Regional Pancreatectomy

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Abstract

Conventional pancreatic resections, including pancreatoduodenectomy, distal pancreatectomy, and total pancreatectomy, result in a loss of normal pancreatic parenchyma and may cause impairment of exocrine and endocrine pancreatic function. The current literature suggests that less invasive surgery is associated with faster recovery and less morbidity than open surgery. Regional pancreatectomy is a kind of less invasive surgery in terms of parenchyma-sparing.

Regional pancreatectomy includes enucleation, inferior head pancreatectomy, spleen-preserving distal pancreatectomy, central pancreatectomy, combined inferior head plus distal pancreatectomy (spleen-preserving), dorsal pancreatectomy (spleen-preserving), and duodenum-preserving pancreatic head resection (DPPHR). Some of them are rather major operations; however, they are less invasive compared with corresponding alternatives in terms of parenchyma-sparing. Regional pancreatectomy is mainly indicated for benign neoplasms, including intraductal papillary mucinous neoplasm (IPMN), mucinous cystadenoma, serous cystadenoma, and small sized neuroendocrine tumors including insulinoma. Invasive ductal carcinoma, even when the tumor is small enough, is not eligible because, most of these tumors show extrapancreatic invasion.

Advancements of surgical techniques have allowed us to perform several types of regional pancreatectomy. Regional pancreatectomy is a technically feasible surgical option for benign, borderline or low-grade malignant tumors of the pancreas. Assistance with pancreatic stenting and/or laparoscopy is recommended in some cases to reduce the invasiveness and/or to prevent complications.

Keywords: Pancreatectomy, Surgical Procedures, Less Invasive, Pancreatic Neoplasm, Laparoscopic Surgery

Introduction

Conventional pancreatic resections, including pancreatoduodenectomy, distal pancreatectomy, and total pancreatectomy, result in a loss of normal pancreatic parenchyma and may cause impairment of exocrine and endocrine pancreatic function. Although such procedures are mandatory for malignant diseases, they seem excessive for benign or borderline conditions.

The current literature suggests that less invasive surgery is associated with faster recovery and less long-term morbidity than open surgery. It is also applicable to pancreatectomy.

Regional pancreatectomy includes enucleation, inferior head resection [1-4], spleen-preserving distal pancreatectomy [5-8], central pancreatectomy [9-11], combined inferior head plus distal pancreatectomy (spleen-preserving) [12,], dorsal pancreatectomy (spleen-preserving) [13], and duodenum-preserving pancreatic head resection (DPPHR)[14, 15](Figure 1).Combined inferior head plus distal pancreatectomy and dorsal pancreatectomy are rather major operation, however, these are much less invasive compared with their corresponding alternative, total pancreatectomy. Inferior head resection is a less invasive alternative of pancreatoduodenectomy.

Advancements of surgical techniques have allowed us to perform several types of regional pancreatic resection. Regional pancreatectomy is mainly indicated for 1) benign or low-grade malignant neoplasms, including branch duct type of intraductal papillary mucinous neoplasm (IPMN), mucinous cystadenoma, serous cystadenoma, small-sized neuroendocrine tumor such as insulinoma, and small-sized solid-pseudopapillary tumor; 2) non-neoplastic cysts such as lymphoepithelial cyst; 3) isolated metastases to the pancreas (especially from renal cancer). Invasive ductal carcinoma, even when the tumor is small enough, is not eligible because the most of these tumors
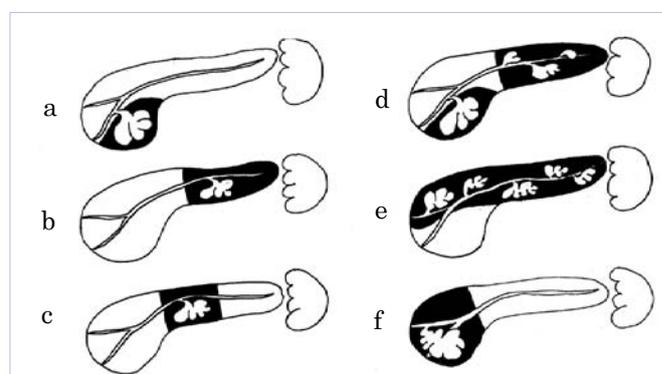

Figure 1: a) inferior head pancreatectomy, b) spleen-preserving distal pancreatectomy, c) central pancreatectomy, d) combined regional pancreatectomy, e) dorsal pancreatectomy (spleen-preserving), f) duodenum-preserving pancreatic head resection (DPPHR).Painted portion in black is to be resected. Figure 1 is cited from one of the references (Hirota, 2013) with some alterations.

show extrapancreatic invasion [16,17,18]. Such techniques are introduced and the associated discussion is reviewed in this manuscript.

Inferior Head Pancreatectomy

Branch duct type of IPMN often develops in the inferior head region of the pancreas. Such benign lesion can be managed by inferior head pancreatectomy (Figure 1a). There are two important steps in this procedure; first, post-operative pancreatic fistula (POPF), and second, the preservation of blood supply to the duodemun, bile duct, and residual pancreas [2,3]. Sugiyama et al. reported the case of a patient in whom preoperative endoscopic pancreatic stenting prevented the development of POPF following local resection of the pancreatic body tumor [1]. Also, Hirota et al. reported the efficacy of preoperative endoscopic pancreatic stenting for preventing POPF formation after the local resections in the pancreatic head region including inferior head pancreatectomy [2]. Taken together, these reports suggest that preoperative endoscopic pancreatic stenting may be an effective prophylactic against POPF development after inferior head pancreatectomy. During inferior head pancreatectomy, injury to the main pancreatic duct (in addition to the side branch ducts) increases the risk of pancreatic fistula formation. Pancreatic stenting may allow the resection plane to seal by decompression of the pancreatic duct [19,-23]. In addition to reducing pancreatic juice leakage from the resection plane, preoperative endoscopic transpapillary pancreatic stenting also prevents injury to the main pancreatic duct in two ways: First, the anatomy of the main pancreatic duct is clarified by palpating the stent, and/ or by viewing its color. Intraoperative ultrasonography and pancreatography (via endoscopic naso-pancreatic drainage tube) are also available [2]. By intraoperative pancreatography, we can check the appropriateness of the resection line and intactness of the pancreatic duct system [2]. Second, the installed stent can prevent dislocation of the main pancreatic duct during manipulation (by retraction of the lesion). Preoperative endoscopic pancreatic stenting in selected patients may be an effective prophylactic to prevent refractory POPF formation following inferior head pancreatectomy. On the other hand, for the preservation of blood supply to the duodenum, bile duct, and residual pancreas, care must be taken not to injure the anterior inferior and posterior inferior pancreaticoduodenal artery along the duodemun.

For the cases with low grade malignancy, extended inferior head pancreatectomy can be applied. In this operation, the inferior head region of the pancreas, the third portion of the duodenum, and inferior pancreatic artery along with surrounding lymphatic nodes were resected (Figure 2). Reconstruction of the duodenum can be done by duodeno-jejunostomy (side to side).

Spleen-Preserving Distal Pancreatectomy

In benign cases, such as insulinoma, branch type IPMN, spleen-preserving pancreatectomy (Figure 1b) is performed. Distal pancreatectomy with preservation of the spleen was first reported in 1988 [5]. The advantage of preserving the spleen is
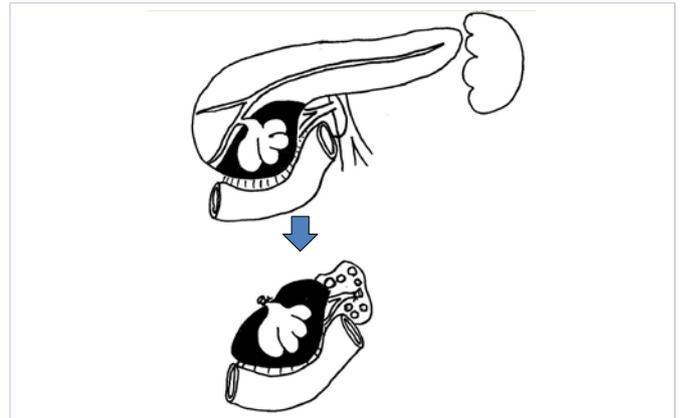

Figure 2: Extended inferior head pancreatectomy.

obvious; it reduces the risk of postoperative severe inflammation and peripheral blood count aberration. Spleen conservation could be achieved by carefully dissecting the splenic vessels off the pancreatic parenchyma or by resecting the main splenic vessels *en bloc* with the pancreas but maintaining the short gastric vessels and left gastroepiploic arcade to ensure the collateral blood supply to the spleen (Warshaw technique) [5,6]. However, spleen-preserving pancreatectomy has recently been shown to have comparable risk of complication to standard pancreatectomy where the spleen is removed [7]. Warshow reported a case of splenic abscess that occurred after sacrificing the splenic artery and vein [5]. The viability of the spleen depends on collateral blood supply through the short gastric and gastroepiploic vessels coursing through the gastrosplenic ligament. The Warshaw technique always induces splenic ischemia since the perfusion is halved. Attempting splenic vessel preservation during distal pancreatectomy appears legitimate since it offers the benefits of splenic preservation, without any significant increment in morbidity.

As a modification of hand-assisted laparoscopic pancreatectomy, we devised a method of the spleen and gastrosplenic ligament preserving distal pancreatectomy, in which pancreatic resection is performed under direct vision extracorporeally [8]. Using laparoscopic dissection technique, we can reduce the size of laparotomy and accordingly the invasiveness of the operation. A total of the two trocars is then placed. After abdominal access is established, the gastrocolic omentum is divided, and the splenic flexure is mobilized. The short gastric and left gastroepiploic vessels are not divided to prevent splenic volvulus after the operation. Retrosplenic Gerota's fascia is transected on the surface of the left kidney. Then, the posterior plane of Gerota's fascia is dissected from lateral to medial direction, allowing the distal pancreas and spleen detached from retroperitoneum. The distal pancreas, spleen, and left side of the stomach are then pulled out of the peritoneal cavity through the minilaparotomy (8 cm) for hand assistance at the epigastrium as Figure 2 of ref. 8. By this procedure, pancreatic resection and closure of the residual pancreatic

stump is performed safely under direct vision extracorporeally. The advantage of the extracorporeal procedure is the safety and certainty in the dissection of the splenic vessels and preparation of the pancreatic stump. The transected main pancreatic duct is doubly ligated, and the transected pancreatic stump is sewn manually. The preserved spleen, stomach and splenic vessels are placed back in the peritoneal cavity after pancreatic resection.

Central Pancreatectomy

Central pancreatectomy (Figure 1c) is a type of regional pancreatic resection for benign neoplasms located in the pancreatic body [9,10]. It is also known as medial pancreatectomy, middle segment pancreatectomy, and median pancreatectomy. The operation was first described in 1957 to treat a patient with chronic pancreatitis [11]. After exposure of neck to the body of the pancreas, central pancreatectomy is performed by proximal and distal transection. The distal portion is reconstructed by pancreatico-jejunostomy in Roux-en-Y style (Figure 3a). We prefer extracorporeal procedure after taking out the pancreatic tail and spleen *ex vivo* (*ex vivo* pancreato-jejunostomy, Figure 3b). If we mobilize the pancreatic body/tail and spleen adequately using laparoscopy, *ex vivo* pancreato-jejunostomy is easily performed with 8 cm of the abdominal incision as extracorporeal hybrid technique. Using laparoscopic dissection technique, we can reduce the size of laparotomy and accordingly the invasiveness of the operation. Reconstruction is usually done in insertion type end-to-side pancreato-jejunostomy[24, 25]. Central pancreatectomy allows the preservation of exocrine and endocrine pancreatic function without loss of duodenal passage, however, it also has a high morbidity associated with pancreatic fistula. Pancreato-gastrostomy can also be applied instead of pancreato-jejunostomy.
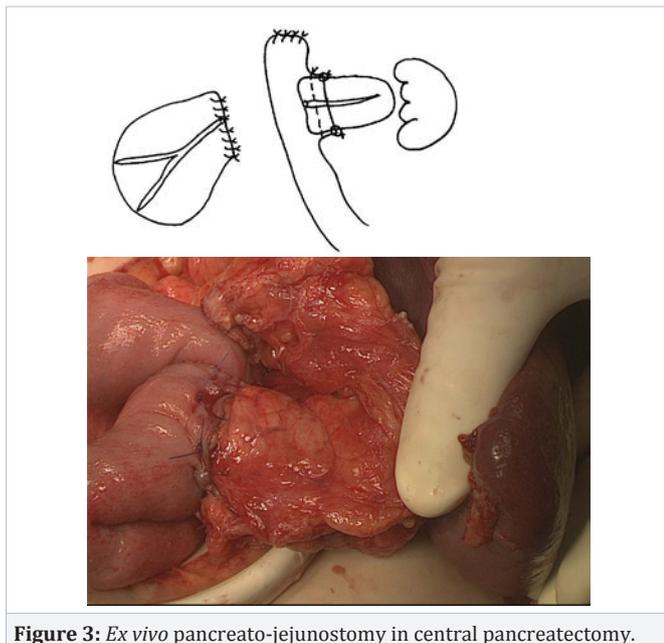

Figure 3: *Ex vivo* pancreato-jejunostomy in central pancreatectomy.

Combined Inferior Head Plus Distal Pancreatectomy (Spleen-Preserving)

For the cases with multiple branched type IPMN lesions, combined resections such as lower head pancreatectomy + distal pancreatectomy (spleen-preserving) can be applied (Figure 1d) [12]. For inferior head resection, preoperative endoscopic pancreatic stenting is useful for the prevention of pancreatic duct injury as described. The stent is also useful for the prevention of pancreatic leakage after both resections. With this kind of combined resection, total pancreatectomy can be avoided, which is really less invasive for the patients.

Dorsal Pancreatectomy (Spleen-Preserving)

For the cases with multiple branched types IPMN lesions, spleen-preserving dorsal pancreatectomy can be applied (Figure 1e). The complete dorsal pancreatectomy was introduced by Thayer et al. for IPMN in a patient with pancreas divisum[13]. If there are no lesions in the inferior head area, that portion can be preserved to avoid total pancreatectomy. The inferior head pancreatic duct branch is drained to the main pancreatic duct. The pancreatic duct system should not be injured during the procedure. This is a rather major operation; however, it is less invasive than total pancreatectomy in terms of parenchymal-sparing.

Duodenum-Preserving Pancreatic Head Resection (DPPHR)

DPPHR was also devised for the clinical treatment of benign lesions of the pancreatic head including chronic pancreatitis (Figure 1f) [14,15]. Beger et al. introduced DPPHR for patients with chronic pancreatitis and inflammatory mass in the head of the pancreas [14]. During the resection of the pancreatic head, peri-duodenal vascular arcade should be maintained. After the resection of the pancreatic head, the distal pancreas is reconstructed by pancreato-jejunostomy in Roux-en- Y style. DPPHR is also a rather major operation. These rather major operations, such as combined inferior head plus distal pancreatectomy, dorsal pancreatectomy, DPPHR, are not suitable for totally laparoscopic surgery. Laparoscopy is one of the tools to reduce the invasiveness in regional pancreatectomy.

Conclusions

Advancements of surgical techniques up to this point have allowed us to perform several types of regional pancreatic resection. Regional pancreatectomies are technically feasible surgical options for treating benign, borderline or low-grade malignant tumors of the pancreas. Assistance with pancreatic stenting and/or laparoscopy [1,2,8] is recommended in some cases to reduce the invasiveness and/or to prevent complications.

References

1. Sugiyama M, Abe N, Yamaguchi Y, Yamato T, Nakaura H, Matsuoka H, et al. Preoperative endoscopic pancreatic stenting for safe local pancreatic resection.Hepatogastroenterology. 2001;48(42):1625-

1627.

2. Hirota M, Kanemitsu K, Takamori H, Chikamoto A, Ohkuma T, Komori H, et al. Localpancreatic resection with preoperative endoscopic transpapillary stenting. Am J Surg. 2007;194(3):308-310.

3. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J, et al. Postoperativepancreatic fistula: an international study group (ISGPF) definition. Surgery.2005;138(1):8-13.

4. Brient C, Regenet N, Sulpice L, Brunaud L, Mucci-Hennekine S, Carrere N, et al. Riskfactors for postoperative pancreatic fistulization subsequent to enucleation. J Gastrointest Surg. 2012;16(10):1883-1887.

5. Warshaw AL. Conservation of the spleen with distal pancreatectomy. Arch Surg. 1988;123(5):550-553.

6. Kimura W, Inoue T, Futakawa N, Shinkai H, Han I, Muto T. Spleen-preserving distalpancreatectomy with conservation of the splenic artery and vein. Surgery. 1996;120(5):885-890.

7. Tsiouris A, Cogan CM,Velanovich V. Distal pancreatectomy with or withoutsplenectomy: comparison of postoperative outcomes and surrogates of splenic function.HPB(Oxford). 2011;13(10):738-744. doi: 10.1111/j.1477-2574.2011.00369.x.

8. Hirota M, Ichihara A, Furuhashi S, Tanaka H, Takamori H, &Baba H. Spleen andgastrosplenic ligament preserving distal pancreatectomy under a minimum incisionapproach assisted by laparoscopy. J Hepatobiliary Pancreat Surg. 2009;16(6):792-795.doi: 10.1007/s00534-009-0113-7.

9. Boggi U, Amorese G, De Lio N, Perrone V, D'Imporzano S, Croce C, et al. Centralpancreatectomy with inframesocolic pancreatojejunostomy. Langenbecks Arch Surg. 2012;397(6):1013-1021.

10. Xiang GM, Tan CL, Zhang H, Ran X, Mai G, &Liu XB. (2012). Central pancreatectomy forbenign or borderline lesions of the pancreatic neck: a single centre experience and literaturereview. Hepatogastroenterology. 2012;59(116):1286-1289. doi: 10.5754/hge11937.

11. Guillemin P, Bessot M. Chronic calcifying pancreatitis in renal tuberculosis:pancreatojejunostomy using an original technic. Mem Acad Chir. 1957;83(28):869-871.

12. Hirota M. Parenchyma-sparing pancreatectomy for benign pancreatic neoplasms. J MinimInvasive Surg Sci, 2013; 2(4), 39-42.

13. Thayer SP, Fernandez-del Castillo C, Balcom JH, Warshaw AL. Complete dorsalpancreatectomy with preservation of the ventral pancreas: a new surgical technique.Surgery. 2002;131(5):577-580.

14. Beger H, Krautzberger W, Bittner R, Buchler M, Limmer J. Duodenal-preservingresection ofthe head of the pancreas in patients with severe chronic pancreatitis. Surgery. 1985;97(4):467-473.

15. Kimura W, Nagai H. Study of surgical anatomy for duodenal-preserving resection ofthepancreas. Ann Surg. 1995;221(4):359-363.

16. Hirota M, Ogawa M. No-touch pancreatectomy for invasive ductal carcinoma of the pancreas.JOP, 2014; 15(3), 243-249.

17. Hirota M, Hashimoto D, Ishiko T, Satoh N, Takamori H, Chikamoto A, et al. Distalpancreatectomy using a no-touch isolation technique. Scand J Surg. 2012;101(3):156-159.

18. Hirota M, Kanemitsu K, Takamori H, Chikamoto A, Tanaka H, Sugita H, et al. Pancreatoduodenectomy using a no-touch isolation technique. Am J Surg. 2010;199(5):65-68.doi: 10.1016/j.amjsurg.

19. Saeed ZA, Ramirez FC,Hepps KS. Endoscopic stent placement for internal and externalpancreatic fistulas. Gastroenterology. 1993;105(4):1213-1217.

20. Kozarek RA, Ball TJ, Patterson DJ, Raltz SL, Traverso LW, Ryan JA, et al. Transpapillarystenting for pancreaticocutaneous fistulas. J Gastrointest Surg. 1997;1(4):357-361.

21. Halttunen J, Weckman L, Kemppainen E, &Kylanpaa ML. The endoscopic managementof pancreatic fistulas. Surg Endosc. 2005;19(4):559-562.

22. Cicek B, Parlak E, Oguz D, Disibeyaz S, Koksal AS, Sahin B. Endoscopic treatment ofpancreatic fistulas. Surg Endosc. 2006;20(11):1706-1712.

23. Bakker OJ, van Baal MC, van Santvoort HC, Besselink MG, Poley JW, Heisterkamp J,et al. Endoscopic transpapillary stenting or conservative treatment for pancreatic fistulas in necrotizing pancreatitis: multicenter series and literature review. AnnSurg. 2011;253(5):961-967.doi: 10.1097/SLA.0b013e318212e901.

24. Hashimoto D, Hirota M, Yagi Y, Baba H. End-to-side pancreaticojejunostomy withoutstitches in the pancreatic stump. Surg Today. 2013;43(7):821-824.doi: 10.1007/s00595-012-0371-x.

25. Hashimoto D, Hirota M, Chikamoto A, Beppu T, Baba H. (2014). Short-term outcome of newend-to-side inserting pancreatico-jejunostomy without stiches on the pancreatic cut end.Hepatogastroenterology. 2014;61(130):489-492.