite Outcome	19.7% (103)

CI = Confidence Interval.
*Composite outcome is a compilation of mortality, all major organ system (cardiac, neurologic, pulmonary, and renal) complications, DVT, PE, and surgical wound infection.
Cardiac = myocardial infarction, cardiac arrest.
Pulmonary = reintubation, ventilation >48 h, pneumonia.
Neurologic = Stroke, transient ischemic attack.
Renal = acute renal insufficiency, acute renal failure.
COPD = Chronic Obstructive Pulmonary Disease.
DVT = Deep Venous Thrombosis; PE = Pulmonary Embolism.

Table 3
Adjusted Odds Ratio for predictors of a composite outcome according to preoperative variables.

Variable	Adjusted Odds Ratios for Composite Outcome with Confidence Interval	p-value
Age (per unit change)	1.00 [0.98–1.02]	0.8935
Male Sex	1.22 [0.78–1.91]	0.3869
Obesity	0.81 [0.27–2.40]	0.7074
Diabetes	1.74 [1.07–2.83]	**0.0245**
Smoking	0.74 [0.46–1.18]	0.2075
COPD	2.40 [1.02–5.66]	**0.0446**
Dialysis/Renal Failure	1.52 [0.05–47.02]	0.8105
Hypertension	0.87 [0.53–1.43]	0.6008
Functional Independence	0.36 [0.10–1.33]	0.1254
Unintentional Weight Loss	1.22 [0.66–2.27]	0.5254
Chronic Steroid Use	0.73 [0.14–3.7]	0.7025
Perioperative Transfusion	1.99 [1.01–3.91]	**0.0455**

Discussion

It is important to review the outcomes of the Puestow as this procedure is performed by surgeons across America in large and small centers. However, most of the literature to date only focuses on single institutions that are typically large volume centers with sample sizes that average approximately 60 patients.[21,22] This study examines outcomes on a larger scale (n = 524) with the NSQIP national database over the course of six years.

When adjusted odds ratios were calculated, there were three perioperative variables that imposed a statistically significant increased risk for incurring a composite outcome postoperatively: diabetes, COPD, and blood transfusions. This has been borne in the literature extensively in patients undergoing pancreatic surgery and other general surgical procedures. Previous studies confirm our findings regarding the risk of blood transfusions. In a meta-analysis of 8,598 hospitalized patients, Rhode et al. reported that minimizing transfusions decreased risk of healthcare associated infections in general.[23] Seykora et al. showed that minimizing transfusions in pancreaticoduodenectomy led to better outcomes in a retrospective review.[24] While a Puestow does not reach the magnitude of a pancreaticoduodenectomy, it still entails a pancreatic anastomosis. The fact that diabetics had higher odds ratio for a composite event in our study also correlates with the literature. A recent meta-analysis of over 27,000 surgical procedures by Martin et al. showed that diabetes alone was found to be an independent risk factor for SSI.[25] In addition, since diabetes is a late stage finding in CP, this risk factor may be a biomarker overall poor health and perhaps the inability to tolerate a major surgery without complications. Overall, DM, COPD, and perioperative transfusions independently influence postoperative outcomes. Our study emphasizes the importance of these particular variables in patients undergoing a Puestow procedure. Efforts should be placed on optimizing these comorbidities, specifically when undergoing preoperative planning. While transfusions may correlate with surgical skill or volume, perioperative transfusions should be avoided if possible.

Despite these aforementioned complications after Puestow, our findings suggest that the rate of complications is acceptable given the extent of the operation. The lateral pancreaticojejunostomy is a major operation that is typically performed open. More recently, surgeons have applied laparoscopic techniques.[26] Although the Puestow is a major operation performed on a chronically inflamed organ in sick patients, the 30-day mortality was relatively low at 1.2%. Our study also showed that 19.7% of patients undergoing Puestow procedures experienced some level of complication. Fortunately a majority of these outcomes were less severe, with largest contribution secondary to superficial SSI's. The next highest contributor to composite outcomes was pulmonary complications, with 6.1% of patients experiencing pneumonia, reintubation, or mechanical ventilation >48 h. This can be explained by the fact that smoking is a known risk factor for the development of pancreatitis.[3] This study showed that 53.8% of the patients were smokers, and smoking and COPD are known risk factors for pneumonia postoperatively.[27] Of note, smoking history is also a well-known cause of wound complications post operatively, and this could have also contributed to the high rate of wound infection seen in our study population.[28] Collectively, these findings suggest that the Puestow operation has an acceptable level of complications.

This study has several limitations. Although the NSQIP database has excellent follow up, it is limited to 30 days post-surgery, and CP is by definition a longstanding process that can have adverse outcomes over months and years.[1] The database is not as detailed as the more recent HPB-NSQIP and does not delineate certain specific outcomes to pancreatic surgery such as pancreatic leaks and fistulas. In addition, the database does not identify qualitative outcomes such as pain, exocrine function, opioid demand, or improvements in quality of life. The database also does not clearly differentiate between a Puestow and a Frey procedure. CPT code 48548 corresponds to a pancreaticojejunostomy, which occurs in both procedures. However, there were 29 cases that listed "excision of lesion of pancreas" as a separate CPT code in our cohort of 524 cases. Therefore, we can speculate that a Frey procedure may have accounted for 5.5% of the subjects in the study, but this cannot be ascertained from the database. There has been literature to suggest that while Puestow and other drainage procedures have short-term benefits, they have higher rates of recurrence in the long term on the order of months to years. Recurrence rates are especially higher compared to CP patients who undergo pancreatic resections (e.g. Frey or Berger procedures).[19] In addition, the varying circumstances surrounding each patient's CP and their indication for Puestow is unknown, which may affect clinical outcomes. The details of the operation are also not available through this type of analysis, and there are myriad techniques that are used to perform this complicated operation that may actually produce varying results.[18] Another limitation of the NSQIP database is the inability to delineate the number of operations performed at centers per year and thus we could not compare outcomes in high volume versus low volume centers. We suspect there would be differences in outcomes after a Puestow procedure according to the volume of surgeries at a given surgery center, but we could not make this comparison based on the available data.

Conclusion

In summary, the Puestow procedure is an acceptable treatment modality for CP, with low rates of short-term mortality and reasonable morbidity. Our data does not allow analysis of long-term outcomes relative to quality of life and pain relief, which would be of value when assessing procedures for CP. Although our results do not compare the different types of operations for CP, it may serve as another source of information for surgeons to educate their respective patients. Minimizing blood transfusions and optimizing preoperative pulmonary status and blood glucose may improve overall 30-day outcome. Further studies with appropriate endpoints are needed to characterize the change in the exocrine function during the pre- and postoperative period, and larger

prospective studies would help to validate these findings.

Author contribution

M.N., E.R, K.L., S.C, R.A, and F.B. all contributed to the study conception and design. K.L., S.C, R.A, and F.B. assisted in the acquisition of data. M.N., E.R, K.L., R.A, and F.B. helped to analyze and interpret data. M.N., K.L., R.A and E.R. assisted in drafting the manuscript. M.N., E.R, K.L., S.C, and F.B. provided critical revision of the manuscript. All authors gave final approval of this manuscript, and all authors agree to be accountable for all aspects of the work.

Declaration of competing interest

None of the authors have any funding or conflicts of interest to disclose.

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