Retrospective comparative study between conventional duct-to-mucosa versus mucosal fixation hepaticojejunostomy in biliary diversion procedures

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Background

The different techniques of hepaticojejunostomy (HJ) are understudied. The aim of the study was to compare the surgical outcomes of conventional duct-to-mucosa HJ and mucosal fixation HJ. HJ is regarded as the definitive management of iatrogenic bile duct injuries, as well as the manner for restoring biliary enteric continuity after resection of benign or malignant tumors.

Patients and methods

Records of patients treated by HJ at the Department of Surgery, Medical Research Institute, Alexandria University and Gastroenterology Surgery Unit, Alexandria Main University Hospital were divided into two groups: those who underwent conventional duct-to-mucosa HJ (G1) and mucosal fixation HJ (G2). The primary outcome measure was the rate of bile leakage; secondary outcomes included operative time, day to resume oral feeding, postoperative morbidity, and mortality.

Results

A total of 143 patients treated by HJ were divided into two groups. The mean duration of hepaticojejunosotmy anastomosis was 29.88±6.72 in G2 versus 32.45 ±7.43 in G1.

The overall morbidity in the mucosal fixation HJ group was significantly lower than in the conventional HJ group [23/52 (44.2%) vs. 56/91, 61.5%, P=0.045]. Biliary leakage incidence was higher in group 1 (21, 23.1%) than in group 2 (5, 9.6%, P=0.045) with reexploration required in two patients. The duration of hospital stay and time to start oral feeding were longer in G1 compared with G2.

Conclusion

The mucosal fixation HJ is a reliable and an efficient technique of biliary diversion as part of pancreaticoduodenectomy or common bile ductinjury or stricture repair.

Mucosal fixation HJ leads to a lower incidence of biliary leakage and overall complications (regardless of the grade) due to better sealing of anastomosis and healthier blood supply.

The incidence of biliary leakage was associated with postoperative pancreatic fistula in pancreaticoduodenectomy surgeries, yet no other significant associations could be identified.

Mortality was not statistically different between the conventional HJ group and the mucosal fixation HJ group.

Keywords:
biliary fistula, hepaticojejunostomy, postoperative pancreatic fistula

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Introduction

Hepaticojejunostomy (HJ) anastomosis is an important part of many surgical procedures including pancreaticoduodenectomy (PD), liver resection, and repair of common bile duct (CBD) injury or stricture.

PD – in which HJ is a cornerstone step – is the procedure of choice for the surgical treatment of periampullary and pancreatic head lesions. While postoperative mortality has dropped to less than 3% at high-volume centers, surgical morbidity is still relevant as the overall rate ranges from 40 to 60%.

Surgeons typically mention three major issues when discussing post-PD morbidity: postoperative pancreatic fistula (POPF), postpancreatectomy hemorrhage, and delayed stomach emptying. For roughly 10 years, these have been extensively discussed in the literature, then examined and formally defined by the International Study Group for Pancreatic Surgery. Although bile leaks occurred in 3–8% of Polydioxanone (PDs) at high-volume institutions, the pathogenesis of these leaks was not sufficiently addressed in this context [1].

Biliary fistula (BF) has been underreported in the literature compared with hundreds of studies centered on POPF published in the previous 30 years. Because of this, there is now a ‘gap’ in the science, one that prevents objective comparisons of various surgical experiences and prevents even the existence of a definition of BF that is widely acknowledged.

There are three main classifications for BF currently in use: the one proposed by the International Study Group for Liver Surgery, the classification by Burkhart and colleagues, and the classification proposed by Miller, which is applicable to all fistulae other than POPF following PD. This contrasts with POPF, which has a single, accepted classification. This confirms the notion that BF are understudied [2–4].

In the literature review consensus that mentioned the HJ technique in miscellaneous operations has only specified the conventional duct-to-mucosa technique to be the only method in which HJ is performed. This technique by default has resulted in accepted postoperative morbidity. That is why the aim of this study was to compare the surgical outcomes of the conventional duct-to-mucosa HJ and a newly developed mucosal fixation technique as a new intervention to improve its impact on postoperative morbidity, especially biliary leakage and thus optimize postoperative outcomes [5].

Patients and methods

Patients

Study population

Records of patients who underwent HJ at the Department of Surgery, Medical Research Institute, Alexandria University and Gastroenterology Surgery Unit, Alexandria Main University Hospital, Alexandria, Egypt during the period from January 2019 to December 2021 were collected. The included patients in the study were divided into two groups: conventional duct-to-mucosa HJ (G1) and mucosal fixation HJ (G2).

Inclusion criteria

(1) Age 30–70 years.
(2) Periampullary carcinoma treated by PD.
(3) Cancer head of the pancreas treated by panreaticoduodenectomy PD.
(4) Iatrogenic CBD injury.

Exclusion criteria

(1) Patients who received neoadjuvant chemotherapy.
(2) Metastatic periampullary and metastatic cancer head of pancreas.
(3) Previous conditions with one of the following comorbid conditions:
    (a) Hypoalbuminemia.
    (b) Chronic anemia.
    (c) Ischemic heart disease.
    (d) Hypothyroidism.
(4) Patients with advanced liver disease (Child B or Child C)

Conventional duct-to-mucosa HJ group (group 1)

The conventional hepaticojejunostomy was performed by a single layer end to side hepaticojejunostomy. Jejunostomy was done matched to the bile duct diameter. The duct to full thickness jejunostomy was performed in eight to 12 stitches with 4/0 PDS sutures in the single interrupted technique (Figure 2).

Mucosal fixation HJ group (group 2)

Technique of mucosal fixation HJ:

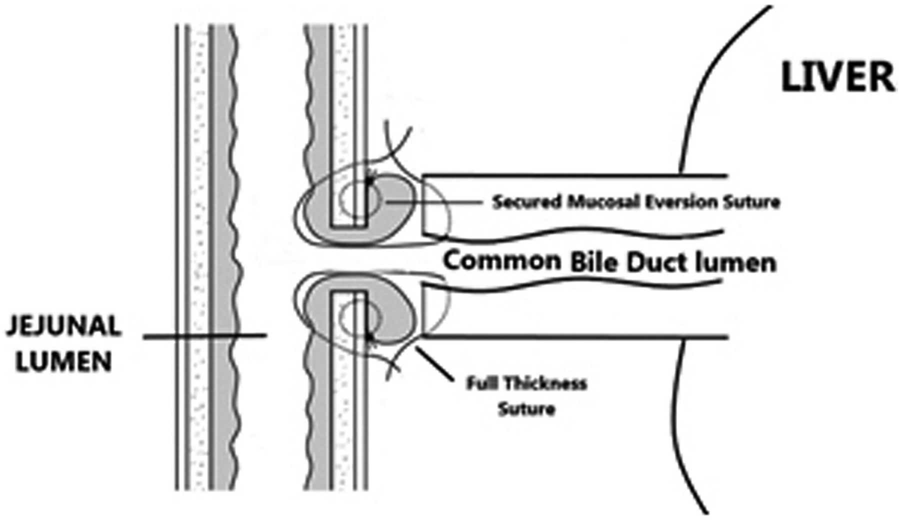
The blind end of the single loop or alternatively the Roux limb of the jejunum is positioned as close to the common hepatic duct stump as possible to start the anastomosis.

Establishment of mucosal eversion, by using diathermy, a small enterotomy is created at the jejunum opposite the main hepatic duct; the diameter of the jejunal orifice should always be significantly smaller than the diameter of the hepatic duct.

Following that, the mucosa is liberally everted and attached outside the lumen to create a sizable circular cushion. As a result of such mucosal fixation, sufficient contact is ensured between jejunal mucosa and duct’s epithelium. Four 6-0 prolene sutures (jejunal seromuscular and jejunal mucosal bites) are used at 12, 3, 6, and 9 h to secure this eversion.

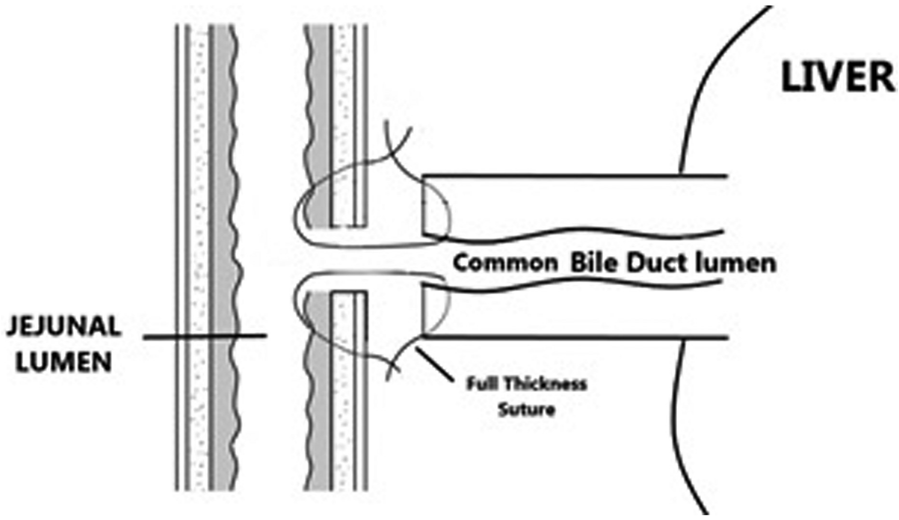
For suturing the true duct-to-mucosa anastomosis’s posterior row, five interrupted 4-0 PDS sutures are inserted – one in the center, two on either side – through the main duct’s full thickness and the circular enterotomy’s full thickness at the jejunum as illustrated in Fig. 1. Because of the mucosal eversion’s

Figure 1



After formation of the secure mucosal eversion and then full thickness jejunal-to-duct bites (mucosal fixation hepaticojejunostomy).

Figure 2



Full thickness duct-to-jejunal mucosa without mucosal eversion (conventional hepaticojejunostomy).

capacity to seal, they can then be knotted with only moderate tension without affecting the anastomotic watertightness.

Besides, we have to mention that every bite to the bile duct has to take a good tissue amount, which has to be at least 4–5 mm in order to avoid tearing and ischemia.

Anterior row of sutures is done using additional five interrupted 4-0 PDS sutures, and the anastomosis is completed in the same manner mentioned above.

Collected data

The following data was collected from the records for both groups:

(1) Detailed history taking with emphasis on age, sex, and body mass index.
(2) Thorough physical examination with special concern on symptoms and signs.
(3) Laboratory investigations.
(4) Radiological investigations: computed tomography abdomen and pelvis, ultrasound

abdomen and pelvis, and Magnetic Retrograde cholangiopancreatography (MRCP).
(5) Intraoperative variables included hepatic duct diameter, operative time, blood loss, and blood transfusion.
(6) Postoperative variables included postoperative complications, drain amylase, liver function, day to resume oral feeding, postoperative stay, reexploration, hospital mortality, and postoperative pathology [6].

Assessments

The primary outcome was the incidence of biliary leak. Biliary leak was defined as fluid with an elevated bilirubin level in the abdominal drain or intraabdominal fluid on or after postoperative day 3 or the need for radiological interventional drainage owing to biliary collections or relaparotomy due to biliary peritonitis. The elevated bilirubin level in the drain or intraabdominal fluid is defined as a bilirubin concentration at least three times higher than the serum bilirubin level measured at the same time. The secondary outcomes were operative time, operative time needed for reconstruction, length of postoperative hospital stay, time of starting oral feeding, postoperative morbidities including POPF, internal hemorrhage, and wound infection. Complications were graded according to their severity on a validated five-point scale using the Dindo–Clavien complication classification system into (grades I, II, III, and IV). Complications that were higher than Dindo–Clavien grade III were considered to be major complications [1,7].

Follow up

Follow-up data for patients were retrieved for the first 4 weeks postoperatively, 2, 3, 6 months, and 1 year respectively. Data were fed to the computer and analyzed using IBM SPSS software package, version 20.0 (IBM Corp., Armonk, NY, USA). Qualitative data were described using number and percent. The Kolmogorov–Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, SD, median, and interquartile range. Significance of the obtained results was judged at the 5% level.

The used tests were:

(1) χ^2 test
For categorical variables, to compare between different groups
(2) Fisher's exact or Monte-Carlo correction
Correction for χ^2 when more than 20% of the cells have an expected count of less than five.
(3) Student's *t* test
For normally distributed quantitative variables, to compare between two studied groups
(4) Mann–Whitney *U* test
For abnormally distributed quantitative variables, to compare between two studied groups.

Ethical approval: The study was approved by the Local Ethics Committee.

Results

Patients' characteristics

The whole study population was 143 patients, of which 83 patients were men (58.0%) and 60 patients (41.9%) were women. The median age was 53 in G1 and 52 in G2. The demographic data of both groups are presented in Table 1. The patients included in the study underwent HJ as part of a periampullary mass resection [24 (26.4%) in G1, 23 (44.2%) in G2], pancreatic mass resection [30 (33%) in G1, 12 (23.1%) in G2], CBD injury repair (mainly iatrogenic) [32 (35.2%) in G1, 12(23.1%) in G2] or CBD stricture repair (subsequent to recurrent cholangitis, mirrizi syndrome or chronic pancreatitis) [5 (5.5%) in G1, 2 (3.8%) in G2] (Table 2).

Intraoperative data

The intraoperative data were comparable in both groups in terms of hepatic duct diameter, the median intraoperative blood loss, and blood transfusion (Table 3). The mean operative time was significantly higher in G2 (4.54±0.5) compared with G1 (4.15±0.83), as was the mean duration of HJ anastomosis (43.92±8.67) in G2, 32.45±7.43 in G1.

Table 1 Comparison between the two studied groups according to demographic data

Demographic data	Group I (*N*=91)	Group II (*N*=52)	Test of significance	*P* value
Sex [*n* (%)]				
Male	48 (52.7)	35 (67.3)	χ^2=2.881	0.090
Female	43 (47.3)	17 (32.7)		
Age (years)	53.51±12.15	53.15±11.20	*t*=0.171	0.864
BMI (kg/m^2)	28.71±4.70	27.27±3.92	*t*=1.959	0.052

χ^2, χ^2 test; group I: patients who underwent conventional hepaticojejunostomy surgery; group II, patients who underwent mucosal fixation hepaticojejunostomy surgery; *t*, Student's *t* test. *P* value for comparing between the studied groups.

Postoperative data

In the mucosal fixation HJ group (G2), the overall morbidity was 23/52 (44.2%), which was considerably lower than the overall morbidity in the traditional HJ group (G1) (56/91, 61.5%, *P*=0.045). In group 1, the median times for starting oral feeding (6 days in G1 vs. 4 days in G2. *P*≤0.001) and drain removal (13 days in G1 vs. 8 days in G2. *P*≤0.001) were delayed compared with group 2. As a result, G1 had a longer median hospital stay (25 days) than G2 (18.5 days, *P*=0.001). Twenty-one (23.1%) patients in group 1 and 5 (9.6%) patients in group 2 both experienced biliary leakage (*P*=0.045). Reexploration was demanded in two (2.2%) patients in group 1 versus one (1.9%) patient in group 2 with intraabdominal collection, causing severe peritonitis due to biliary leakage and sepsis. However, there were no significant differences between both groups as regards the incidence of other complications such as internal hemorrhage wound infection, chest infection, and pulmonary embolism (Table 4).

Mortality

The hospital mortality in this study was six (6.6%) patients in group 1 versus three (5.8%) patients in group 2 (^{FE}P=1.000). The causes of death included chest infection, pulmonary embolism, and septic shock.

Discussion

With the refinement of surgical techniques and perioperative care in biliary surgery, postoperative morbidity and mortality have markedly decreased. However, the incidence of bile leakage has not changed over the past few decades, ranging from 4.0 to 9.8% in recent studies.

According to the International Study Group for Liver Surgery, biliary leak is defined as fluid with an elevated bilirubin level in the abdominal drain or intraabdominal fluid on or after postoperative day 3 or the need for radiological interventional drainage owing to biliary collections or relaparotomy due to biliary peritonitis. The elevated bilirubin level in the drain or intraabdominal fluid is defined as a bilirubin concentration at least three times higher than the serum bilirubin level measured at the same time.

Biliary leakage is divided into the following grades:

Grade A is defined as bile leakage requiring no or little change in patients' clinical management.
Grade B is bile leakage mandating a change in patients' management but can be managed without a relaparotomy or a Grade A bile leakage lasting for more than 1 week.
Grade C is bile leakage requiring relaparotomy [8].

Biliary complications remain a common cause of major morbidity as the presence of bile in the peritoneal cavity may impair the normal host defense mechanisms and predispose the development of sepsis, liver failure and mortality; moreover, it is a common cause of prolonged hospital stay [9].

Table 2 Comparison between the two studied groups according to radiology

Radiology	Group I (*N*=91) [*n* (%)]	Group II (*N*=52) [*n* (%)]	χ^2	^{MC}P
CT				
Periampullary mass	24 (26.4)	23 (44.2)	4.727	0.186
CBD injury	32 (35.2)	15 (28.8)		
Pancreatic mass	30 (33)	12 (23.1)		
CBD stricture	5 (5.5)	2 (3.8)		

χ^2, χ^2 test; CT, computed tomography; CBD, common bile duct; group I, patients who underwent conventional hepaticojejunostomy surgery; group II, patients who underwent mucosal fixation hepaticojejunostomy surgery. *P* value for comparing between the studied groups.

Table 3 Comparison between the two studied groups according to intraoperative data

Intraoperative data	Group I (*N*=91)	Group II (*N*=52)	Test of significance	*P* value
Hepatic duct diameter (mm)	12.24±3.88	13.02±4.11	*t*=1.129	0.261
Hepatic duct length (mm)	13.01±4.84	12.54±4.91	*t*=0.557	0.579
Operative time (h)	4.15±0.83	4.54±0.50	*t*=3.451*	0.001*
Blood loss (ml)	1633 (124–2972)	1611 (143–2993)	*U*=2211.0	0.515
Blood transfusion (U)	3.0 (1.0–4.0)	2.0 (1.0–4.0)	*U*=2233.5	0.566
Duration of anastomosis (min)	31.0 (20.0–45.0)	43.0 (30.0–60.0)	*U*=820.0	<0.001*

Group I, patients who underwent conventional hepaticojejunostomy surgery; group II, patients who underwent mucosal fixation hepaticojejunostomy surgery; *t*, Student's *t* test; *U*: Mann–Whitney *U* test. *P* value for comparing between the studied groups. **P* value less than equal to 0.05, statistically significant.

Table 4 Comparison between the two studied groups according to postoperative data

Postoperative data	Group I (*N*=91)	Group II (*N*=52)	Test of significance	*P*
Hospital stay (days)	25.43±10.30	18.85±8.38	*t*=3.923*	<0.001*
Drain removal (days)	12.87±4.58	7.83±3.57	*t*=7.311*	<0.001*
Amount of draining (ml)	597.44±352.92	430.87±251.17	*t*=3.278*	0.001*
Time starting oral (days)	5.99±1.42	4.10±2.04	*t*=5.920*	<0.001*
Patients with complications				
No complication	35 (38.5)	29 (55.8)	χ^2=4.009*	0.045*
Complication	56 (61.5)	23 (44.2)		
Complications grade	*N*=56	*N*=23		
Grade I	26 (46.4)	11 (47.8)	χ^2=1.333	^{MC}P=0.738
Grade II	18 (32.1)	9 (39.1)		
Grade III	10 (17.9)	2 (8.7)		
Grade IV	2 (3.6)	1 (4.3)		
Drain bilirubin (mg/dl)	1.80 (0.70–14.0)	0.85 (0.20–11.50)	*U*=971.5*	<0.001*
Biliary leakage	21 (23.1)	5 (9.6)	χ^2=4.031*	0.045*
POPF	29 (31.9)	13 (25)	χ^2=0.752	0.386
Internal hemorrhage	4 (4.4)	2 (3.8)	χ^2=0.025	^{FE}P=1.000
Wound infection	73 (80.2)	44 (84.6)	χ^2=0.430	0.512
Chest infection	4 (4.4)	2 (3.8)	χ^2=0.025	^{FE}P=1.000
Reexploration	2 (2.2)	1 (1.9)	χ^2=0.012	^{FE}P=1.000
Mortality rate	6 (6.6)	3 (5.8)	χ^2=0.038	^{FE}P=1.000
Pulmonary embolism	3 (3.3)	2 (3.8)	χ^2=0.030	^{FE}P=1.000
Reflux cholangitis	7 (7.7)	4 (7.7)	χ^2=0.000	^{FE}P=1.000
Anastomotic stricture	8 (8.8)	5 (9.6)	χ^2=0.027	^{FE}P=1.000

χ^2, χ^2 test; FE, Fisher's exact test; IQR, interquartile range; POPF, postoperative pancreatic fistula; *t*, Student's *t* test; *U*, Mann–Whitney test; group I, patients who underwent conventional hepaticojejunostomy surgery; group II, patients who underwent mucosal fixation hepaticojejunostomy surgery. *P* value for comparing between the studied groups. **P* value less than equal to 0.05, statistically significant.

Multiple risk factors have been found to cause higher morbidity following HJ such as Bile leakages (BLs), including male sex, higher American Society of Anesthesiologists score, poorer preoperative functional status, diabetes, hypertension, and long-term steroid use. However, no clinical or investigatory marker, whether radiological or laboratory, was statistically significant enough to be a predictor or a prognostic factor as mentioned in the results of the present study [4].

It is important to note the strong association between the incidence of POPF and biliary leakage following pancreaticoduodenectomy surgery, in which case the morbidity and mortality incidence increase. It was found that intraabdominal infection after PD was more common in the elderly, patients subjected to systemic stress or those with localized fluid collection, and that infection may precipitate biliary leakage by inducing tissue necrosis. This resonated with the results of the present study yet it did not reach statistical significance [10–12].

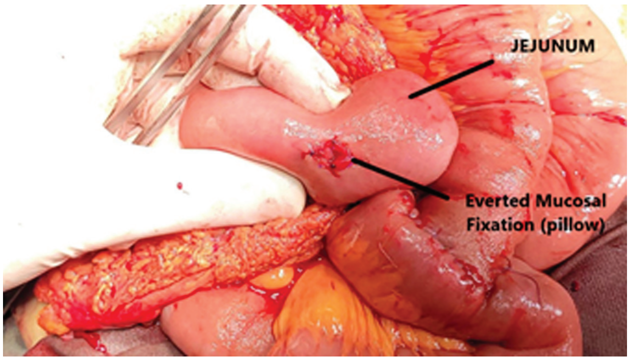
Mucosal fixation method has shown a great development in the duct-to-mucosa anastomosis because of the peculiar sealing ability of the highly vascular everted jejunal mucosa.

We attribute the effectiveness of our innovative strategy to the unique sealing properties of the highly vascularized everted intestinal mucosa.

It should be remembered that there are various essential procedures to follow in order to create a secure hepaticoenteric anastomosis, including the following: (a) the precise apposition of the enteral mucosa and duct wall; (b) preservation of adequate blood flow by maintaining 4–5 mm between each suture to prevent ischemia; (c) ensuring that the jejunal orifice is smaller than the duct diameter; and (d) avoiding any duct tears brought on by traction or tight tension sutures, which can reduce blood flow [2,6,13–15] (Figs 3 and 4).

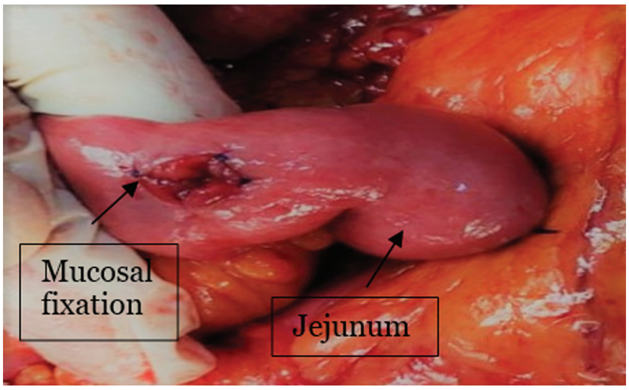
As a consequence of the enhancement done in the mucosal fixation technique, postoperative morbidity has significantly declined toward achieving an optimized rate of operative complications. As previously illustrated in Table 4, the incidence of postoperative complications [23/52 (44.2%) in G2 vs. 56/91 (61.5%) in G1 (*P*=0.045)], and more specifically biliary leaks, was significantly lower with the mucosal fixation technique (5, 9.6%) rather than the conventional method (21, 23.1%) (*P*=0.045). On the contrary, there was no statistically significant

Figure 3



Intraoperative photograph of the jejunal mucosal fixation before performing anastomosis.

Figure 4



Intraoperative photograph of the jejunal mucosal fixation before performing anastomosis.

difference regarding the occurrence of reflux cholangitis or anastomotic stricture (which was manifested in the form of postoperative elevated serum bilirubin level and fever mainly) in both groups.A thorough and standard preoperative diagnostic workup (high-quality imaging and operative risk assessment), consideration of patient-specific risk factors, application of goal-directed therapy to reduce these risks, and provision of highly specialized perioperative and postoperative care and medication protocols (Medications prescribed frequently contain the somatostatin analog octreotide, which has been found to promote anastomosis healing and reduce the frequency of biliary leaks.) are all necessary for a successful biliary surgery [9,16].

Although we used data from a pancreatic and biliary surgery registry with predetermined characteristics and outcomes, our study's most obvious weakness is its retrospective nature. Another drawback is the absence of consistent documentation of some known risk factors for BF, such as intraoperative blood loss, specific bile duct diameter at the location of transection, and texture, particularly in procedures performed at the start of the analyzed period.

Conclusion

The mucosal fixation HJ is a reliable and efficient technique of biliary diversion.

Mucosal fixation HJ leads to a lower incidence of biliary leakage and overall complications (regardless of the grade) due to better sealing of anastomosis and healthier blood supply.

The incidence of biliary leakage was associated with POPF in PD surgeries, yet no other significant associations could be identified.

Mortality was not statistically different between the conventional HJ group and the mucosal fixation HJ group.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published and due efforts will be made to conceal her identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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