REVIEW ARTICLE

WHIPPLE PROCEDURE: PANCREATICOGASTROSTOMY VERSUS PANCREATICOJEJUNOSTOMY: A LITERATURE REVIEW

Sameer Rehman, Affan Umer, Michael Kuncewitch, Ernesto Molmenti

Department of Radiology, Hartford Hospital, Department of Surgery, Saint Francis Hospital and Medical Centre, Hartford, Department of Surgery, North Shore-Long Island Jewish University Hospital, New York-USA

Pancreatic cancer is one of the leading causes of oncologic morbidity and mortality worldwide. The definitive surgical management for pancreatic cancer includes pancreaticoduodenectomy with either anastomosis to, or implantation of remnant pancreas to the stomach (pancreaticogastrostomy) or the jejunum (pancreaticojejunostomy). Operative morbidity and mortality following pancreaticoduodenectomy frequently results from complications associated with a pancreaticojejunal anastomotic leak. Pancreaticogastrostomy is an alternative method of restoring pancreatic continuity with the gut, which has been employed by a number of institutions showing some benefit in operative mortality.

Keywords: Pancreatic neoplasm; Pancreatico gastrostomy; Pancreaticoduodenectomy; Pancreatic surgery complication

J Ayub Med Coll Abbottabad 2016;28(1):179–82

INTRODUCTION

Pancreatic cancer is one of the leading causes of oncologic morbidity and mortality worldwide.[1] In western countries pancreatic cancer is the fourth most common cause of cancer related deaths.[2] Patients may present with a variety of symptoms ranging from, weight loss abdominal pain, jaundice or a palpable mass in the abdomen. Pancreatic cancer is relatively indolent in its early stages and is difficult to diagnose. Therefore most pancreatic cancers are diagnosed at advanced stages and may have distant metastasis. The most common metastatic foci of the primary tumour are the local lymph nodes, the ligament of treitz, portal vein, celiac plexus, and mesenteric blood vessels. Distant metastasis include liver, lungs and very rarely to the overlying skin. The 5-year survival rate is approximately 5.5% despite progress in surgical management, diagnostic imaging and medical-oncologic treatment.[1]

Primary pancreatic tumours can be divided into two types: the non-endocrine and the endocrine. Further sub-division can be made into 5 types; namely epithelial, exocrine, endocrine, mesenchymal and unknown or mixed-origin type. The non-endocrine tumours include adenocarcinomas (most common) as well as acinar cell carcinomas, adenosquamous carcinomas, colloid carcinomas, giant cell tumours, hepatoid carcinomas, intraductal papillary-mucinous neoplasms, mucinous cystic neoplasms, pancreatoblastomas, serous cystadenomas, signet ring cell carcinoma, solid and pseudopapillary tumours and undifferentiated carcinomas. Endocrine carcinomas mainly include insulinomas and glucagonomas.

Whipple Procedure:

The surgical treatment for pancreatic cancer is the resection of the pancreatic head (or the entire pancreas) along with removal of other structures (gallbladder, duodenum or antrum of stomach) and then re-implantation of the remnant pancreas to the stomach (pancreaticogastrostomy) or the jejunum (pancreaticojejunostomy). Halsted in 1898 performed the first local excision of the Vater's ampulla for carcinoma of the ampulla.[3] The first successful resection of a peri-ampullary tumour was done by Kausch in 1909.[4] This was a two stage operation conducted six weeks apart; first a cholecystojejunostomy was performed, followed by a second operation that included resection of the head of the pancreas along with the pylorus of the stomach and the first and second portions of the duodenum. The operation was completed with a gastroenterostomy, closure of the distal common bile duct, and anastomosis of the remaining pancreas to the 3rd part of the duodenum. This was the foundation of the pancreatojejunostomy which was popularized in 1935 by Whipple and colleagues.[5] A form of pylorus-sparing pancreaticojejunostomy can also be undertaken (Figure-1).

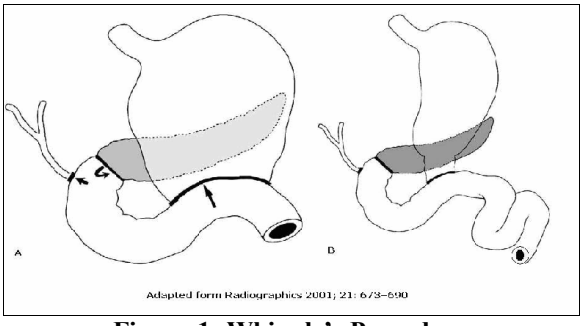

Figure-1: Whipple's Procedure

A. Pancreatoduodenectomy is shown in which the head of pancreas, duodenum, and gastric antrum have been removed with a loop of jejunum brought up to the upper right quadrant to anastomose with the pancreas, stomach, and bile duct. The anastomoses denoted by the black arrows are the gastrojejunostomy, pancreatojejunostomy, and choledochojejunostomy. **B.** Shows a pylorus-sparing pancreatoduodenectomy: the pylorus is preserved along with a small segment of duodenum, and an anastomosis between the stomach and distal duodenum (gastroduodenostomy) is formed.

Pancreaticojejunostomy:

Whipple's surgery is a two stage procedure but a little different from the original Pancreatojejunostomy. In the first stage of the operation a gastroenterostomy along with division of the common bile duct is performed. This is followed by a cholecystogastrostomy. In the second stage the head of the pancreas and duodenum is removed and the stump of the pancreas is closed by a suture without making an anastomosis of the pancreas with the intestine. However, Whipple later described the whole procedure in a single operation in 1940[6] and included a pancreaticojejunostomy in 1942[7]. This was intended to prevent pancreatic fistula formation after the pancreatic stump was closed. The end-to-end anastomosis between the jejunum and the pancreas in many centres is typically done in 2 layers. The inner layer is composed of the cut edge of jejunum and the main pancreatic duct and the outer layer is comprised of the overturned seromuscular layer of the jejunum sutured onto the pancreatic parenchyma. The outer layer is 3–4 cm away from the inner anastomosis (Figure-2). Some centres will invaginate the pancreas into the jejunum without performing a duct-to-mucosal anastomosis.[8]

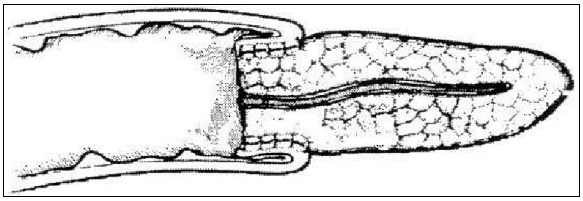

Figure-2: Pancreaticojejunostomy; the pancreatic remnant is invaginated into jejunum to prevent leakage in an end-to-end fashion

The occurrence of pancreatic fistula after surgery increases hospital length of stay, morbidity and mortality.[9,10] This emphasizes the importance of analysing methods that minimizes anastomotic leakage. Major complications of pancreaticojejunostomy include pancreatitis, abscess, haemorrhage and the formation of fistula, at the pancreatic-jejunum anastomosis. Although improvement in operative technique and anaesthesia have decreased operative mortality rates to less than 5% in large volume centres[11], postoperative complication such as an uncontained leak of the pancreas, haemorrhage and sepsis will increase mortality to a rate of 20–40%.[12,13] Howard in 1968 reported zero operative mortality in 41 resection cases[14], and only 4 fistula of the pancreatico-jejunosotomy as complications. These fistulas result because of anastamotic leaks and it may be possible to reduce its rate. Various techniques have been used to stop the leakage including: ligation of the duct of pancreas[15], closure of the duct using rubber or fibrin glue application[16], fibrin glue around the pancreaticojejunal anastomosis[17] and various modifications on anastomosing techniques[18–22], among them Roux-en-Y reconstruction with pancreaticojejunostomy[22] and pancreaticogastrostomy[23]. This article will focus on how pancreaticogastrostomy might have the potential to improve post-operative complications of the Whipple procedure, particularly the rate of anastomotic leakage.

Pancreaticogastrostomy:

In the past postoperative deaths after pancreaticoduodenal resection occurred in very high frequency. The first animal pancreaticogastrostomy was conducted by Tripodi *et al*[24] in 1934 and then later by Person *et al*[25] in 1939. Both of them showed promising results regarding the long term secretions of pancreatic juices. The first successful human pancreaticogastrostomy was performed by Waugh and Clagett in 1946.[26] Pancreaticogastrostomy is performed by preparing the pancreatic stump by;

1. Securing hemostasis,
2. Identifying the pancreatic duct and
3. Circumferentially mobilizing approximately 2 cm of the remaining pancreas, taking care not to damage the splenic vein.

Next the stomach is prepared by making a 10 cm long gastrotomy along its anterior aspect, and a small 3 cm incision is performed on the posterior wall. The mobilized part of pancreas is then passed through the small incision on the posterior wall. Once the stump of the pancreas is within the lumen, it is sutured to the back wall in a single-layer, interrupted fashion, with care taken not to involve the pancreatic duct within the suture line (Figure-3).[27] The anterior gastrostomy is then closed.

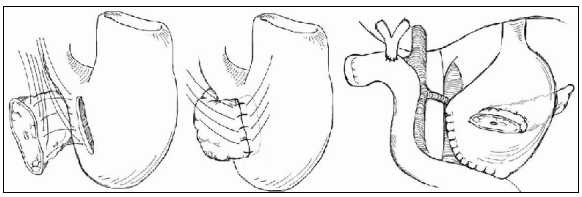

Figure-3: The pancreatic remnant is sutured to the posterior wall of the stomach

Many studies have shown positive results with this technique.[28,29] As discussed previously, the remnant pancreas is usually responsible for the postoperative complications and mortality associated with pancreaticoduodenectomy. The complete removal of the pancreas may prevent this problem but unfortunately, patients with complete pancreatectomy fail to thrive even after meticulous endocrine and exocrine replacement and develop brittle diabetes. The use of pancreaticogastrostomy not only helps preserve endocrine function of the pancreas but can also reduce pancreatic fistula rates. Several studies advocate for and report similar potential benefits for a pancreaticogastrotomy in the Whipple procedure in recent years.[30–34]

Table-1: Advantages of Pancreaticogastrostomy in Whipple's Surgery

Easy to perform
Stomach lies in front of pancreatic stump
No luminal discrepancy in size with pancreatic remanent
Less prone to ischemia because of gastric vascular supply
Exocrine enzymes enter acidic environment
Low pH prevents complete activation
Lower leak rate because that enzymes don't get activated
Alkaline pancreatic secretions protect gastrojejunostomy from marginal ulcer.
Single loop of jejunum for gastric and biliary anastomosis
Two, not three anastomoses to single loop
Less chance of kinking
Adapted from Ann Surg 1995;222:580-92.

The procedure has several advantages including: the deactivation of the pancreatic enzymes by the acidic gastric secretions, the prevention of auto digestion of the pancreas and the anastomosis (stomach does not contain enterokinase therefore trypsinogen is not activated to trypsin preventing subsequent activation of other digestive enzymes). Another benefit of pancreaticogastrostomy is that it may provide for reduced tension on the anastomosis because the pancreas is attached to the posterior wall of the stomach, with which it is normally in direct contact. Furthermore the abundant blood supply of the stomach complements the healing of the anastomosis and the thick wall of the stomach grip the sutures well. Randomised controlled trials have been conducted comparing pancreaticogastrostomy with pancreaticojejunostomy but they were inconclusive regarding the rates of pancreatic fistula formation, postoperative complication and mortality.[34] Meta-analysis by Mckay suggested that pancreaticogastrostomy is safer anastamotic choice in pancreatoduodenectomy although most of their support for the results came from cohort studies.[35] Wente *et al* also suggested that Pancreaticogastrostomy was more advantageous than pancreaticojejunostomy, however all the random controlled trials in that study failed to show any superiority (indicating both procedures are equal in terms of perioperative outcome) and the results are most likely subjected by publication bias.[36]

CONCLUSION

Following Whipple resection, restoration of pancreatic continuity with the gastrointestinal tract has traditionally been performed between the pancreas and proximal jejunum. This suture line is frequently placed at risk as a result of postoperative pancreatitis with ensuing haemorrhage, abscess, and fistula formation. On the other hand sutures between the pancreas and the stomach (pancreaticogastrostomy) may prove more secure than those between the pancreas and the jejunum since the stomach has a thicker wall and the anastomosis can be reinforced from within the lumen of the stomach. In conclusion, this method of restoration of pancreatic-intestinal continuity merits greater consideration due to its simplicity and safety. The authors believe that this method of restoration has the potential to achieve better post-operative outcomes if employed in high volume pancreaticoduodenectomy centres.

Conflict of interest: No conflicts of interests were reported from any of the authors.

Funding: There were no funding sources that contributed to the planning, execution or publication of this study.

AUTHOR'S CONTRIBUTION

SR, MK were responsible for the literature review. SR and AU were responsible for the initial draft, while all authors contributed to subsequent revisions. AU revised and edited the paper for final submission. He is also the guarantor. All authors read and approved the final manuscript.

REFERENCES

1. Vajdic CM, van Leeuwen MT. Cancer incidence and risk factors after solid organ transplantation. Int J Cancer 2009;125(8):1747–54.
2. Jemal A, Siegel R, Ward E, Murray T, Xu J, Thun MJ. Cancer statistics, 2007. CA Cancer J Clin 2007;57(1):43–66.
3. Halsted WS. Contributions to the surgery of the bile passages, especially of the common bile duct. Boston Med Surg J 1899;141(26):645–54.
4. Kaush W. Das carcinom der papilla duodeni und seine radikale entfernung. Beitr Klin Chir 1912;78(439):29–33.
5. Whipple AO, Parsons WB, Mullins CR. Treatment of carcinoma of the ampulla of Vater. Ann Surg 1935;102(4):763–79.
6. Whipple AO. The rationale of radical surgery for cancer of the pancreas and ampullary region. Ann Surg 1941;114(4):612–5.
7. Whipple AO. A reminiscence: pancreaticoduodenectomy. Rev Surg 1963;20:221–5.
8. Peng SY, Wang JW, Lau WY, Cai XJ, Mou YP, Liu YB, *et al*. Conventional Versus Binding Pancreaticojejunostomy

After Pancreaticoduodenectomy A Prospective Randomized Trial. Ann Surg 2007;245(5):692–8.
9. Lin JW, Cameron JL, Yeo CJ, Riall TS, Lillemoe KD. Risk factors and outcomes in postpancreaticoduodenectomy pancreaticocutaneous fistula. J Gastrointest Surg 2004;8(8):951–9.
10. Machado NO. Pancreatic Fistula after Pancreatectomy: Definitions, Risk Factors, Preventive Measures, and Management—Review. Int J Surg Oncol 2012;2012:602478.
11. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J, *et al*. Postoperative pancreatic fistula: an international study group (ISGPF) definition. Surgery 2005;138(1):8–13.
12. Schmidt CM, Powell ES, Yiannoutsos CT, Howard TJ, Wiebke EA, Wiesenauer CA, *et al*. Pancreaticoduodenectomy: a 20-year experience in 516 patients. Arch Surg 2004;139(7):718–27.
13. Cameron JL, Riall TS, Coleman J, Belcher KA. One thousand consecutive pancreaticoduodenectomies. Ann Surg 2006;244(1):10–5.
14. Howard JM. Pancreatico-duodenectomy: forty-one consecutive operation Whipple resections with an operative mortality. Ann Surg 1968;168(4):629–40.
15. Lillemoe KD, Cameron JL, Kim MP, Campbell KA, Sauter PK, Coleman JA, *et al*. Does fibrin glue sealant decrease the rate of pancreatic fistula after pancreaticoduodenectomy? results of a prospective randomized trial. J Gastrointest Surg 2004;8(7):766–72.
16. Warshaw AL, Thayer SP. Pancreaticoduodenectomy. J Gastrointest Surg 2004;8(6):733–41.
17. Willams JG, Bramhall SR, Neoptolemos JP. Purse-string pancreaticojejunostomy following pancreatic resection. Dig Surg 1997;14(3):183–6.
18. Murr MM, Nagorney DM. An end-to-end pancreaticojejunostomy using a mechanical purse-string device. Am J Surg 1999;177(4):340–1.
19. Landen S. Consolidation of a friable pancreas for pancreaticojejunal anastomosis. Dig Surg 1998;15(4):297–8.
20. Roder JD, Stein HJ, Böttcher KA, Busch R, Heidecke CD, Siewert JR. Stented versus nonstented pancreaticojejunostomy after pancreaticoduodenectomy: a prospective study. Ann Surg 1999;229(1):41–8.
21. Sakorafas GH, Friess H, Balsiger BM, Büchler MW, Sarr MG, *et al*. Problems of reconstruction during pancreatoduodenectomy. Dig Surg 2001;18(5):363–9.
22. Sutton CD, Garcea G, White SA, O'Leary E, Marshall LJ, Berry DP, *et al*. Isolated Roux-loop pancreaticojejunostomy: a series of 61 patients with zero postoperative pancreaticoenteric leaks. J Gastrointest Surg 2004;8(6):701–5.
23. Ingebrigtsen R, Langfeldt E. Pancreaticogastrostomy. Lancet 1952;2(6728):270–1.
24. Tripodi AM, Sherwin CF. Experimental transplantation of the pancreas into the stomach. Arch Surg 1936;28(2):345–56.
25. Person EC, Glenn F. Pancreaticogastrostomy, Experimental transplantation of the pancreas into the stomach. Arch Surg 1939;39:530–50.
26. Waugh JM, Clagett OT. Resection of the duodenum and head of pancreas for carcinoma: an analysis of thirty cases. Surgery 1946;20:224–32.
27. Tewari M, Shukla H. Anterior gastrotomy technique of fashioning pancreaticogastrostomy following pancreaticoduodenectomy for pancreatic head and periampullary cancer. Indian J Surg 2005;67(6):339.
28. Takao S, Shimazu H, Maenohara S, Shinchi H, Aikou T. Modified pancreaticogastrostomy following pancreaticoduodenectomy. Am J Surg 1993;165(3):317–21.
29. Reding R. Pancreato-gastrostomy as a modification of Whipple's method. Zentralbl Chir 1978;103(14):943–6.
30. Aranha GV, Hodul P, Golts E, Oh D, Pickleman J, Creech S. A comparison of pancreaticogastrostomy and pancreaticojejunostomy following pancreaticoduodenectomy. J Gastrointest Surg 2003;7(5):672–82.
31. Arnaud JP, Tuech JJ, Cervi C, Bergamaschi R. Pancreaticogastrostomy compared with pancreaticojejunostomy after pancreaticoduodenectomy. Eur J Surg 1999;165(4):357–62.
32. Duffas JP, Suc B, Msika S, Fourtanier G, Muscari F, Hay JM, *et al*. A controlled randomized multicenter trial of pancreatogastrostomy or pancreatojejunostomy after pancreatoduodenectomy. Am J Surg 2005;189(6):720–9.
33. Bassi C, Falconi M, Molinari E, Salvia R, Butturini G, Sartori N, *et al*. Reconstruction by pancreaticojejunostomy versus pancreaticogastrostomy following pancreatectomy: results of a comparative study. Ann Surg 2005;242(6):767–73.
34. Yeo CJ, Cameron JL, Maher MM, Sauter PK, Zahurak ML, Talamini MA, *et al*. A prospective randomized trial of Pancreaticogastrostomy versus pancreaticojejunostomy after pancreaticoduodenectomy. Ann Surg 1995;222(4):580–8.
35. McKay A, Mackenzie S, Sutherland FR, Bathe OF, Doig C, Dort J, *et al*. Meta-analysis of Pancreaticojejunostomy versus pancreaticogastrostomy reconstruction after pancreaticoduodenectomy. Br J Surg 2006;93(8):929–36.
36. Wente MN, Shrikhande SV, Müller MW, Diener MK, Seiler CM, Friess H, *et al*. Pancreaticojejunostomy versus pancreaticogastrostomy: systematic review and meta-analysis. Am J Surg 2007;193(2):171–83.

Address for Correspondence:

Affan Umer, MD, Department of Surgery, 114 Woodland Street, Hartford, CT, 06105-USA
Tel: +1 860 816 3017
Email: affan.umer.83@gmail.com