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## Pancreaticojejunostomy vs. Pancreaticogastrostomy in Whipple's Operation: A Literature Review

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**IMPORTANCE** Pancreatic malignancy is one of the leading causes of morbidity and mortality. The definitive surgical treatment for resectable pancreatic cancer includes pancreaticoduodenectomy (Whipple's Operation). Operative morbidity and mortality following pancreaticoduodenectomy (PD) is mainly associated with leakage of pancreatic enzymes leading to formation of either pancreatic fistulas or intra-abdominal collections. Various types of pancreatico-enteric anastomosis have been proposed to prevent these complications. Different studies have been performed to compare the outcomes of Pancreaticogastrostomy (PG) versus Pancreaticojejunostomy (PJ) in terms of incidence of post-operative pancreatic fistulas (POPF). Although it is widely accepted that no one technique is superior to the other but one of the underlying facts is that there are various ways of doing pancreatic anastomosis and moreover individual surgeon's comfort and practice also matters. A review of literature was carried out to address the techniques of doing PJ and PG and comparison of postoperative complication rate in Pancreaticogastrostomy (PG) versus Pancreaticojejunostomy (PJ). We concluded that techniques of doing PJ and PG are surgeon dependent according to the characteristics of pancreatic remnant stump and there is no significant difference in the rate of clinical POPF between PG and PJ.

**KEY WORDS** Knowledge Management, surgeon, surgery

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### Invited Review

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Pancreaticoduodenectomy (PD) is the best surgical treatment option for benign and malignant tumors of the pancreatic head, distal bile duct, and ampulla. Despite improvements in post-operative care and advancement in surgical techniques, morbidity related to this operation remains very high. Since the establishment of PD, pancreatico-enteric reconstruction has been a highly valued research area, which is considered to be closely related to the success or failure of the surgery<sup>1</sup>. In general, pancreatico-digestive tract reconstruction includes Pancreaticojejunostomy (PJ) and Pancreaticogastrostomy (PG). Unlike gastrointestinal anastomosis, these two types of reconstruction after pancreatic surgery are diverse, with different results and evaluations. Therefore, there is still room for improvement in PJ and PG and these procedures are still the focus of future research in PD. The incidence of complications after PD is significant, with some large pancreatic centers reporting an incidence of approximately 10-45%<sup>2-7</sup>. The incidence of post-operative pancreatic fistula (POPF), delayed gastric emptying (DGE) and gastrointestinal or abdominal hemorrhage has been reported to be 3%-45%<sup>8</sup>, 5%-61%<sup>9-10</sup> and 1%-8%<sup>11</sup> respectively. Other complications include abdominal empyema, wound infection,

and pulmonary infection<sup>12</sup>. This review will provide an overview of the evolution of the pancreatico-enteric anastomosis following PD, the spectrum of anastomosis performed around the world, and finally present the current evidence in support of each anastomosis.

### HISTORICAL BACKGROUND OF PANCREATICODUODENECTOMY

Codivilla performed the first *en bloc* excision of the head of the pancreas for pancreatic cancer<sup>13</sup>. However, he did not perform a pancreatico-enteric anastomosis as part of the reconstruction. In fact, the first person to attempt a pancreatico-enteric anastomosis following a transduodenal partial PD was William Halsted<sup>14</sup>. In 1898, he implanted the pancreatic duct into the repaired line of incision of the duodenum. He reported no POPF, an outcome that was also noted by other surgeons such as Koerte, Navarro, Kerr, Bohm, Schussler and Slaymer following transduodenal ampullary excision<sup>15</sup>. By 1941, Allen Whipple began to appreciate that two important contributors to PD-related morbidity were pancreatic fistulae from the over sewed ducts, in the short-term, and fat indigestion necessitating pancreatic extracts in the long-term<sup>16</sup>. By 1945, he reported the

success of his single staged procedure with the implantation of the pancreatic duct into the jejunum (PJ) below the choledochojejunostomy<sup>17</sup>. The first to successfully perform a PG were Waugh and Clagett in a cohort of 30 patients<sup>18</sup>. The rationale provided for PG being an improved alternative to PJ includes the suggestion that the anastomosis is tension-free since the body of the pancreas forms bed of the stomach and the weight of biliary and pancreatic secretions pooling up in the jejunum exerting a traction effect on the anastomosis is obviated, well vascularized (considering the robust gastric blood supply), without risk of activation of pancreatic enzymes or mixing of the pancreatic and biliary secretions<sup>19-20</sup>.

### PANCREATICOJEJUNOSTOMY (PJ)

Conventionally Pancreaticojejunostomy is performed as end to side, double layer, duct to mucosa anastomosis in which inner layer incorporates full thickness jejunal wall to pancreatic duct and outer layer as seromuscular jejunal stitch to pancreatic tissue. Reported leak rate after conventional technique is 6-22%<sup>21</sup>. Invagination of pancreatic tissue with or without duct to mucosa stitches has been studied with promising results. Invagination with duct to mucosa stitches is reported to have rate of POPF as low as 3.3%<sup>22</sup>. The only major difference in the inversion or invaginating end-to-side anastomosis and the duct-to-mucosa end-to-side anastomosis is in the size of the jejunal opening, a wide jejunal opening matching the diameter of the cut surface of the pancreas in the former and a 'pin-hole' opening in the jejunum in the latter<sup>23,24</sup>.

### PANCREATICOGASTROSTOMY (PG)

Conventionally Pancreaticogastrostomy is performed as invaginated double layer anastomosis to posterior wall of stomach with or without pancreatic duct stenting. Fernandez et al., reported doing pancreaticogastrostomy with gastric partition in which they made pancreaticogastric anastomosis to partitioned part of stomach. They compared it with conventional Pancreaticojejunostomy in a randomized controlled trial and demonstrated that this technique was significantly superior to Pancreaticojejunostomy in reducing pancreatic fistula risk<sup>25</sup>. It has been proposed that lack of enterokinase and acidic environment in stomach inactivates pancreatic enzymes, which along with good blood supply of stomach may have role to play in reducing risk of anastomotic leak<sup>26</sup>. While potential of anastomotic leak is reduced by pancreaticogastrostomy, long term exocrine and endocrine functions are compromised more in these patients as compared to those who underwent Pancreaticojejunostomy<sup>27</sup>. Furthermore, risk of digestive tract bleeding is also more after pancreaticogastrostomy, though management of GI bleed is easy via upper gastrointestinal endoscopy should bleeding occur<sup>28</sup>.

### OTHER FACTORS FOR POPF:

In addition to postoperative care and surgical technique, certain patient and disease related factors predispose patients to high risk of POPF development<sup>29</sup>. Soft texture of pancreas is an established risk factor for POPF<sup>30</sup>. There are only a few randomized controlled trials that have been conducted on or have reported separate subgroup analysis for this select

subgroup of patients. Bassi et al., reported on difference in fistula rate after pancreaticogastrostomy versus pancreaticojejunostomy for patients with soft pancreas<sup>31</sup>. Contrary to that, subgroup of patients with soft pancreas in randomized controlled trial by Topal et al., demonstrated that Pancreaticogastrostomy was superior to pancreaticojejunostomy for postoperative pancreatic fistula<sup>32</sup>. There has been no meta-analysis to date to compare pancreaticogastrostomy versus pancreaticojejunostomy in patients with intra-operative soft texture of pancreas which needs to be addressed via pooled data analysis.

### INDIVIDUAL VARIATIONS

There are many ways of performing pancreatic anastomosis and adopting one way of doing anastomosis as compared to the other depends upon comfort and training of operating surgeon in addition to other factors. Adopting and mastering another way of doing the same task when surgeon is comfortable with one way is not always easy and may not reproduce the same results as proposed by other surgeons. This is why same technique has different rates of pancreatic fistula reported from different centers<sup>33</sup>.

### DISCUSSION

There are multiple randomized controlled trials conducted to date to compare Pancreaticogastrostomy versus Pancreaticojejunostomy. Three trials found that rate of pancreatic fistula was significantly lower in Pancreaticogastrostomy group<sup>34, 35, 36</sup> and these trials had used definition proposed by International Study Group of Pancreatic Fistula (ISGPF) to define pancreatic fistula (PF). There are few trials which were conducted before 2005 and they used definitions of PF according to their individual centers. Meta-analysis conducted on these trials have reached at different results. Another meta-analysis conducted in 2016 by Qin et al., found statistically significantly less POPF in PG group as compared to PJ group<sup>37</sup>. This meta-analysis included all studies irrespective of their definition of pancreatic fistula. Another meta-analysis by Crippa et al., failed to detect any difference in the two groups<sup>38</sup> but random effect model was used to analyze the results as opposed to former meta-analysis.

A study conducted by the senior author (FH) of his own results of 101 patients undergoing PD, 87 % with PG and 13 % with PJ showed biochemical subclinical leak (Type A) in 13.9% whereas POPF Type B was 7.9% and Type C in 5%. Although a comparison of PG and PJ was not done but the study showed PG as a safe option in PD especially for soft pancreas with short pancreatic duct<sup>39</sup>.

A very recent meta-analysis published in 2019 included 11 randomized controlled trials and concluded that overall PF morbidity is significantly lower in the PG group than in the PJ group. Grade A PF did not affect the disease outcome; therefore, they further analyzed the incidence of grade B and C PF. Grades B and C PF was not significantly different between the two groups<sup>40</sup>.

According to recent Cochrane Review<sup>41</sup>, PJ and PG reconstruction were similar in postoperative pancreatic fistula

rate, mortality, length of hospital stay, surgical re-intervention rate, and risk of any surgical complications. The overall postoperative pancreatic fistula rate was 24.3% (181/746) in the PJ group and 21.4% (164/767) in the PG group but they downgraded the quality of evidence to low due to high risk of bias<sup>41</sup>.

In another study conducted by Savio George Barreto and et al, it has been concluded that there is no difference in POPF rates between PG and PJ, as well as individual variations, except in a high-risk anastomosis where performance of a PJ may be preferred<sup>42</sup>.

Analysis of post-operative hemorrhage was done in nine trials with 788 PG and 734 PJ patients. Postoperative hemorrhage showed a significantly lower morbidity in the PJ group than in the PG group<sup>40</sup> but DGE was not significantly different between the two groups. Similarly, the overall rate of postoperative bleeding was 9.3% (63/681) in the PJ group and 13.8% (97/705) in the PG group according to Cochrane review<sup>41</sup>.

## ARTICLE INFORMATION

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However, there is no trial or meta-analysis published as yet that reported superiority of Pancreaticojejunostomy over Pancreaticogastrostomy.

## CONCLUSION

There is no difference in the incidence of clinically significant PF between the two groups. However, postoperative bleeding is higher in PG than in PJ. Surgeon's training and comfort and features of pancreatic remnant should be important consideration while selecting the type of pancreatic anastomosis.

## CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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