Section: General Surgery

Original Research Article

STANDARDIZATION AND LEARNING CURVE OF MODIFIED BLUMGART TECHNIQUE OF PANCREATICO-JEJUNOSTOMY BY THE BEGINNERS

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ABSTRACT

Background: Pancreato-duodenectomy is a challenging procedure, and pancreatico-jejunostomy is the Achilles heel of this surgery. Several technical modifications of pancreatico-enteric anastomosis are practiced by surgeons to reduce the development of a postoperative pancreatic fistula which includes pancreatico-gastric anastomosis, binding technique, separation of the pancreatic and biliary anastomoses by creation of dual roux loop and so forth. There are many studies comparing those techniques but no such technique is regarded as the safest. A recent meta-analysis demonstrated lower incidence of clinically relevant postoperative pancreatic fistula following Blumgart anastomosis compared to other type of PJ anastomoses. **Materials and Methods:** We report an observational study of pancreatico-duodenectomy done for patients with distal cholangiocarcinoma and periampullary tumours by two surgeons at two tertiary centers of West Bengal and studied the learning curve of the pancreaticojejunal anastomosis using a modified Blumgart's technique during the initial phase of the learning curve. We studied the post-operative outcome and short term survival. All data were analyzed using IBM SPSS version 21. **Result:** Average time for construction of the pancreatico-jejunostomy was 52.50 ± 6.9 mins and the mean total operative procedural duration was 319 ± 17.3 mins. Procedural difficulties for the pancreatico-jejunal anastomosis plateaued after approximately ten cases for each surgeon. The incidence of clinically relevant postoperative pancreatic fistula was 18.75 %. There was one mortality in the immediate postoperative period. Median survival had significance correlation with postoperative pancreatic fistula p=0.005. Overall survival and recurrence free survival at a median follow up period of 14 months was 84.375%. **Conclusion:** Blumgart technique of pancreatico-jejunal anastomosis during pancreato-duodenectomy may be replicated safely by the beginners in their early career and is an apt approach. At the least ten cases are required by the beginners to standardize the anastomotic technique while operating as an independent surgeon during the early phase of the learning curve.

INTRODUCTION

Pancreato-duodenectomy is considered one of the most demanding procedure in general surgical practice in view of the consequences of postoperative pancreatic fistula (POPF), the commonest complication of this procedure.[1] Several factors have been attributed as risk factors for developing POPF, such as, age, gender, diabetes, primary etiology, preoperative jaundice, biliary drainage, intraoperative blood transfusion, type of pancreatico-enteric anastomosis, consistency of pancreatic stump and size of pancreatic duct in a patient to mention the most common ones.[2] There is no single technique for pancreatico-jejunostomy and surgeons are still thriving to find out the best approach which will be replicable by all with acceptable outcome.[3]

A multinational study from fifteen institutions including analysis of more than 4000 pancreatico-duodenectomies revealed variable occurrence of clinically relevant pancreatic fistula (CR- POPF) which was approximately 15%.[4]

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Several technical modifications of pancreatico-enteric anastomosis have been tried to reduce the development of a POPF which includes pancreatico-gastric anastomosis, binding technique of pancreatico-jejunostomy, separation of the pancreatic and biliary anastomoses by creation of dual roux loop as done in the Machado technique and so forth.[5-7] There are many studies comparing those techniques but no such technique is proven leak-proof.

A recent meta-analysis demonstrated lower incidence of CR POPF following Blumgart anastomosis compared to other type of PJ anastomosis (0.67–7.14% vs 10% -20% respectively.[8]

Studies also indicate that outcome of pancreatico duodenectomy is much better in high volume centers compared to low volume centers,[9] however the demarcation of high volume or low volume centers are not uniform and varied from < 4 cases per year to < 20 cases per year for low volume centers, and, from >10 cases per year to > 40 cases per year for high volume centers.[10] Studies from some low-medium volume centers in Italy has documented non inferior outcome with provision of multidisciplinary care support for such patients.[11]

Park and colleagues demonstrated that a learning curve for pancreatoduodenectomy do exist but it varies among surgeons and could not be generalized.[12] The most often used parameters to define the learning curve were operative time, intraoperative blood loss, and postoperative complications and the learning curve for open pancreatectomy was considered to be 30 cases with a range of 20-50 cases in a large systematic review.[13]

We hereby wish to study the learning curve to standardize Blumgart technique of pancreatico-jejunal anastomosis and to study the outcome of the procedure performed by the beginners.

MATERIALS AND METHODS

After obtaining institution ethics committee approval we examined prospective and retrospective data from prospectively maintained dataset. The initial thirty-two cases of pancreato duodenectomy performed by two surgeons at two centers from 2019-2024 were included in this study.

Diagnostic and staging evaluation included ERCP [Fig 1.] or side viewing endoscopy with biopsy and /or brush cytology, pancreatic protocol MDCT scan along-with celiac axis, superior mesenteric axis and spleno-portal axis reconstruction for the diagnosis and staging of the disease and for operative planning. Endoscopic biliary drainage was performed for patients with cholangitis, and malnutrition.

Patient demographics, co-morbidities and preoperative clinical parameters such as age, gender, presence of diabetes mellitus, hypertension, smoking habit, serum bilirubin, serum albumin, INR, CA 19-9 levels and the records of biliary drainage were noted.

We followed the steps of pancreato-duodenectomy (PD) as mentioned elsewhere (14).

Intraoperative variables included texture of the pancreas, pancreatic duct diameter, estimated blood loss, red blood cell transfusions, operative duration, time to complete pancreatico-jejunal anastomosis and the type of resection, such as, pylorus preserving pancreato-duodenectomy (PPPD) or classical Whipple procedure. Classical Whipple procedure were undertaken for patients with duodenal carcinoma and few cases of distal cholangiocarcinoma (9/32) where isolation of the first part of duodenum was difficult. Octreotide was not used routinely. Postoperative details included the duration of ICU stays, incidence of post-operative pancreatic fistula (as per the International Study Group of Pancreatic Surgery definitions), delayed gastric emptying, post pancreatectomy hemorrhage, records of re-interventions and days to discharge from hospital.

A modified Blumgart technique of pancreatico-jejunostomy was performed for all the cases as previously described by the author (8). Details of pancreatico-jejunostomy is described below as we included some minor modifications.

After specimen removal (Fig.2) proximal jejunum was brought to the left upper quadrant through the transverse mesocolon from right side of the middle colic artery. A 10-15 cm length of jejunum was placed to lie comfortably adjacent to the cut end of the pancreas. PJ was constructed in two layers. The inner duct to mucosa layer using 5/0 polydioxanone sutures and the outer transpancreatic-jejunal – seromuscular- layer -cuff using 3/0 polypropylene sutures completely enclosing the pancreatic cut end.

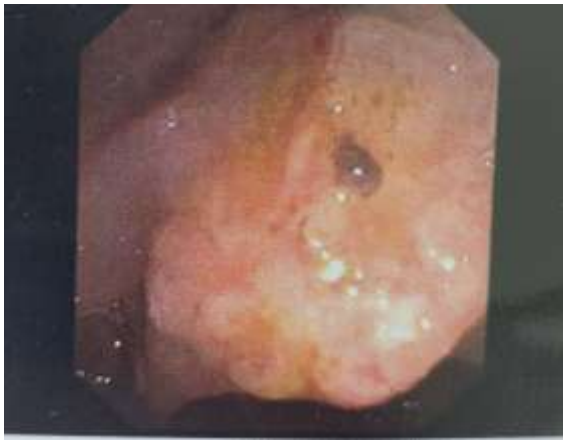

Figure 1: ERCP image showing adenocarcinoma ampulla of vater

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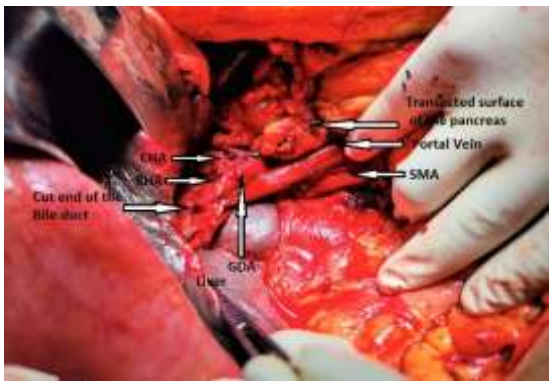

Figure 2: The surgical field after specimen removal

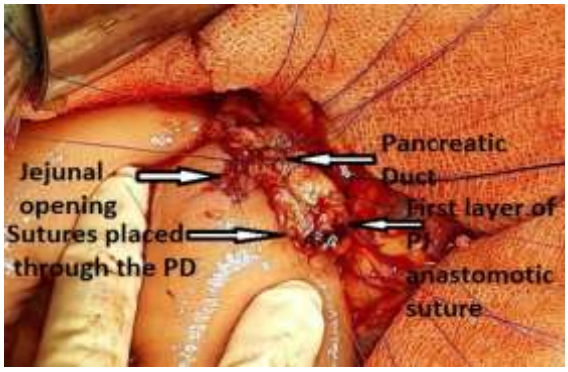

Figure 3: The surgical field after the posterior layer of trans-pancreatic sutures and posterior layer of ducto-mucosal anastomosis

The outer layer of the sutures were taken through the pancreas at a vertical distance of approximately 7.5 mm and horizontally 1 cm away from the pancreatic cut margin. The needle of the 3/0 polypropylene suture was passed through the whole thickness of the pancreas and then passed through the jejunal seromuscular layer vertically. Then the needle was passed from posterior to anterior surface of the pancreas close to the entry point and thus the posterior part of the outer layer suture was placed. Before taking the trans-parenchymal pancreatic passes the curvature of the needles were reduced (ski needle) to facilitate the passes through pancreatic parenchyma. Similarly, other sutures were placed taking care not to pass the needle through the pancreatic duct. All these sutures (five –six in number depending on the vertical dimension of the cut surface of the pancreas) were kept untied at this point to facilitate parachuting of the jejunum around the pancreatic remnant.

The jejunum was incised approximately one cm away from the posterior layer of anastomosis to construct the duct-to-mucosal anastomosis. A good pouting of the jejunal mucosal layer was secured by placing four corner stitches apposing the sero-muscular layer with the everted mucosal layer with 4/0 polyglactin sutures.

Now the pancreatic ductal stitches were placed with 5/0 polypropylene sutures. All the ductal sutures encompassed full thickness of the pancreatic parenchyma. Anterior ductal sutures were placed first to facilitate opening of the pancreatic duct that enabled clear visualization of posterior pancreatic ductal and jejunal mucosal margins.

At this stage the outer layer sutures (3/0 polypropylene) were pulled gently to appose the jejunal loop to the pancreas and the knots were tied with 3 throws (half-tied) and the threads were held with soft clamps with needles on (Fig. 3). Posterior layer of the ducto-mucosal sutures were tied next. Then the anterior ducto-mucosal sutures (inner layer) were completed similarly. We did not use any stent for the pancreatic ductal anastomosis. The previously placed half-tied sutures (outer layer) were passed through the jejunal sero-muscular layer to complete the PJ anastomosis. These sutures were placed approximately 1 to 2 cm from the duct-mucosal layer so that the jejunal limb completely encloses the pancreas without any tension. The topmost and the bottom seromuscular sutures were taken on the lateral and anterior surface of jejunum in a 'U' shaped manner (the mentioned modification) to enclose the corners of the pancreatic stump (Fig.4) thus creating a complete jejunal wrap around the pancreas.[15]

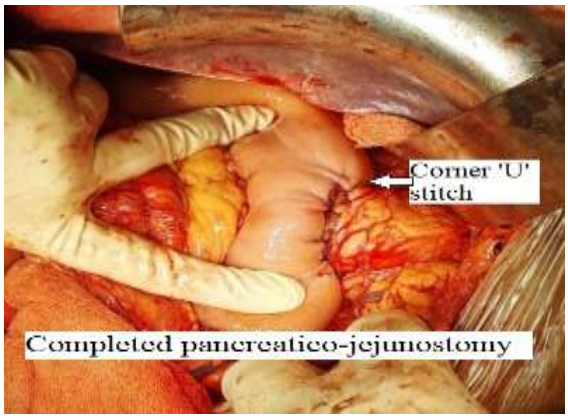

Figure 4: Completed panctreatico-jejunostomy

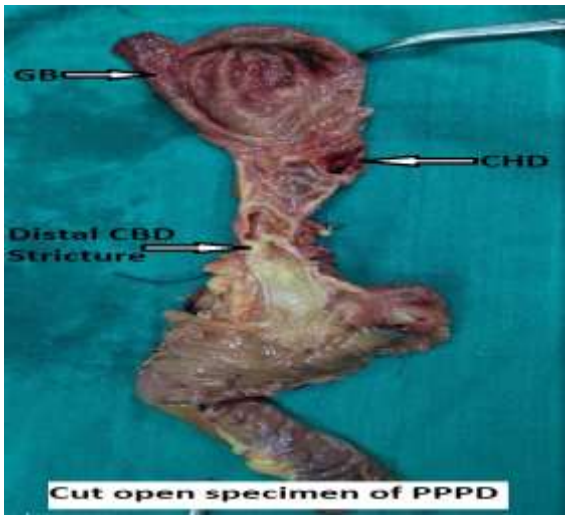

Figure 5: Specimen of PPPD done for distal cholangiocarcinoma

We recorded intraoperative variables, such as, total operative time, time to construct the PJ starting from placement of the first outer layer polypropylene suture till completion of the anterior lower-most

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sutures, intraoperative blood loss, and per operative PRBC transfusions. Bilio-enteric anastomosis and jejunogastric anastomosis were completed (Fig. 4) and two drains were placed in proximity of the pancreatic and biliary anastomoses (Fig. 5).

After the procedures, the patients were shifted to high dependency units and standard postoperative pathway were followed. Postoperative events and complications were recorded and managed carefully. Post-operative morbidities were recorded as per the ClavienDindo classification. Patients were followed at 2-4 weeks interval during the first 3 months and 3-6 monthly thereafter. Adjuvant treatment were added as required and tolerated.

Statistical Analysis: Data recording and analysis were performed with IBM SPSS V 21. Quantitative values were expressed as mean (s.d.) or median values, with ranges. Categorical data are shown with percentage frequencies. Correlation between two nominal variables were assessed with chi-square test and for comparing a nominal with categorical variables Spearman rank correlation tests were used. For all statistical tests the significance level was fixed at P <0·050. Survival data was represented with Kaplan-meier curve.

RESULTS

We included initial 32 cases of pancreato-duodenectomy done for distal cholangiocarcinoma and periampullary tumours operated by two surgeons in two institutes. Twenty-one (65.6%) of them were male. Median age of the study population was 52 yrs with a range of 28 - 67 yrs. Eleven (34%) patients were diabetic, five (16%) were hypertensive, and nine (28%) were smoker. Preoperative median CA 19-9 level was 41 (20-210) u/L. Eleven (34 %) patients underwent preoperative biliary drainage. [Table 1]

Pylorus preserving pancreaticoduodenectomy (PPPD) was done for 23 (72%) patients, and classical Whipple were done for the rest. Average pancreatic duct size at the cut surface was 3.6 ± 1.29 mm and 16 (50%) patients had soft pancreas. It took approximately ten cases for standardization of the procedure by both the surgeons. Average time for pancreatico-jejunostomy was 52.50 ± 6.9 mins (Chart 1). Total operative procedural duration was 319 ± 17.3 mins. Estimated blood loss was 576 ± 106 ml. None of the intraoperative parameters had significant correlation with POPF. [Table 2, 3]

Table 1: Patient demographics and Preoperative status

Age (yrs) **Median, Range**	**52 [28-67]**
Gender (Male)	21 (65.6%)
Diabetes Mellitus	11 (34%)
Hypertension	5 (16%)
Smoker	9 (28%)
CA 19-9 U/mL Median, IQR	41 (20-210)
Preop Bilirubin (Total) mg% Median, IQR	9 (5-18)
ALP U/mL Median, IQR	328 (232-545)
Albumin (gm%) Median, IQR	3.3 (2.9-3.7)
INR Median, IQR	1.2 (1.1-1.4)
Preoperative biliary drainage	11 (24%)

Table 2: Operative details

PPPD / Classical Whipple	23 (72%)/ 09 (28%)
Diameter of PD Median, IQR	3.6 ± 1.29
Soft pancreas	16 (50%)
Duration for construction of PJ (min) Mean ± SD	52.50 ± 6.9
Total operative duration (min) Mean ± SD	319 ± 17.3
Blood loss (ml) Mean ± SD	576 ± 106
PRBC Transfusion (units) Median, IQR	3 (2-5)

Table 3: Correlation of intraoperative parameters and survival with POPF

		Chi square value	**Spearman correlation value**	**p value**
Soft Pancreas	POPF	1.58		0.66
PD diameter			-.108	0.56
Duration of PJ			0.11	0.55
EBL			0.177	0.33
Survival		13.03		**0.005**

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Table 4: Post op recovery of patients and histopathology findings

POPF: n (%)	
Grade A	8 (25%)
Grade B	5 (16%)
Grade C	1 (3%)
Octreotide used n (%)	4 (12.5%)
Gastroparesis n (%)	5 (16%)
Postpancreatectomy haemorrhage n (%)	1 (3%)
Intra abdominal collection n (%)	5 (16%)
Post op complication	
Clavien Dindo n (%)	
Grade 1	9 (28)
Grade 2	11 (34)
Grade 3a	5 (16)
Grade 5	1 (3)
Time in ICU (days) (median, range)	3 [1-18]
Time to discharge (days) (median, range)	14 [6-24]
HPR/ TNM	
Distal cholangiocarcinoma n,(%)	25 (78)
(T1N0)	15
(T1N1)	3
(T2N0)	5
(T2N1)	2
Duodenal adenocarcinoma	3 (9)
(T1N0)	2
(T2N0)	1
Ampullary carcinoma	3 (9)
(T1N0)	3
Pancreatic ductal adenocarcinoma	1 (3)
(T2N0)	1

Median ICU and hospital stays were 3 days [range 1-18 days] and 14 days [range 6-24 days] respectively. Clinically relevant POPF developed in six (18.75%) patients. Gastroparesis occurred in six (18.75%) patients, and intra-abdominal bleeding occurred in a patient who finally succumbed to death (Tables 4). We found significant correlation of POPF and median overall survival (p=0.005). [Table 3]

The single patient in our series who died was a 50 year-old male with distal cholangiocarcinoma and controlled diabetes mellitus on OHA. Intraoperative period was uneventful with 600 ml blood loss and stable haemodynamic parameters. He developed high output pancreatic fistula since postoperative day five. Octreotide and parenteral nutrition were started and antibiotics were escalated. In view of no significant peri-pancreatic collection on non-contrast CT scan he was managed conservatively. However, he gradually developed sepsis and presented with PPH and features of DIC on postoperative day fourteen and died on postoperative day eighteen.

Histopathological examination revealed that twenty-five patients had distal cholangiocarcinoma, among them fifteen had T1N0 tumour, three had T1N1tumour, five had T2N0 tumours, and two had T2N1 tumours. Three each had adenocarcinoma arising from the duodenum and the ampulla. One patient in our series had a periampullary carcinoma of pancreatic ductal origin. [Table 4]

Median follow up period of the patients in our series was 14 months [range 0-40 months]. Overall and recurrence free survival at a median follow up period was 84.375 % (Chart 2). Two patients developed malignant ascites at 24 and 28 months post-surgery and four patients were lost to follow up.

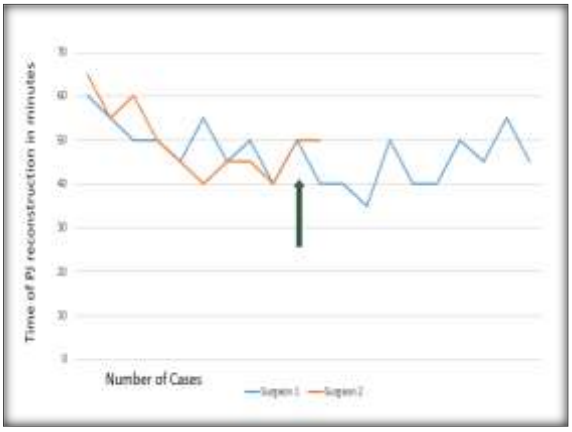

Chart 1: Comparative analyses of time taken to construct the pancreatico-jejunostomy by two surgeons. Curves show a plateau at approximately ten cases (indicated by green arrow)

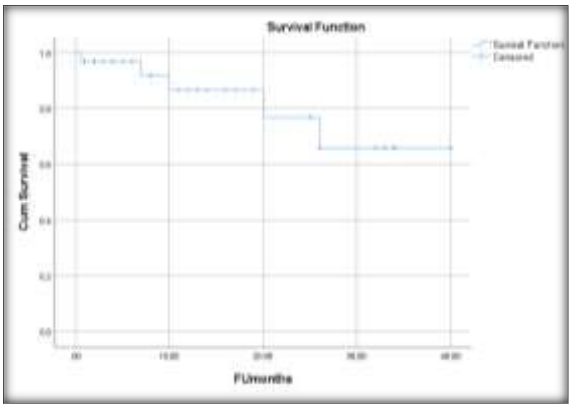

Chart 2: At median follow up of 14 months the OS and RFS were 84.375%

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DISCUSSION

Evolution of the management of pancreatic duct after pancreato-duodenectomy took several decades to reach to two types of standardized procedures, namely, the pancreatico-gastrostomy and pancreatico jejunostomy. However, many variations of the techniques do exist in clinical practice and no single procedure was found to be associated with superior outcome.[3,5-7]

After the first demonstration of PD by Walther Kausch in 1909 as a two stage procedure, Allen Whipple introduced the single stage extirpation of tumour and reconstruction in 1941. In view of high incidence of POPF, related morbidity, and mortality various reconstruction techniques evolved over time. Currently the PJ techniques most common in practice are invagination and duct-to-mucosa techniques. In 2017, a meta-analysis of 1043 patients (DTM: 518; Dunking: 525) identified no significant difference between the two groups in terms of overall as well as clinically relevant POPF rate. 11.9% in DTM (41 of 343 patients) and 10.8% in the dunking group (38 of 350 patients with an OR 0.95, 95%CI [0.30, 2.96], p= 0.92.[16]

In a prospective RCT in 2003 Bassi and his colleagues randomized 144 patients undergoing PD to either a two-layer duct-to-mucosa PJ anastomosis or a single-layer end-to-side anastomosis. PFs were seen in 14% of patients—13% in the duct-to-mucosa group and 15% in the end-to-side group (no significant differences).[17]

Blumgart technique of pancreatico-jejunostomy was first reported in 2010 and has been adopted in various centers.[15] Zhenlu Li and coauthors reported superiority of Blumgart technique over other techniques. In their meta-analysis including one RCT and ten retrospective comparative studies with 2412 patients 1155 (47.9%) underwent BA and the rest underwent non-Blumgart anastomosis. BA was associated with significantly lower rates of CR-POPF (OR 0.38, 0.22 to 0.65; P = 0.004) than non-Blumgart anastomosis.[18]

As mentioned above, POPF is the most dreaded complication following a pancreatico-duodenectomy. The incidence of CR- POPF is approximately 12%-16 % in the series from high volume centers.[4] Incidence of DGE varies from 6%-30% and PPH approximately 2.5% - 12%, and morbidity approximately 20%-40%. The reported 90-day mortality following a PD is approximately 1% - 5% (19-22). Our study reflected a significant correlation of POPF with median overall survival (p=0.005). There are various techniques of PJ aimed to reduce POPF. However, no specific technique of PJ has been proven to be leak-proof and it is advised that surgeons should perform a single technique that gives the best results for them.

We adopted Blumgart technique during the initial phases of doing pancreato-duodenectomy and found that good results can be replicated by this technique even by the beginners. As per our experience, standardization of the PJ anastomosis in Blumgart technique in practice required approximately ten cases (Chart 1). Although, the learning curve for PD is variably reported as 20 – 80 cases for the complete procedure, the PJ in Blumgart technique could be standardized by the surgeons with relative ease. Other challenging steps were during the dissection phase namely, the portal venous margin and the retroperitoneal or SMA margin clearance in view of chances of significant blood loss or dissection through the planes of desmoplastic reaction.

Park and colleagues demonstrated that a learning curve for pancreatoduodenectomy do exist and is different among surgeons. For one surgeon the operating time and blood loss were gradually but significantly improved over first 150 cases whereas for another surgeon the operating time plateauted after 100 cases.[12]

T Seng and co-authors demonstrated that the outcome improved after 60 cases per surgeon as reflected by the reduction of median EBL (1100 vs 725 mL, P= .001), decreased operative time (589 vs 513 minutes, P = .001), and decreased length of stay (15 vs 13 days, P = .004) and reduction of R1 resections (30% vs 8%, P = .001). Longitudinal study of the single surgeon's cases beyond the first 120 cases also added to the experience of the Surgeon with improving outcome (P = .001), however, 'experience' of a surgeon is difficult to define and the results are difficult to generalize.[23]

Similarly, other studies have also demonstrated significant learning curve at the individual and 'center' level which depended on the experience of the entire surgical team performing high volume of pancreatic resections.[21]

Difficulties of the PJ anastomosis in the Blumgart technique during the learning phase included handling multiple sutures placed in the pancreas and placing controlled traction on the transpancreatic sutures particularly for soft textured pancreatic parenchyma. Needles needed to be skewed to a suitable angle for making the passes through the pancreatic duct-parenchyma easy during transpancreatic and the ducto-mucosal layer of the anastomosis. Small pancreatic duct diameters posed significant challenge, but there was no increase in pancreatic leak rate for those cases when performed under magnification using surgical loupes. Hypothetically, a complete wrap by the jejunal loop around the pancreas is likely to prevent any leaks from the pancreatic ducts, both from the main and side branches. Carrying out the steps in careful and diligent manners yields good outcome even in the hands of low volume surgeons.

Limitations of the study: The study was performed by two low volume surgeons with long inclusion period which may not be a good model to study the learning curve.

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CONCLUSION

Adoption of Blumgart technique of anastomosis may be a suitable approach for the beginners in their early career. As per our experience, a minimum of ten cases are required to standardize the pancreatico-jejunostomy for the beginners. The most challenging aspect of the procedure are handling the multiple sutures and making a complete jejunal wrap with creation of the corner 'U' stiches. The outcome of the technique is satisfactory even if performed by the beginners.

Ethical approval and consent to participate: The entire study was conducted only after achieving ethical clearance from institutional ethics committee [Memo No: IPGME&R/IEC/2024/0601] where the study was conducted and on availability of valid consent from all human participants or their legal guardian. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest: The authors have no conflicts of interest.

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Authors' contributions:

Dr Rinki Das: Study design, concept, data collection and analysis, writing of manuscript, manuscript editing.

Dr Ritankar Sengupta: Study design, concept, data collection and analysis, manuscript editing.

Dr Soham Patra: Data collection and analysis, manuscript editing.

Dr Saurabh Das: Data collection and analysis, manuscript editing

REFERENCES

1. Bassi C, Marchegiani G, Dervenis C, Sarr M, Abu Hilal M, Adham M, Allen P, Andersson R, Asbun HJ, Besselink MG, Conlon K, Del Chiaro M, Falconi M, Fernandez-Cruz L, Fernandez-Del Castillo C, Fingerhut A, Friess H, Gouma DJ, Hackert T, Izbicki J, Lillemoe KD, Neoptolemos JP, Olah A, Schulick R, Shrikhande SV, Takada T, Takaori K, Traverso W, Vollmer CM, Wolfgang CL, Yeo CJ, Salvia R, Buchler M; International Study Group on Pancreatic Surgery (ISGPS). The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years After. Surgery. 2017 Mar;161(3):584-591. doi: 10.1016/j.surg.2016.11.014. Epub 2016 Dec 28. Erratum in: Surgery. 2024 Sep;176(3):988-989. doi: 10.1016/j.surg.2024.05.043. PMID: 28040257.
2. Zhang B, Yuan Q, Li S, Xu Z, Chen X, Li L, Shang D. Risk factors of clinically relevant postoperative pancreatic fistula after pancreaticoduodenectomy: A systematic review and meta-analysis. Medicine (Baltimore). 2022 Jul 1;101(26):e29757. doi: 10.1097/MD.0000000000029757. PMID: 35776984; PMCID: PMC9239615.
3. Olakowski M, Grudzińska E, Mrowiec S. Pancreaticojejunostomy-a review of modern techniques. Langenbecks Arch Surg. 2020 Feb;405(1):13-22. doi: 10.1007/s00423-020-01855-6. Epub 2020 Jan 23. PMID: 31975148; PMCID: PMC7036071.
4. McMillan MT, Soi S, Asbun HJ, Ball CG, Bassi C, Beane JD, Behrman SW, Berger AC, Bloomston M, Callery MP, Christein JD, Dixon E, Drebin JA, Castillo CF, Fisher WE, Fong ZV, House MG, Hughes SJ, Kent TS, Kunstman JW, Malleo G, Miller BC, Salem RR, Soares K, Valero V, Wolfgang CL, Vollmer CM Jr. Risk-adjusted Outcomes of Clinically Relevant Pancreatic Fistula Following Pancreatoduodenectomy: A Model for Performance Evaluation. Ann Surg. 2016 Aug;264(2):344-52. doi: 10.1097/SLA.0000000000001537. PMID: 26727086.
5. Bradbeer JW, Johnson CD. Pancreaticogastrostomy after pancreaticoduodenectomy. Ann R Coll Surg Engl. 1990 Jul;72(4):266-9. PMID: 2166459; PMCID: PMC2499216.
6. Peng SY, Mou YP, Liu YB, Su Y, Peng CH, Cai XJ, Wu YL, Zhou LH. Binding pancreaticojejunostomy: 150 consecutive cases without leakage. J Gastrointest Surg. 2003 Nov;7(7):898-900. doi: 10.1007/s11605-003-0036-6. PMID: 14592664.
7. Machado MC, Machado MA. Systematic use of isolated pancreatic anastomosis after pancreatoduodenectomy: Five years of experience with zero mortality. Eur J Surg Oncol. 2016 Oct;42(10):1584-90. doi: 10.1016/j.ejso.2016.05.023. Epub 2016 May 29. PMID: 27266408.
8. Grobmyer SR, Kooby D, Blumgart LH, Hochwald SN. Novel pancreaticojejunostomy with a low rate of anastomotic failure-related complications. J Am Coll Surg. 2010 Jan; 210(1):54-9. doi: 10.1016/j.jamcollsurg.2009.09.020. Epub 2009 Oct 28. PMID: 20123332.
9. Alsfasser G, Leicht H, Günster C, Rau BM, Schillinger G, Klar E. Volume-outcome relationship in pancreatic surgery. Br J Surg. 2016 Jan; 103(1):136-43. doi: 10.1002/bjs.9958. Epub 2015 Oct 27. PMID: 26505976.
10. Ahola R, Sand J, Laukkarinen J. Centralization of Pancreatic Surgery Improves Results: Review. Scand J Surg. 2020 Mar;109(1):4-10. doi: 10.1177/1457496919900411. Epub 2020 Jan 23. PMID: 31969066.
11. Saulle R, Vecchi S, Cruciani F, Mitrova Z, Amato L, Davoli M. The combined effect of surgeon and hospital volume on health outcomes: a systematic review. Clin Ter. 2019 Mar-Apr;170(2):e148-e161. doi: 10.7417/CT.2019.2125. PMID: 30993312.
12. Park HM, Han SS, Park SJ, Kim SW. Learning curve for pancreatoduodenectomy: can it be generalized? ANZ J Surg. 2020 Jul;90(7-8):1414-1421. doi: 10.1111/ans.15874. Epub 2020 Apr 7. PMID: 32255265.
13. Müller PC, Kuemmerli C, Cizmic A, Sinz S, Probst P, de Santibanes M, Shrikhande SV, Tschuor C, Loos M, Mehrabi A, Z'graggen K, Müller-Stich BP, Hackert T, Büchler MW, Nickel F. Learning Curves in Open, Laparoscopic, and Robotic Pancreatic Surgery: A Systematic Review and Proposal of a Standardization. Ann Surg Open. 2022 Jan 27;3(1):e111. doi: 10.1097/AS9.0000000000000111. PMID: 37600094; PMCID: PMC10431463.
14. Logarajah SI, Jackson T, Darwish M, Nagatomo K, Cho E, Osman H, Jeyarajah DR. Whipple pancreatoduodenectomy: A technical illustration. Surg Open Sci. 2021 Dec 8;7:62-67. doi: 10.1016/j.sopen.2021.11.007. PMID: 35036890; PMCID: PMC8749264.
15. Lee WJ. Fish-Mouth Closure of the Pancreatic Stump and Parachuting of the Pancreatic End with Double U Trans-Pancreatic Sutures for Pancreatico-Jejunostomy. Yonsei Med J. 2018 Sep;59(7):872-878. doi: 10.3349/ymj.2018.59.7.872. PMID: 30091321; PMCID: PMC6082987.
16. Kilambi R, Singh AN. Duct-to-mucosa versus dunking techniques of pancreaticojejunostomy after pancreaticoduodenectomy: Do we need more trials? A systematic review and meta-analysis with trial sequential analysis. J Surg Oncol. 2018 Apr;117(5):928-939. doi: 10.1002/jso.24986. Epub 2018 Mar 25. PMID: 29575015.
17. Bassi C, Falconi M, Molinari E, Mantovani W, Butturini G, Gumbs AA, Salvia R, Pederzoli P. Duct-to-mucosa versus end-to-side pancreaticojejunostomy reconstruction after pancreaticoduodenectomy: results of a prospective

ISSN (O): 2687-5365; ISSN (P): 2753-6556

randomized trial. Surgery. 2003 Nov;134(5):766-71. doi: 10.1016/s0039-6060(03)00345-3. PMID: 14639354.
18. Li Z, Wei A, Xia N, Zheng L, Yang D, Ye J, Xiong J, Hu W. Blumgart anastomosis reduces the incidence of pancreatic fistula after pancreaticoduodenectomy: a systematic review and meta-analysis. Sci Rep. 2020 Oct 21;10(1):17896. doi: 10.1038/s41598-020-74812-4. PMID: 33087777; PMCID: PMC7578105.
19. Merath K, Mehta R, Tsilimigras DI, Farooq A, Sahara K, Paredes AZ, Wu L, Ejaz A, Pawlik TM. In-hospital Mortality Following Pancreatoduodenectomy: a Comprehensive Analysis. J Gastrointest Surg. 2020 May;24(5):1119-1126. doi: 10.1007/s11605-019-04307-9. Epub 2019 Jul 10. PMID: 31292889.
20. Narayanan S, Martin AN, Turrentine FE, Bauer TW, Adams RB, Zaydfudim VM. Mortality after pancreaticoduodenectomy: assessing early and late causes of patient death. J Surg Res. 2018 Nov;231:304-308. doi: 10.1016/j.jss.2018.05.075. Epub 2018 Jun 27. PMID: 30278945; PMCID: PMC8246070.
21. Shrikhande SV, Shinde RS, Chaudhari VA, Kurunkar SR, Desouza AL, Agarwal V, Bhandare MS. Correction to: Twelve Hundred Consecutive Pancreato-Duodenectomies from Single Centre: Impact of Centre of Excellence on Pancreatic Cancer Surgery Across India. World J Surg. 2020 Aug;44(8):2794. doi: 10.1007/s00268-020-05519-w. Erratum for: World J Surg. 2020 Aug;44(8):2784-2793. PMID: 32322940.
22. Shrikhande SV, Barreto SG, Somashekar BA, Suradkar K, Shetty GS, Talole S, Sirohi B, Goel M, Shukla PJ. Evolution of pancreatoduodenectomy in a tertiary cancer center in India: improved results from service reconfiguration. Pancreatology. 2013 Jan-Feb;13(1):63-71. doi: 10.1016/j.pan.2012.11.302. Epub 2012 Nov 10. PMID: 23395572.
23. Tseng JF, Pisters PW, Lee JE, Wang H, Gomez HF, Sun CC, Evans DB. The learning curve in pancreatic surgery. Surgery. 2007 Apr;141(4):456-63. doi: 10.1016/j.surg.2006.09.013. Epub 2007 Jan 22. Corrected and republished in: Surgery. 2007 May;141(5):694-701. PMID: 17383522.

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