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Study of Surgical Anatomy for Duodenum-Preserving Resection of the Head of the Pancreas

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Objective
The authors precisely examined the topography of the duodenum, pancreas, bile duct, and supplying vessels from the perspective of performing duodenum-preserving resection of the pancreatic head.

Summary Background Data
Little has been reported regarding the detailed surgical anatomy that is crucial in this procedure.

Methods
The authors precisely examined the local anatomy of the pancreas head and duodenum, using materials from 40 autopsy cases.

Results
Arcade formation between the anterior superior pancreaticoduodenal (ASPD) artery and the anterior inferior pancreaticoduodenal (AIPD) artery was found in all of the cases. After departing from the gastroduodenal artery, the ASPD ran toward a point 1.5 cm below the papilla of Vater, then turned to the posterior aspect of the pancreas to join the AIPD. In 88% of the cases, an arcade was found between the posterior superior pancreaticoduodenal (PSPD) artery and the posterior inferior pancreaticoduodenal (PIPD) artery. The ASPD, AIPD, PSPD, PIPD, or their branches to the duodenum, the bile duct, and the papilla of Vater were not completely buried in the pancreatic parenchyma in any of these cases. Generally, it was easy to dissect the pancreas from the duodenum because of the loose connection. Near the accessory papilla, however, dissection of the vessels was difficult, and the pancreatic parenchyma sometimes was found in the wall of the duodenum. Dissection of the pancreas from the common bile duct and identification of the main pancreatic duct at the junction with the terminal portion of the bile duct were straightforward in all cases.

Conclusions
It may be possible to remove the head of the pancreas while preserving of the vascular arcades and their branches to the duodenum, the bile duct, and the papilla of Vater.

Duodenum-preserving resection of the pancreatic head recently has been performed for benign and sometimes, malignant diseases of the pancreas.[1-7] Beger et al.[2,3] cut the pancreas head about 1 cm beside the duodenal wall for patients with chronic pancreatitis. The results of the postoperative conditions, such as diabetes mellitus, body weight, and serum analysis, of these patients have been much better than those of patients who underwent pancreatoduodenectomy. Recently, Japanese researchers[5-7] have performed complete resection of the pancreatic head with preservation of the entire duodenum in cases of mucin-producing pancreatic carcinoma, which showed a very slight tendency to invade and a good prognosis.[8,9]

However, little has been reported regarding the detailed surgical anatomy that is crucial in this procedure, although several authors[10-12] have analyzed the vessels of the head of the pancreas. Therefore, in this study, we precisely examined the topography of the duodenum, pancreas, bile duct, and supplying vessels using autopsy materials.

MATERIALS AND METHODS

Among the autopsy cases at the Tokyo Metropolitan Geriatric Hospital from 1992 to 1993, 40 cases were studied in which the pancreas was normal and well preserved. The duodenum, the pancreas and the bile duct were extirpated *en bloc* and fixed in formalin. The local anatomy of this region was grossly examined.

Sections about 3-mm thick were cut from the accessory papilla at a right angle to the accessory duct. These sectioned tissues were embedded in paraffin, cut to 4 μm, stained with hematoxylin and eosin (H & E), and examined histologically.

RESULTS

Anatomy of the Arteries of the Head of the Pancreas

Arcade formation between the anterior superior pancreaticoduodenal (ASPD) artery and the anterior inferior pancreaticoduodenal (AIPD) artery was found in all of the cases (Figs. 1–3). After departing from the gastroduodenal artery, the ASPD ran toward a point 1.5 cm below the papilla of Vater, and then turned to the posterior aspect of the pancreas to join the AIPD. Thus, in contrast to prevailing belief, the AIPD was found on the "posterior" surface of the pancreas (Fig. 4).

Figure 1. Arteries and posterior "membrane" of the head of the pancreas in an autopsy case after resection of pancreatic parenchyma.

In 88% of the cases, an arcade was found between the posterior superior pancreaticoduodenal (PSPD) artery and the posterior inferior pancreaticoduodenal (PIPD) artery. This arcade always was located dorsal to the pancreatic head and the common bile duct. Arterial branches to the common bile duct and the papilla of Vater were divided from the PSPD.

In none of the cases were the AIPD, PSPD, PIPD, or their branches to the duodenum, the bile duct, and the papilla of Vater completely buried in the pancreatic pa-

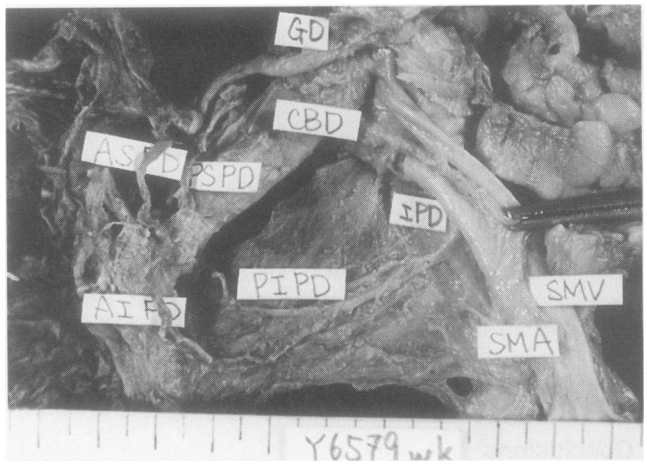

Figure 2. Arteries of the pancreas head in an autopsy case after resection of pancreatic parenchyma. ASPD = anterior superior pancreaticoduodenal artery; AIPD = anterior inferior pancreaticoduodenal artery; PSPD = posterior superior pancreaticoduodenal artery; PIPD = posterior inferior pancreaticoduodenal artery; IPD = inferior pancreaticoduodenal artery; CBD = common bile duct; SMA = superior mesenteric artery; SMV = superior mesenteric vein.

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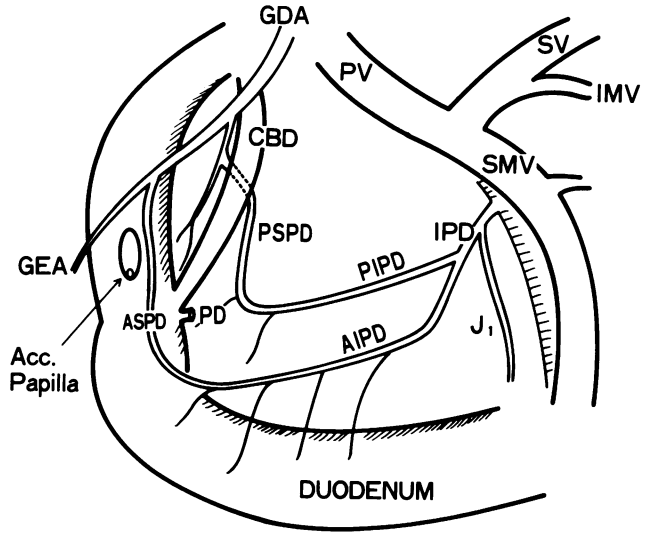

Figure 3. Schema of the topography of the head of the pancreas, showing the arteries and common bile duct. PV = portal vein; IMV = inferior mesenteric vein; SV = splenic vein; J1 = upper jejunal artery; GEA = gastroepiploic artery; Acc. Papilla = accessory papilla. See Fig. 2 for other abbreviations.

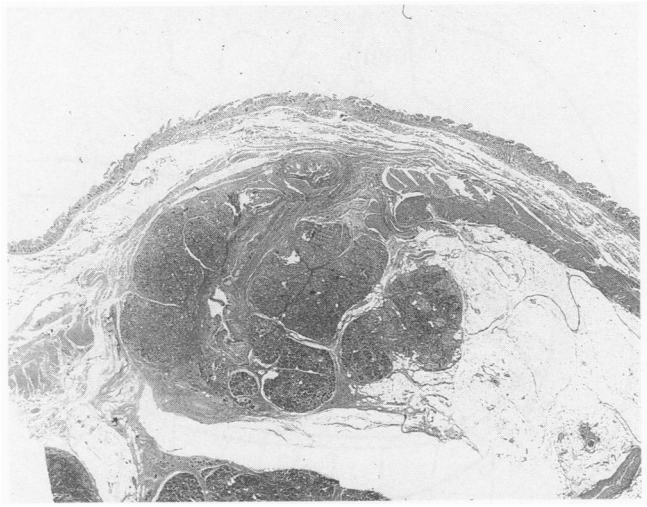

Figure 5. Histologic findings in the neighborhood of the accessory papilla. The pancreatic parenchyma "invaded" the submucosal or muscular layer of the duodenum.

renchyma. This anatomic feature enabled us to preserve these vessels when the head of the pancreas was removed. However, the ASPD and its branches to the duodenum were buried rather deeply, although not completely, in all of the cases.

Generally, it was easy to dissect the pancreas from the duodenum because of the loose connection. Nevertheless, we had to remove a part of the duodenal wall in 88% of the cases to completely extirpate the pancreatic tissue because the pancreatic parenchyma "invaded" the submucosal or muscular layer of the duodenum in the neighborhood of the accessory papilla. This fact was confirmed histologically (Fig. 5).

Dissection of the pancreas from the common bile duct and identification of the main pancreatic duct at its junction with the terminal portion of the bile duct were straightforward in all cases.

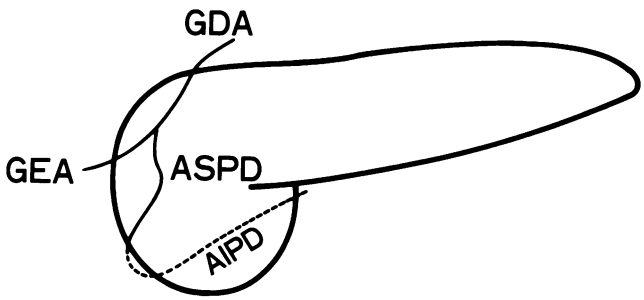

Figure 4. Schema of the anterior superior and inferior pancreaticoduodenal arteries.

In each case, we found a connective tissue membrane on the posterior aspect of the pancreas head (Figs. 1 and 2). All of the pancreaticoduodenal arteries and veins were situated on this membrane.

Anatomy of the Veins of the Head of the Pancreas

Arcade formation corresponding to that between the ASPD vein and the AIPD vein was not found (Fig. 6). However, the gastrocolic tract runs in the gutter formed between the dorsal and ventral pancreas, where it branches to the pancreatic parenchyma (Fig. 7). The gastrocolic tract departs from the superior mesenteric vein (SMV) about 15 to 20 mm below the junction between the splenic vein (SV) and the SMV.

Arcade formation between the PSPD vein and the PIPD vein was not always apparent. These veins become quite small near the papilla of Vater.

The PIPD vein departs from the upper jejunal vein (J1), and runs horizontally behind the SMV toward the right on the posterior membrane of the head of the pancreas. It branches to the third portion of the duodenal wall and runs toward the papilla of Vater. The stem vein of the PIPD vein and J1 departs from the left posterior aspect of the SMV at a point about 20 to 30 mm below the SV-SMV junction.

The PSPD vein joins the posterior side of the portal vein (PV) at a point 0 to 15 mm above the SV-SMV junction. The PSPD vein runs horizontally near the upper edge of the pancreas head, crosses the anterior of the bile duct, and then runs along the right side of the bile duct,

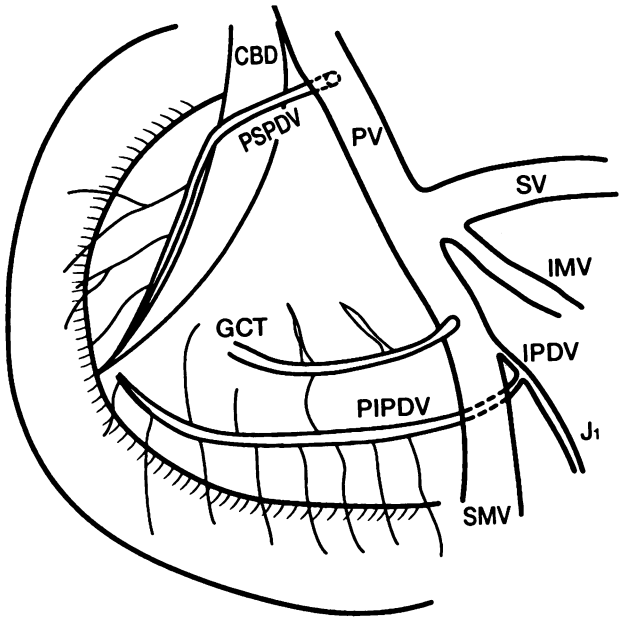

Figure 6. Schema of the topography of the head of the pancreas, showing the veins and common bile duct. PSPDV = posterior superior pancreaticoduodenal vein; PIPDV = posterior inferior pancreaticoduodenal vein; IPDV = inferior pancreaticoduodenal vein; CBD = common bile duct; SMV = superior mesenteric vein; PV = portal vein; IMV = inferior mesenteric vein; SV = splenic vein; J1 = the upper jejunal vein; GCT = gastrocolic tract.

toward the papilla of Vater. The inferior mesenteric vein joins near the lower edge of the SV-SMV junction.

DISCUSSION

The stream of surgery these days flows toward both radical extended and organ-preserving procedures. Since the report by Traverso et al.,[13] pylorus-preserving pancreatoduodenectomy has been performed worldwide for both benign pancreatic ailments, such as chronic pancreatitis, and carcinoma of the head of the pancreas, the lower bile duct, or papilla of Vater.[14,15] Body weight, as well as physiologic and endocrinologic functions, can be preserved much better after pylorus-preserving pancreatoduodenectomy than after conventional pancreatoduodenectomy.[16] In addition, if the duodenum could be preserved, these functions would be much better preserved than after pylorus-preserving pancreatoduodenectomy. Takada et al.[16] reported the importance of preserving the duodenum to maintain gastrointestinal hormones at physiologic levels. In Japan, this type of operation has been performed mainly for mucin-producing carcinoma of the pancreas, in which radical dissection of the lymph nodes is not necessary.[5-7] Recently, subtotal pancreatectomy or resection of the uncinate process with preservation of the duodenum also has been performed for this disease.[17-19]

To perform a duodenum-preserving pancreatic head resection, we first should have precise knowledge regarding the anatomy of the pancreatoduodenal region, especially of the pancreaticoduodenal arteries, which provide blood to the duodenum. The most desirable procedure might be to preserve the duodenal branches of the pancreaticoduodenal arteries. However, most authors have performed this surgery without addressing this point. Fry and Child[1] emphasized the need to preserve the pancreaticoduodenal arteries to avoid duodenal necrosis. However, they did not refer to the precise anatomy and reported that "sometimes it has been possible to reserve vessels," and "fortunately the common duct has not been injured." Beger et al.[2,3] reported a duodenum-preserving pancreas head resection in 1980 and 1985. They did not address the pancreaticoduodenal arteries and resected the pancreatic parenchyma 5 to 10 mm from the duodenal wall. Lambert et al.[4] reported that duodenum showed only edema, even after the pancreas had been resected along the duodenum. Similar findings have been reported by Japanese authors.[6,7] The latter claimed that the most important point in performing this procedure would be to avoid Kocher's maneuver, so as to keep the small collaterals from the retroperitoneum to the duodenum unimpaired. They suggested that sufficient blood could be obtained from the duodenal mesentery and retroperitoneum. However, some of their cases suffered leakage of the pancreatoduodenostomy, which was ascribed to duodenal blood insufficiency, even after the collaterals were left intact.[7]

Preservation of the pancreaticoduodenal arteries would provide a better supply of blood to the duodenal wall. From this study, it appears possible to remove the head of the pancreas while preserving the vascular ar-

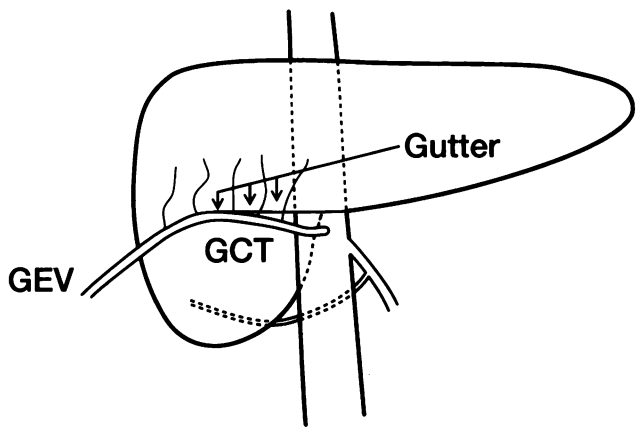

Figure 7. Schema of the gutter of the pancreas, the gastrocolic tract, and the gastroepiploic vein. GCT = gastrocolic tract; GEV = gastroepiploic vein.

cades and their branches to the duodenum, the bile duct, and the papilla of Vater. Near the accessory papilla, however, dissection of the vessels may be difficult because the pancreatic parenchyma sometimes is found deep in the wall of the duodenum. It might be better in such cases to leave this portion intact and to perform a subtotal resection of the head of the pancreas.

It was possible to generalize regarding the anatomy of the veins of the head of pancreas, despite the complex variety of patterns of the pancreatic veins. Although preservation of the venous system might be less important than arterial salvation when considering duodenum-preserving pancreas head resection, it might be better to retain as many veins as possible for effective venous return from the duodenum.

All of the pancreatoduodenal arteries and veins run on a connective tissue membrane situated on the posterior of the pancreas. We should take care not to injure this membrane. This is one of the most crucial aspects of preserving the arteries that supply blood to the duodenum.

Based on the aforementioned basic anatomy of the pancreatic head, we performed subtotal pancreatectomy in a patient with mucin-producing carcinoma of the pancreas. The main lesion of the carcinoma was between the body and tail, with intraductal spread to the main pancreatic duct in the head, the branches of which appeared normal. Therefore, subtotal pancreatectomy with preservation of the pancreaticoduodenal arteries was performed. The main pancreatic duct was cut at the pancreaticobiliary junction. Both the bile duct and the papilla of Vater also were preserved. The color of the duodenum after this procedure was very good. The postoperative course was uneventful. The specimen revealed that papillary carcinoma occupied the main pancreatic duct from the head to the tail of the pancreas. The surgical margin was free of cancer cells.

Thus, duodenum-preserving subtotal pancreatectomy or subtotal resection of the pancreatic head, based on the above topography, may be a reliable option for surgical treatment of benign lesions as well as low-grade malignancy spreading to or primarily involving the head of the pancreas.

Acknowledgment

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