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Multi center experience of interrupted versus continuous parachuting suturing technique of hepatico-jejunostomy posterior layer anastomosis

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***Abstract*---**Background: In Biliary enteric anastomosis procedures, hepatico-jejunostomies are a crucial step. Depending on the situation, the hepatico-jejunostomy operation procedure varies depending on the surgical school, and can be continuous or interrupted. Patients and Methods: A prospective comparative randomized study included 100 Patients complaining of malignant pancreatic tumour (65%), iatrogenic bile duct injury (20%), multiple common bile duct stones (10%) and liver transplantation of cirrhotic patients (5%) underwent hepatico-jejunostomy anastomosis to review a multi-center experience of hepatico-jejunostomy anastomosis in Theodor Bilharz Research Institute and Faculty of Medicine of Cairo University with regard to the types of anastomosis performed, early and late complications, and long-term patency and outcomes. Results: According to the type of suturing technique, hepatico-jejunostomy anastomosis patients are sub grouped into posterior interrupted sutures group A and posterior parachuting sutures group B. A significant direct correlation of leakage in group A with obstructive jaundice (r = 0.327 and p value = 0.02), CBD diameter (r = 0.408 and p value = 0.001), and Duct wall thickness (r = 0.408 and p value = 0.001) While there were inverse correlations with pre-operative stent (r = -0.375 and p value = 0.01), and number of threads (r = -0.541 and p value = 0.001). Contrary- wise, leakage in group B showed a significant direct correlation with number of threads (r = 0.500 and p value = 0.001), in addition to technique time (r = 0.418 and p value = 0.001).The correlation study also revealed a significant inverse correlation of stricture in group B with bile duct diameter (r = -0.443 and p value = 0.001). Conclusion: Continuous parachuting suturing technique is significantly faster than the interrupted technique, resulting in shorter operating times and lower costs. There is no statistically significant difference between the interrupted suture technique and the continuous parachuting technique in both anastomotic leakage and strictures.

***Keywords*---**Hepatico-jejunostomy, Biliary enteric anastomosis, continuous or interrupted sutures

1. Background:

Biliary enteric anastomosis procedures are always needed in pancreatic head surgery, liver surgery, liver transplantation, and bile duct damage. Surgical procedures for hepatico-jejunostomy vary by surgical school and may be continuous or interrupted depending on the situation **(House *et al*., 2006)**. While a variety of techniques are available to restore Biliary enteric continuity, the biliary tree is most commonly anastomosed to the jejunum (either as a Roux-en-Y anastomosis or a simple loop) or less commonly to the duodenum **(Antolovic *et al*., 2007)**. The anastomosis may be performed to the common bile duct, common hepatic duct, first or second order hepatic duct branches, or less commonly to the gallbladder. Anastomosis may be performed in an end-to-side or side-to-side fashion, using continuous or interrupted sutures. Stents may be deployed across the anastomosis **(Akamsatsu *et al*., 2011)**. Basic guidelines for a successful

hepatico-jejunostomy procedure are tension-free reconstruction, Anastomosis in the area of well perfused, intact bile duct and small bowel mucosa, mucosal adaptation between the bile duct and jejunum and Creation of anastomosis near to the hepatic duct bifurcation **(Chok *et al.*, 2009)**. The main complications after hepatojejunostomy are leakage and anastomotic stenosis. In the literature, the leakage rate after hepatojejunostomy varies between 2.3 and 5.6% **(Asano *et al.*, 2016)**. Even in high-volume centres, Postoperative complications are relatively rare, bile duct leakage can have far-reaching consequences, including a high risk of prolonged hospitalization and the necessity for interventional drainage or re-laparotomy, which is associated with significant morbidity and mortality **(Kadaba *et al.*, 2017)**. Anastomotic stenosis report rates between 3.7 and 8.0% **(Tarantino *et al.*, 2019)**.

Various surgical techniques are available to create hepatico-jejunostomy, as interrupted suture technique and continuous suture technique **(Orii *et al.*, 2018 and Koch *et al.*, 2011)**. It is also feasible to use a mixture of both procedures' posterior and anterior wall in different techniques **(Linke *et al.*, 2015)**. The interrupted suture approach has the benefit of being universally applicable, even for small bile ducts, although the costs and operating time for this technique should be higher than for the continuous suture technique **(Wellner, 2017 and Klaibar *et al.*, 2015)**. For larger bile ducts, the continuous technique offers a better sealing of the anastomosis. Conversely, advocates of the interrupted technique allege that the continuous suture might lead in long term to a higher rate of stenosis at the anastomosis **(Olthof *et al.*, 2016 and Mercado *et al.*, 2009)**. Despite the frequent necessity of hepatico-jejunostomies in surgery and the relevant consequences for the patient with leakage or stenosis, there are no randomized studies to compare the different surgical techniques **(Bruuner *et al.*, 2018)**.

Aim of work

To compare multi-center experience of interrupted versus continuous parachuting suturing technique of hepatico-jejunostomy posterior layer anastomosis regarding early and late complications.

2. Patients and Methods

This prospective randomized study included 100 patients underwent hepatico - jejunostomy anastomosis in operations involving bilio-enteric anastomosis as pancreatic head surgery, biliary surgery and liver transplantation in the period from November 2021 to 2022 at Theodor Bilharz Research Institute (TBRI) and Faculty of Medicine of Cairo University. All patients were evaluated by history, clinical examination and investigations.

The study included 100 patients divided according to the technique of hepatico-jejunostomy anastomosis regarding the circumstances of the surgery into interrupted suture group (A) and continuous parachuting suture group (B).

2.1. **Surgical technique:**

Operative Technique :

Careful dissections with adhesolysis until identification of the biliary tree. Then, exposing components of the hepatoduodenal ligament including the hepatic artery, portal vein and bile duct. The orifice of the bile duct was prepared and freed from the surrounding structures. In case of biliary tract injury, preoperative identification of the biliary tree can be assisted by insertion of catheter if available, peritoneal lavage is done to identify the site of the biliary tree. Roux loop of jejunum is prepared as a conduit. The distal open end of the Roux loop of jejunum was pulled up through the mesocolon. The proximal open end of the jejunum is prepared for Jejuno-jejunostomy 50 cm from DJ with end to side anastomosis 2 layers using absorbable monofilament suture 3/0 polydioxanone (PDS IV, Ethicon)

2.1.1. **Surgical technique of post. Continuous HJ:**

First, two stay sutures are placed in the right and left corners figure (1). The continuous suture on the posterior wall started from left to right penetrating whole thickness from outside-in manner using absorbable monofilament suture, 4/0 polydioxanone (PDS IV, Ethicon) diameter (figure 2). After the continuous suture encounters, the retained stay sutures at the right and left corners were tied. Then, the thread of continuous suture and stay suture are tied and the needle is passing out from the serosal surface of the intestine. After cutting the inside thread of the right and left corners, the interrupted sutures of the anterior wall started from left to right with outside-in manner figure (4). The sutures were left unknotted and held by small straight clamps, which were held in order, by passing their handles through long right-angle forceps. All the sutures were placed in this manner with a suture distance of 1.5-2 mm. The next step was knotting the anterior row sutures one by one. Then checking integrity of the suture line and then the sutures were cut.

2.1.2. **Surgical technique of interrupted HJ technique:**

First, preparing a hole on the jejunum for the anastomosis. Starting the anastomosis by the posterior row of sutures using an absorbable monofilament suture, such as 4/0 polydioxanone (PDS IV, Ethicon) diameter. The initial posterior row was made by taking a stitch from the jejunum (direction in-out) and then the bile duct (direction out-in) .The jejunal stitches were near full-thickness (the needle was inserted just above the free edge of the mucosa-submucosal layer, passed tangentially and exited on serosal surface). This type of suturing provided easy inversion along with complete opposition. The sutures were left unknotted and held by small straight clamps, which were held in order, by passing their handles through long right-angle forceps. All the sutures were placed in this manner with a suture distance of 1.5-2 mm figure (3). The next step was knotting the posterior row sutures one by one. Then checking the integrity of suture line before cutting the sutures. The next step was suturing of the anterior row figure (4). Similar sutures were placed to the entire anterior row. Then, the sutures were knotted one-by-one, the suture line was checked for its integrity and then the sutures were cut.

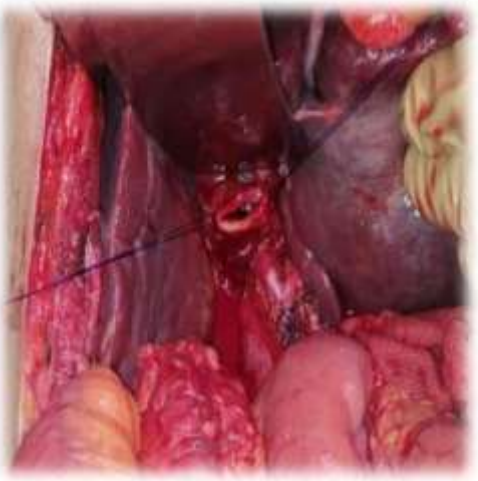

Figure 1: 2 stay sutures at angles of hepatic duct

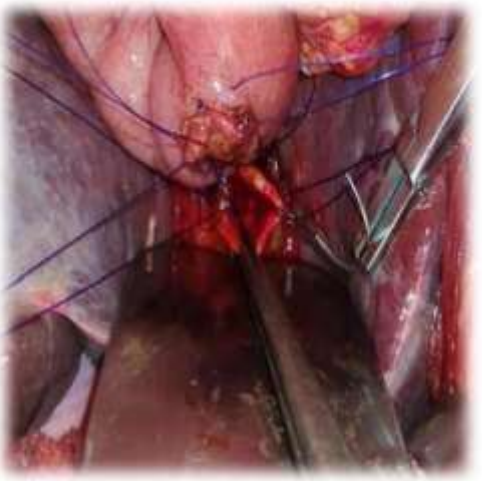

Figure 2: post. Continuous sutures of HJ

Figure 3: post. Interrupted sutures of HJ

Figure 4: ant. Interrupted sutures of HJ

2.2. Data analysis:

The data analyzed using Microsoft Excel 2010 and statistical package for social science (SPSS version 26.0) for windows (SPSS IBM., Chicago, IL). Continuous normally distributed variables were represented as mean ±SD. with 95% confidence interval, and using the frequencies and percentage for categorical variables; a p value < 0.05 will be considered statistically significant. To compare the means of normally distributed variables between groups, the Student 's t test was performed. $\chi 2$ test or Fisher's exact test was used to determine the distribution of categorical variables between groups. Spearman's rank correlation coefficient (r) was done to show the correlation between different parameters in this study.

3. Results:

This prospective randomized study included 100 Patients underwent hepatico-jejunostomy anastomosis during the period from November 2021 to 2022 in the Theodor Bilharz Research Institute (TBRI) and Faculty of Medicine of Cairo University.

According to the type of suturing technique, hepatico-jejunostomy anastomosis patients are sub grouped into interrupted sutures group (A) and continuous parachuting sutures group (B). The demographic data of both groups and the type of surgical procedure were matching, table (1).

Group A group include 50 patients 26 females and 24 males with Mean age is 44.6 while in group B group 50 patients were included 28 females and 22 males with mean age is 45.7 , According to the BMI, the patients in group A ranged from 22 to 27 with mean BMI 24.36 while the patients in group B ranged from 21 to 28 with mean BMI 25.26. 32 patients had DM in group A while 28 patients had DM in group B. There were 22 patients had HTN in group A while 31 patients had HTN in group B.

In 65 patients (65%), the indication for surgery was a malignant process. Of those, 45 patients (45%) had pancreatic ductal adenocarcinoma and 20 patients (20 %) had ampullary carcinoma. 35 patients (35%) had benign disease, 20 patients (20%) of which were due to iatrogenic bile duct injury, 10 patients (10%) of which were due to multiple common bile duct stones, 5 patients (5%) of which were due to liver transplantation in cirrhotic patients.

Table 1: Demographic data (age, gender, BMI, DM, HTN and no. of patients)

		Group A	Group B	P. value
(Mean±SD) age		54.7±13.5	57.3±9.2	0.2
Gender (NO. & %)	Male	24 (48.0%)	22 (44.0%)	0.3
	Female	26 (52.0%)	28 (56.0%)	
BMI (Mean±SD)		24.36±2.35	25.26±1.65	0.2
DM ((NO. & %)		32 (64.0%)	28 (56.0%)	0.5
HTN ((NO. & %)		22 (44.0%)	31 (62.0%)	0.2
No. IN Of pateints	Malignant	25 (50.0%)	40 (80.0%)	0.001**
	Benign	25 (50.0%)	10 (20.0%)	

* P. value <0.05 is significant, ** p. value <0.01 is highly significant.

The mean follows up for patients with cancer was 3 months (range 1–6), while that for patients with benign disease was 1 month (range 0–2).

The Clinical assessment of patients revealed that there were 82 (82%) patients presented with obstructive jaundice, 39 patients (39%) were in the interrupted group while 43 patients (43%) were in the combined group.
Biliary tree dilatation, defined as a bile duct diameter >6mm, was identified preoperatively in 80 patients (80%).

Preoperative biliary drainage, with stenting, via percutaneous transhepatic cholangiography (PTC) or endoscopic retrograde cholangiopancreatography (ERCP), was performed in 70 patients (70%).
Bile duct wall thickness identified preoperatively in 76 patients (76%). Table 2

Table (2): Preoperative data.

	Group A N=50	Group B N=50	P.value
Pt. presented with Obstructive jaundice (no. & %)	39 (39%)	43 (43%)	0.01**
Stenting (no. & %)	40 (80.0%)	45 (90.0%)	0.1
CBD diameter (dilated) (no. & %)	30 (60.0%)	40 (80.0%)	0.001**
Duct wall thickness (no. & %)	30 (60.0%)	46 (92.0%)	0.001**

* p. value <0.05 is significant, ** p. value <0.01 is highly significant.

In our study, a scale of difficulty of the technique was made from one to ten, with one being the easiest and ten being the most difficult. The mean of difficulty of the technique ±SD in interrupted group was 6.1±1.2 while in the continuous parachuting group was 4.4±0.8. The mean ±SD of the number of threads in the interrupted group was 13.1±1.6 compared to 9.4±1.3 in the other group. The mean ±SD of the time of each technique per minute was 25.2±0.6 and 16.5±1.2 respectively, (Table 3).

Table (3): Intraoperative data

	Group A (NO. 50)	Group B (NO. 50)	P. value
Difficulty (Mean±SD)	6.1±1.2	4.4±0.8	0.001**
No. of threads (Mean±SD)	13.1±1.6	9.4±1.3	0.001**
Technique time/min (Mean±SD)	25.2±0.6	16.5±1.2	0.001**

* p. value <0.05 is significant, ** p. value <0.01 is highly significant.

According to post-operative complications, there were 16 patients (16 %) with anastomotic strictures, 7 patients in Group A and 9 patients in Group B, detected at a median duration of 3 months. There were also 13 patients had anastomotic bile leaks (13 %), 8 patients in Group A and 5 patients Group B, all of which were detected during the immediate postoperative period (within the first 5 days). There were also 38 patients had wound infection (38 %), 18 patients in Group A and 20 patients Group B, all of which were detected during the immediate postoperative period (within the first month).

Table (4): Postoperative data

	G1 (NO. 50)	G2 (NO. 50)	P. value
Leakage (NO. & %)	8 (16%)	5 (10%)	0.1
Stricture (NO. & %)	7 (14%)	9 (18%)	0.5
Wound infection (NO. & %)	18 (36.0%)	20 (40.0%)	0.6

* p. value <0.05 is significant, ** p. value <0.01 is highly significant.

The correlation of our study revealed, a significant direct correlation of leakage in Group A with obstructive jaundice (r = 0.327 and p value = 0.02), CBD diameter (r = 0.408 and p value = 0.001), and Duct wall thickness (r = 0.408 and p value = 0.001) While there were inverse correlations with pre-operative stent (r = -0.375 and p value = 0.01), and number of threads (r = -0.541 and p value = 0.001). Contrary-wise, leakage in Group B showed a significant direct correlation with number of threads (r = 0.500 and p value = 0.001), in addition to technique time (r = 0.418 and p value = 0.001).The correlation study also revealed a significant inverse correlation of stricture in Group B with bile duct diameter (r = -0.443 and p value = 0.001).

4. Discussion:

A variety of approaches are available to restore biliary-enteric continuity, the biliary tree is most commonly anastomosed to the jejunum (either as a Roux-en-Y anastomosis or a simple loop) or less commonly to the duodenum **(Dimou *et al.*, 2011)**. The anastomosis may be done to the bile duct, common hepatic duct, first or second order hepatic duct branches, or rarely to the gallbladder **(Pottakkat *et al.*, 2010)**. Anastomosis may be done by interrupted or continuous sutures and fashioned in an end-to-side or side-to-side manner. Stents can be deployed through the anastomosis **(Burkhart *et al.*, 2013 and Kasahara *et al.*, 2006)**. Hepatico-jejunostomies are a common surgical procedure with a low incidence of complications. Various surgical techniques are available to create a hepatico-jejunostomy **(Soejima *et al.*, 2006)**.

Specific complications of biliary-enteric anastomosis include early postoperative anastomotic leak and delayed biliary stricture. Both of these complications have an adverse impact on patient outcome and can contribute to long-term morbidity or mortality. The reported incidence of complications following biliary reconstruction ranges between 3% and 43%. **(House *et al.*, 2006 and Duconseil**

***et al*., 2014)**.
Our study provides an overview of the surgical technique used for the creation of a hepatico-jejunostomy, early and late complications, and long-term patency and outcomes.

In this study, the intra-operative the diameter of the bile duct and duct wall thickness with p value (0.001) are the most common determinants criteria for deciding whether to use one of two different suturing techniques. The continuous suture technique is unfavorable in very small hepatic ducts as it increases the susceptibility of bile duct stricture. This is in partial agreement with **Brunner *et al*. (2018)**. **House *et a*l., (2006)** who reported that the most common decision criteria using both techniques are the bile duct diameter and duct wall thickness with p value 0.001, but with recommendation that in very small hepatic ducts, the continuous suture technique can be demanding.

In our study there were 13 anastomotic bile leaks, all were detected during the immediate postoperative period (within the first 5 days). 7 of which were done by the interrupted suturing technique while 5 were done by continuous parachuting suturing technique. This result shows no statistically significant difference between 2 groups (P >0.05). Of these patients, 9 were managed by pig tail drainage. Two patients had external biliary drainage via PTD and two had to undergo re-laparotomy and re-anastomosis. The results are in agreement with **Kasahara *et al*., (2006)** who reported that the rate of bile leak in the study done on 68 patients undergoing the interrupted technique was 10 cases 14.7 % versus 1 case 20% overall for the continuous technique from total 5 patients included.

While **Kadaba *et al*., (2017)** reported that the rate of bile leak in patients undergoing the continuous technique in a study done on 455 patients was 17 cases 3.7 %. This denotes that the rate of leakage in our study represents an average value with **Kasahara *et al*., (2006)** but the rate of leakage in combined group in our study is higher than the rate of leakage in RS **(Kadaba *et al*., 2017).** In our study, there were 16 anastomotic strictures or stenosis 16%. The rate of anastomotic strictures in patients undergoing the interrupted technique was 7 cases versus 9 cases overall for the continuous parachuting technique. This result shows no statistically significant difference (P >0.05). These patients were managed with PTD either by repeated dilatation and/or stenting (internal/external stent).

These results in agreement with **Soejima *et al*., (2006)** who reported that the rate of stenosis in patients undergoing the interrupted technique (53 patients) was 17 cases 31.8 % versus 4 case 22% overall for the continuous technique (18 patients).

on the other hand, our results not consistent with the study conducted with **Asano *et al*.., (2016)** who operated on 200 patients with posterior continuous technique, reported that anastomotic stenosis was proven in 16 cases 8.0%, compared with the study conducted with **House *et al*., (2006)**. reporting its incidence with interrupted suture 2.6%.

Also, in agreement with **Duconseil *et al*., (2014)** who reported that the major risk factors for anastomotic stenosis was the common hepatic duct (CHD) size demonstrated that bile duct size<5mm was significantly associated with the occurrence of biliary stricture, and the only identified risk factor was a skinny bile duct.

In our study we didn't document the length of the proximal stump of the CHD available for anastomosis. Arterial blood supply is considered to be an essential factor affecting the condition of bile duct stump. However, **Asano *et al*., (2016)** demonstrated that major arterial blood supply to the supra-duodenal bile duct come from below 60%, whereas only 38% came from above. Thus, the length of remnant bile duct from hepatic hilum would directly affect the arterial blood supply of its stump. Thus, distally transected CHD has a potential risk for poor arterial blood supply. However

Our study suggests that the continuous parachuting suture technique is considered to be significantly faster, shortening the operation time, with lower costs as regard number of threads used in both technique as compared to interrupted technique which was more possible and less difficult in cases with small bile duct diameter (p value<0.01).
These results in agreement with study done by **Brunner *et al*., (2018)** and other study done by **Asano *et al*., (2016)** who reported that the continuous suture technique is considered to be significantly faster as compared to high cost and long operating time in the more possible interrupted technique with p value 0.002.

Limitation of the study:
We possibly underestimated the rate of HJ stenosis as it needs longer time for following up. Second, we did not prospectively evaluate all patients who have subclinical anastomotic stenosis as their serum bilirubin may be normal while alkaline phosphatase and GGT are raised. Finally, we didn't document the length of the proximal stump of the CHD available for anastomosis which plays an important role in the process of post-operative biliary stricture.

5. Conclusion:

The results of this study showed that the continuous parachuting suturing technique was considered to be significantly faster than the interrupted technique, resulting in shorter operating times and lower costs. There is no statistically significant difference between the interrupted suture technique and the combined technique in both anastomotic leakage and strictures.

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Authors declared that they have no competing interests
Availability of the data and materials:

Data and materials are available with corresponding author upon reasonable request.

Author's contribution:
All authors made significant contributions to conception, design, acquisition, analysis and interpretation of data
All authors agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be responsible for all aspects of the work.

Ethics approval and consent to participate:
Not applicable. A formal ethical approval is not required, because our manuscript does not report on or involve the use of any animal or human data or tissue (as to the Declaration of Helsinki and the submission guidelines on the journal website).
Consent for publication: Not applicable.

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