

Modifications of the Duodenum Preserving Pancreatic Head Resection



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1. Pathogenesis and indications for surgical intervention in chronic pancreatitis

Exocrine and endocrine pancreatic insufficiency and recurrent episodes of abdominal pain comprise the characteristic clinical features of chronic pancreatitis. Severe pain is the leading cause for hospitalization, inability to work, early retirement and addiction to analgesics in devastating conditions of chronic pancreatitis (30).

Like other therapeutic modalities, surgery addresses pain as the incapacitating symptom, while causative treatment options are still lacking.

Based on studies on the natural history of chronic pancreatitis by Ammann and associates, it was hypothesized, that eventually most patients will become pain free with progressive "burning out" of the organ (1). Therefore, a conservative approach has been proposed.

However, a recently published study based on a larger population and observing a longer follow-up showed that pain alleviation did not occur in more than 50% of the patients while the disease progressed (30). The socio-economic burden of the disease is closely related to recurrent disabling pain attacks which cause periodic sick leaves and frequent hospitalization (30). Considering the impact of the "burning out" process on the patient and society, therapeutic nihilism may not be the appropriate approach.

The indications for surgical intervention are intractable pain, complications related to adjacent organs, endoscopically not permanently controlled pancreatic pseudocysts in conjunction with ductal pathology, and conservatively intractable internal pancreatic fistula (18, 30, 41). Occasionally the inability to exclude pancreatic cancer despite broad diagnostic work-up also requires surgery (34). The ideal surgical approach should address all these problems.

Abstract

Surgery for chronic pancreatitis has gained wide acceptance because of excellent results regarding pain alleviation and control of complications arising from adjacent organs. After the introduction of the duodenum preserving pancreatic head resection by Beger almost three decades ago, many modifications have been proposed, evaluated and compared. This article reviews the variety of operations, the reported results and potential advantages.

Besides the Beger- and Frey procedure, none of the modifications have been properly evaluated in a prospective randomized trial. Both procedures managed to relieve the outlined problems while achieving low operative mortality and morbidity. Only the operations according to Beger and Frey can be considered standard procedures in chronic Pancreatitis.

Key words: Chronic pancreatitis, surgery, duodenum preserving pancreatic head resection.

Riassunto

La chirurgia della pancreatite cronica ha acquisito un crescente consenso per via dei suoi eccellenti risultati riguardanti la risoluzione del dolore ed il controllo delle complicazioni a carico degli organi adiacenti. Dopo l'introduzione della cefalopansectomia con conservazione del duodeno da parte di Beger (circa 30 anni orsono), molte modificazioni sono state proposte, valutate e comparate. Questo articolo attua una review delle diverse operazioni, dei risultati conseguiti ed i potenziali vantaggi. Tuttavia gli interventi di Beger e Frey, non sono stati valutati propriamente in studi randomizzati e prospettici. Entrambe le operazioni risolvono i problemi sopra descritti e garantiscono una bassa mortalità e morbilità operatoria. Entrambe le operazioni di Beger e Frey possono essere considerate come tecniche standard nella chirurgia per la pancreatite cronica. Parole chiave: Pancreatite cronica, chirurgia, cefalopansectomia con conservazione del duodeno.

Pain is the crucial symptom in severe chronic pancreatitis. Reflecting experimental evidence and clinical experience, ductal and parenchymatous hypertension and neural alterations in combination with extensive fibrosis have been developed as basic hypotheses on the pathogenesis of pain in chronic pancreatitis (7, 12, 14, 15, 26).

Tab. I – AIMS OF SURGICAL TREATMENT FOR CHRONIC PANCREATITIS

1. Pain relief
2. Control of pancreatitis associated complications of adjacent organs
3. Preservation of exocrine and endocrine pancreatic function
4. Social and occupational rehabilitation
5. Improvement of quality of life

Referring to these different ideas of pain origin, drainage and resection have emerged as the main principles of surgery in chronic pancreatitis. Exclusively draining and resective operations (8, 13, 16, 18, 19, 41) have failed to meet all the aims of an ideal surgical treatment for chronic pancreatitis (Tab. I).

More recently, a variety of different procedures has been either proposed (4, 17) or recalled (39, 42) relying on both drainage and resection with emphasis of one or the other. Classical partial pancreatoduodenectomy according to Whipple, pylorus preserving pancreatoduodenectomy (PPPD) according to Traverso-Longmire, duodenum preserving resection of the head of the pancreas according to Beger (DPRHP), and longitudinal pancreaticojejunostomy combined with local pancreatic head excision (LPJ-LPHE) according to Frey managed to provide pain relief, to control complications arising from adjacent organs, and to identify intraoperatively pancreatic cancer, which had been missed despite broad diagnostic work-up (12, 15, 34, 37).

2. Surgical Methods

Duodenum preserving resection of the head of the pancreas according to Beger (4, 5) (Fig. 1a,b)

Beger devised this operation in the early 70's and reported his results some years later (5).

After ventral dissection and dorsal mobilization of the head of the pancreas, frozen sections are sampled. The gland is tunneled above the portomesenteric vein, where it is divided. Hemostasis of the left resection margin is achieved by transfixing stitches. The resection is carried out towards the papilla of Vater. The pancreatic head is resected almost completely leaving only a small margin of pancreatic tissue between the duodenum and the common bile duct. Towards the vena cava a small rim of pancreatic tissue is preserved, too. The bile duct is freed from scarring tissue to ensure sufficient bile flow. Preservation of the gastroduodenal artery is not mandatory. While resecting the uncinate process, care should be applied to spare the meso-duodenal vessels. A pancreaticojejunostomy and pancreatojejunostomy is performed using a Roux-en-y loop of proximal jejunum. If the common bile duct can not be decompressed, a choledochotomy proximal to the papilla should be performed fixating the margins to the dorsal pancreatic plate, so bile can drain into the resection cavity (20).

Warren's modification (40) (Fig. 2)

Four years after Beger's report on duodenum preserving pancreatic head resection, Warren et al. suggested a modification of this procedure. After performing the pancrea-

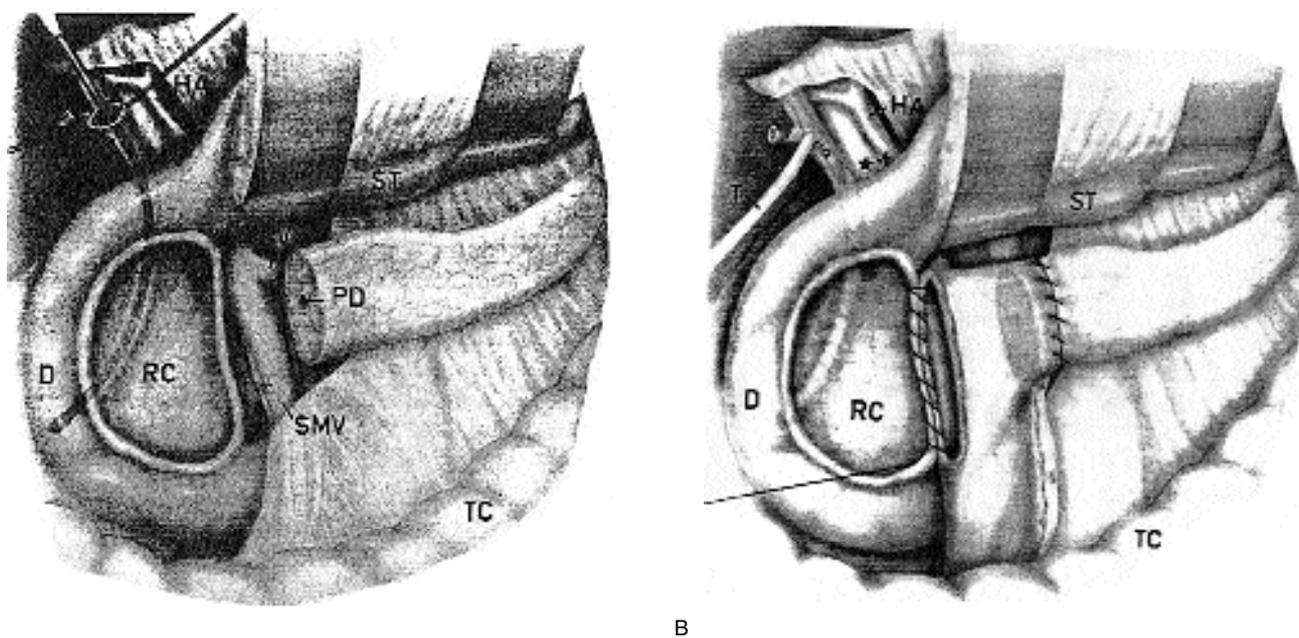


Fig. 1: The duodenum preserving pancreatic head resection according to Beger from *Ann Surg*, 1995, 221:350-358.
 A: After pancreatic head resection (D: duodenum, CBD: common bile duct, HA: hepatic artery, ST: stomach, SV: splenic vein, PD: pancreatic duct, RC: resection cavity of the head of the pancreas, SMV: superior mesenteric vein, TC: transverse colon, T: T tube, *: stump of the gastroduodenal artery).
 B: Reconstruction.

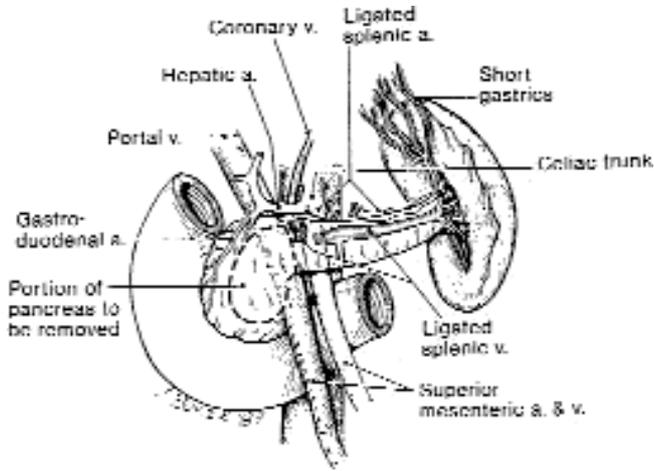


Fig. 2: Warren's modification from Surg Gynecol Obstet, 1984, 159:581-583.

tic head resection much in the way Beger described it, the body and tail of the pancreas are denervated by ligating and dividing the splenic vein at its junction with the superior mesenteric vein. The splenic artery is divided as it approaches the pancreas from the celiac axis. Viability of the spleen is ensured through its extensive arterial and venous collateral circulation, principally the gastroepiploic and short gastric systems. The entire flap (pancreas, splenic artery and vein and associated nerve fibers) is freed from all tissue until the pancreas is attached only to the vessels at the hilus of the spleen. This maneuver supposedly severs all somatic and autonomic nerve fibers. Finally a Roux-en-y loop of jejunum is prepared and the pancreatic duct anastomosed with a small mucosal opening.

The longitudinal pancreaticojejunostomy combined with local pancreatic head excision (LPJ-LPHE) according to Frey (17) (Fig. 3a,b)

Frey and co-workers reported on a modification of the DPRHP (5, 17). The operative difference between the two methods is a more radical resection of the pancreatic head in the Beger procedure. Freys' technique combines a modified longitudinal pancreaticojejunostomy according to the Partington-Rochelle (33) with limited excision of the pancreatic head.

After a Kocher maneuver and identification of the superior mesenteric and portal vein, the pancreatic duct is opened longitudinally, proximally and distally. Absorbable sutures are placed parallel to, and not lesser than 3-4 mm from, the duodenum along the inner aspect of the duodenum for hemostasis. The head of the pancreas is cored out leaving a cuff of pancreas along the inner aspect of the duodenum. Care should be taken to not interrupt the gastroduodenal artery and the anterior pancreaticoduodenal arcade on the same patient. Medially, a margin of at least 4-5 mm of pancreatic head is left right to the portal vein to avoid dividing the pancreas. Posteriorly, a shell of pancreas remains between the cored out head, the uncinate process and the inferior vena cava. A Roux-en-y double layer pancreaticojejunostomy is performed.

Takada's modification (38) (Fig. 4a,b)

In 1993 Takada et al. proposed a variation of a duodenum-preserving pancreatic head resection (689}. The mobilization is similar to the Beger procedure, but a

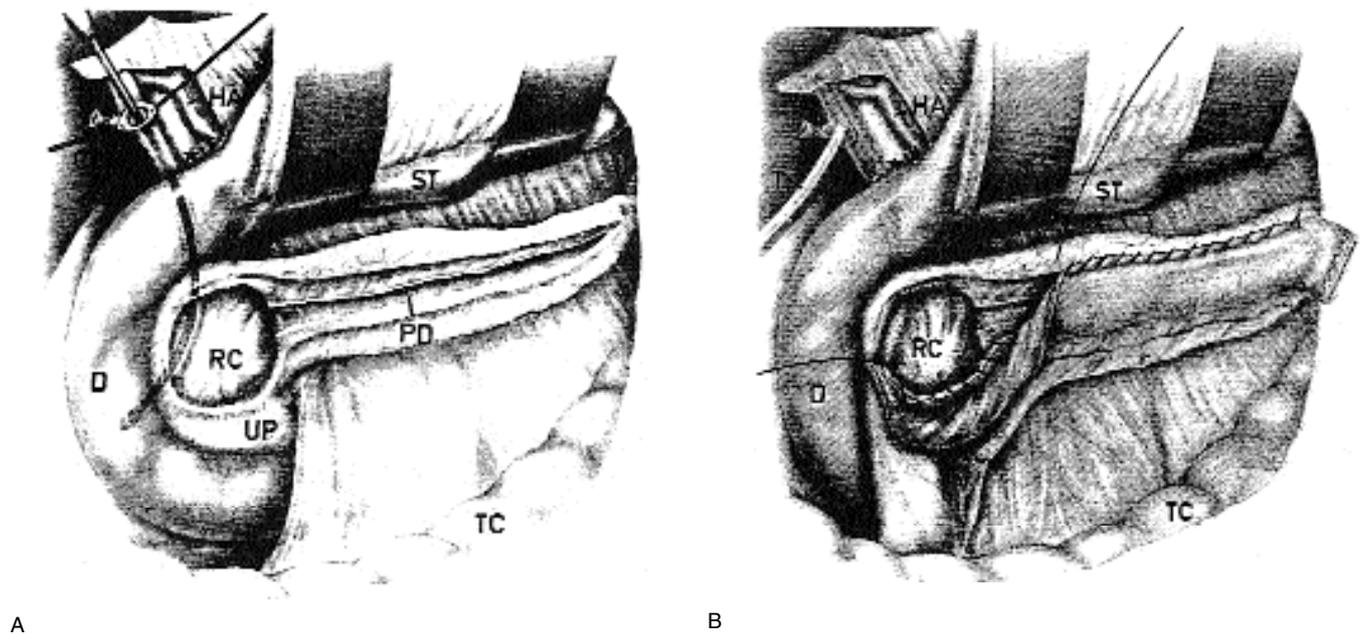


Fig. 3: The longitudinal pancreaticojejunostomy combined with local pancreatic head excision according to Frey from Ann Surg, 1995, 221:350-358. A: After excision (D: duodenum, CBD: common bile duct, HA: hepatic artery, ST: stomach, SV: splenic vein, PD: pancreatic duct, RC: resection cavity of the head of the pancreas, UP: uncinate process, TC: transverse colon, T: T tube, *: stump of the gastroduodenal artery). B: Reconstruction.

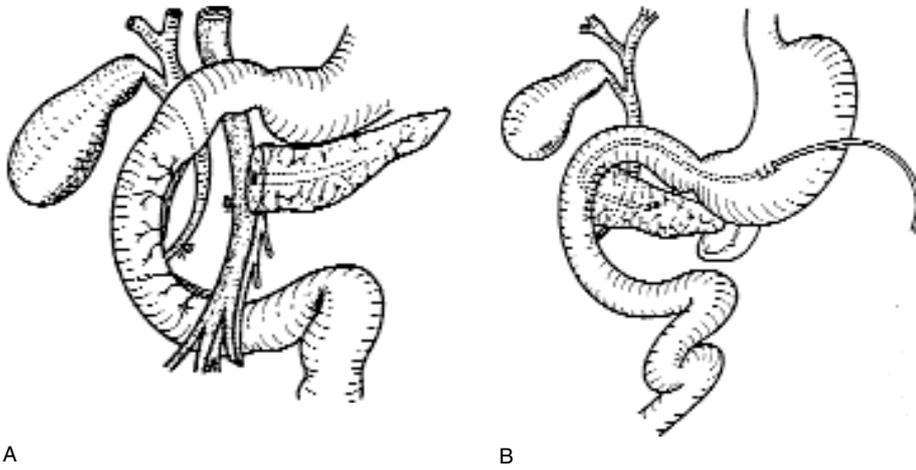


Fig. 4: Takada's modification from Hepato-Gastroenterol, 1993, 40:356-359.
A: After resection.
B: Reconstruction.

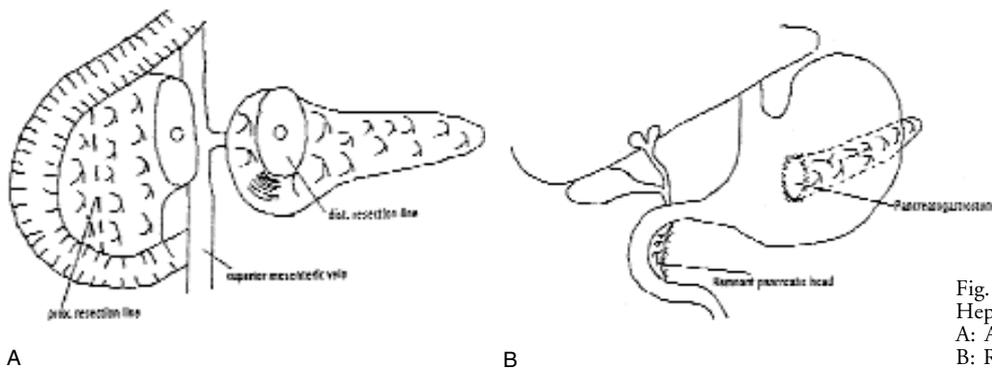


Fig. 5: Kimura's and Sapy's modification from Hepato-Gastroenterol, 1998, 45:1870-1873.
A: After resection.
B: Reconstruction.

Kocher maneuver is not performed. After transection of the pancreatic gland over the portal vein, a polyvinyl tube is inserted into the pancreatic duct and a suture is placed to fix the tube. The anterior superior pancreaticoduodenal artery is divided and the pancreatic head is resected towards the duodenum. The pancreatic duct is divided at its junction with the bile duct. After complete resection of the pancreatic head, the remaining pancreatic duct is anastomosed to the duodenum. The posterior cut edge of the pancreas is sutured to the duodenal wall. A small incision is made into the duodenum opposite to the remaining pancreatic duct and the pancreatic duct tube is introduced into the duodenum and brought out of the intestinal tract through the anterior wall of the middle third of the stomach. The pancreaticoduodenal anastomosis is performed. Then the duodenum is sutured to the anterior cut edge of the pancreas.

Kimura's and Sapy's modifications (27,28,35) (Fig. 5a,b)

Kimura et al. suggested a different modification of a duodenum preserving pancreatic head resection with detailed description how to preserve the duodenal blood supply.

After a complete Kocher maneuver is performed, the pancreas is cut above the portal vein and removed from the third portion of the duodenum. Then the posterior surface of the pancreatic head is removed from the connective tissue membrane, which should be left intact in order to ensure blood flow to the duodenum. The main pancreatic duct is cut at its junction with the terminal portion of the bile duct. The pancreas is cut in the line of the anterior superior pancreaticoduodenal artery (running along the right side of the common bile duct and supplying the papilla of Vater with blood). So in essence the pancreatic tissue between the duodenum and the common bile duct is left intact as to preserve sufficient blood flow to the papilla. After carefully suturing the cut surface of the pancreas with nylon mono-filament strings, the remaining body of the pancreas is anastomosed in the posterior wall of the stomach. A very similar technique using a pancreatogastrostomy for reconstruction of the alimentary tract has been described by Sapy et al a few years later (35). He did not indicate how much pancreatic tissue was left at the duodenal wall and to what extent the common bile duct was freed from pancreatic and connective tissue.

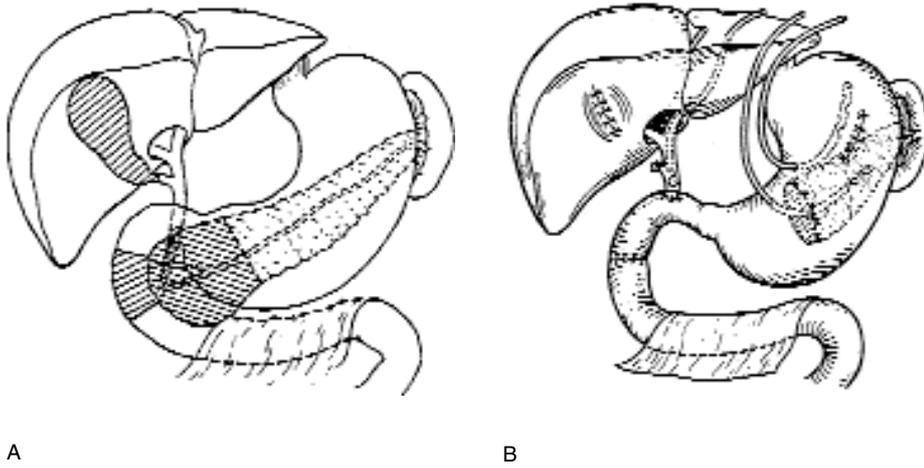


Fig. 6: Nakao's modification from Hepato-Gastroenterol, 1998, 45:533-535.
A: Resection line.
B: Reconstruction.

Nakao's modification (32) (Fig. 6a,b)

Nakao described a pancreatic head resection with segmental duodenectomy including minor and major papilla in 1998.

After cholecystectomy, the pancreas is divided above the portal vein. The extra-pancreatic nerve plexus between the uncinata process and the superior mesenteric artery is preserved, so the inferior pancreaticoduodenal artery is preserved. The posterior inferior pancreaticoduodenal artery is ligated and divided. The anterior inferior pancreaticoduodenal artery is divided near the major papilla. The common bile duct is divided at the upper border of the pancreas. Two to three centimeters of ischemic area of the duodenum is observed including the major and minor papilla. The oral side of the duodenum is divided at 5 to 7 cm from the pyloric ring. The distal part of the duodenum is divided at the margin of the anterior inferior pancreaticoduodenal artery ligation. The gastroduodenal artery is completely spared. The length of the resected duodenum ranges from 3 to 5 cm. The reconstruction of the alimentary tract is performed with pancreatogastrostomy, duodenoduodenostomy, and choledochoduodenostomy.

The V-shape excision (22) (Fig. 7)

Most recently, another "extended" drainage procedure has been described addressing the rare entity of sclerosing ductal pancreatitis referred to as "small duct disease" with maximal Wirsungian duct diameter of less than 3 mm (22). This operation features a longitudinal V-shaped excision of the ventral aspect of the pancreas combined with a longitudinal pancreatojejunostomy sewn to the edge of the organ.

After performing an extensive Kocher maneuver, a metal probe is placed into the common bile duct through a proximal choledochotomy to identify the intrapancreatic course of the distal common bile duct. Starting from the upper and lower edges of the gland, the ventral pancreatic aspect is longitudinally excised, with the tip of the excised wedge being located deep in the dorsal part

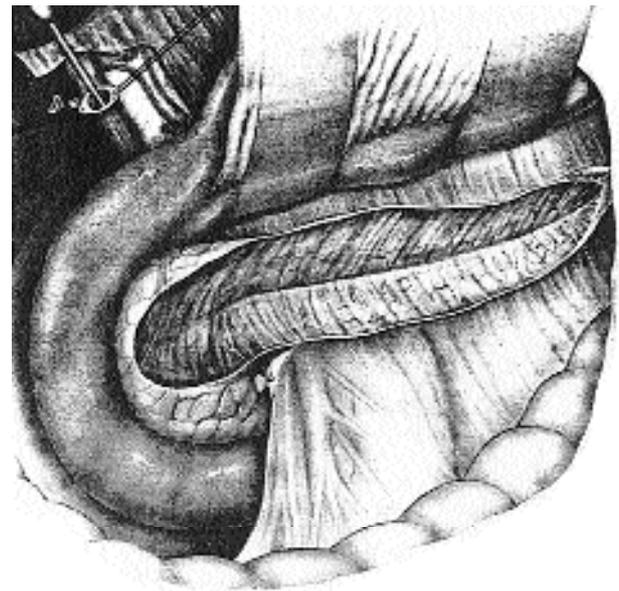


Fig. 7: The V-shape excision of the ventral aspect of the pancreas. Through a proximal choledochotomy, a metal probe is inserted into the duodenum from Ann Surg, 1998, 227:213-219.

of the pancreas. A longitudinal triangular cavity results to ensure adequate drainage of secondary and tertiary ductal branches. In case of common bile duct stenosis, the intrapancreatic course of the choledochal duct is freed from fibrotic tissue. Finally, a Roux-en-y pancreatojejunostomy is performed using a single layer monofilament running suture. A T-tube is placed into the common bile duct.

3. Results of the surgical intervention

The duodenum preserving resection of the head of the pancreas according to Beger (4) and the longitudinal pancreaticojejunostomy combined with local pancreatic head excision (LPJ-LPHE) according to Frey (17)

Duodenum preserving pancreatic head resection as intro-

duced by Beger has been shown to offer both, reliable pain relief and the advantage of low mortality and acceptable morbidity with preservation of endocrine and exocrine function (2, 3, 9, 12, 23, 24).

Of the first 57 patients reported by Beger, 86% were completely rehabilitated and only 5,4% developed diabetes mellitus after surgery (4). Compared to the pylorus preserving Whipple procedure, patients undergoing a duodenum preserving pancreatic head resection according to Beger have less pain, greater weight gain, a better glucose tolerance and a higher insulin secretion capacity at comparable morbidity rates (15% vs. 20%) and 0% mortality (10).

The finding that patients undergoing the DPRHP procedure suffer from less pain, however, is somewhat puzzling, as the extent of resection in both operations is rather similar. Thus, it is difficult to understand why the preservation of the gastroduodenal passage and common bile duct continuity should cause better pain relief. Another randomized controlled trial comparing the duodenum preserving pancreatic head resection according to Beger with the classical Whipple procedure showed advantages regarding preservation of the pancreatic function and occupational rehabilitation for the DPRHP procedure (29).

The experience with LPJ-LPHE has so far been limited to the reports of the institution, the procedure originated from (15, 17) and the Hamburg experience (21, 23, 24).

Both the DPRHP and LPJ-LPHE have been found to effectively control pain with 0% procedure related mortality in a randomized controlled trial (24). Effective control of complications of adjacent organs was achieved in 90% (Beger) vs. 100% (Frey). Both groups displayed an improvement in quality of life index of 67%. Neither procedure lead to further deterioration of endocrine or exocrine pancreatic function. But in this trial morbidity was 20% in the DPRHP group compared to 9% in the LPJ-LPHE group. The resection of the head of the pancreas is not as radical as in the DPRHP procedure, which makes the LPJ-LPHE technically less demanding. This fact could be an explanation for the observed lower morbidity.

As depicted from data reported in the literature and recently shown by a prospective randomized trial, the results of the "extended" drainage operation (LPJ-LPHE) in terms of pain relief and management of pancreatitis-associated complications of adjacent organs match the outcome achieved by resections, such as the partial pancreatoduodenectomy according to Whipple (29, 34), the pylorus-preserving pancreatoduodenectomy (PPPD) according to Longmire-Traverso (10, 21, 31, 37), and DPRHP (2, 9, 12, 15, 23, 24). Within an intermediate follow-up period, preservation of pancreatic function, and social and occupational rehabilitation were also shown to be comparable after LPJ-LPHE and DPRHP (23, 24). As mortality of resectional procedures like PD (29, 34), PPPD (10, 31, 37) or DPRHP (2, 10, 23-25) has dropped to nearly nil in experienced centers, the argument of an increased mortality cannot be used any further in favor of drainage operations. However, signi-

ficantly lower peri- and postoperative morbidity still favors draining procedures. Moreover, with regard to development of endocrine and exocrine pancreatic insufficiency a definitive advantage can be shown for the "extended" drainage operation (LPJ-LPHE) as well as for DPRHP (2, 10, 11, 23-25) as compared to PD (29, 34) or PPPD (10, 31, 37). Preservation of the gastroduodenal passage and of the continuity of the common bile duct seems to be of utmost importance for regulation of the exocrine secretory capacity and glucose metabolism (6, 29). Results of a prospective randomized trial comparing LPJ-LPHE with PPPD confirmed these findings (21).

Warren's modification (40)

Two patients were treated according to the Warren modification (40) and both were pain free after the operation (the observation period is not mentioned). Interestingly the flap survived in both patients. It is very likely, that pain control was achieved because the pancreatic head has been resected, since it is most likely, that this part is the "motor" of the disease (12). The number of patients investigated does not allow any conclusions about the efficacy of this procedure.

Takada's modification (38)

Takada's technique (38) offers "physiologic" restoration of the alimentary tract, since no Roux-en-y reconstruction is needed. However, despite its technical feasibility, its results have never been evaluated in comparison to other pancreatic head resection methods (Whipple, PPPD, DPRHP, LPJ-LPHE), so an improvement regarding pain-control, preservation of exocrine and endocrine function, postoperative gastrointestinal function and mobility, mortality and morbidity can only be hypothesized. Moreover Takada reported on a series of 11 patients, that 3 patients developed duodenal necrosis, out of which 1 patient died. In all three cases the gastroduodenal artery was divided. Therefore this routine was changed to preservation of the posterior superior gastroduodenal artery, and duodenal necrosis did not occur any more (38). But whether or not the duodenal necrosis was induced through the anastomosis or through the division of the gastroduodenal artery remains speculative. This is even more so as Beger states in his report on the first cases of duodenum preserving pancreatic head resection, that preservation of the gastroduodenal artery is not crucial to maintain sufficient blood-flow to the duodenum (4).

Kimura's and Sapy's modifications(27, 28, 35)

Sapy's report did include 14 patients (35). Morbidity was 28,5% with 0% mortality. Complete pain relief was achieved in 80% of patients. Body weight was unchanged in 50%, decreased in 15% and gained in 35% of

patients. Progression of endocrine dysfunction was observed in 2 patients (average follow-up of 2 years). Unfortunately, Kimura et al. did only report on one patient suffering from mucin producing carcinoma undergoing this procedure. The postoperative course was uneventful except for a "slight deformity" in the distal common bile duct. So on the one hand the procedure with its two main alterations i.e. drainage of the remaining pancreas into the stomach and leaving substantial pancreatic tissue between the duodenum and the common bile duct has to be shown to be safe and effective in chronic pancreatitis in a bigger group of patients. On the other hand, the report of a "slight deformity" in the distal common bile duct can be caused by leaving a pancreatic rim in the vicinity of the duct. Since common bile duct stenosis is a common complication in chronic pancreatitis (10), this procedure could potentially leave the narrowing part around the duct leading to persistent stenosis, therefore making this operation unsuitable for selected patients. Also it is not obvious why the pancreatic rim needs to be left in place, since the common bile duct is freed completely from the surrounding pancreatic and connective tissue in the Beger procedure and reports on papillar, or duodenal necrosis are missing.

Nakao's modification (32)

In 14 cases (including mucin producing cystic tumor (n = 9), annular pancreas (n = 1), anomalous arrangement of the pancreaticobiliary ductal system (n = 1), carcinoma of the duodenum (n = 1), carcinoma of the papilla (n = 1) and distal common bile duct cancer (n = 1), mortality was 0% (32). Minor leakage from the duodenoduodenostomy and choledochoduodenostomy was observed in 3 resp. 1 cases. All responded to conservative treatment. During a follow up period between 3 months to 6 years, one patient died due to liver metastasis (distal bile duct carcinoma). All other patients are still alive.

The proposed advantage of this procedure is that the risk of duodenal necrosis close to the papilla due to accidental division of the posterior superior pancreatoduodenal artery is nil, since this portion of the duodenum is resected anyway. This way a more radical pancreatic head resection can be performed. If the risk of inducing duodenal necrosis justifies an a priori segmental duodenal resection with the additional risk of duodenoduodenostomy leakage remains to be seen. Also, if a more radical pancreatic head resection is wanted e.g. in cases of malignancies, two well-established methods (Whipple or pylorus preserving Whipple) can be considered the gold standard. Nakao did not report about the possible advantages of segmental duodenectomy in comparison with the standard procedures (improved exocrine or endocrine pancreatic function, etc.).

The V-shape excision (22)

Mortality was nil with a morbidity of 15,4% in a series

of 13 patients (22). During a median follow up of 30 months, complete relief of symptoms was observed in 92% of patients. Exocrine and endocrine pancreatic function was well preserved and quality of life increased significantly postoperatively.

With this new procedure, the role of distal pancreatectomy, which has until now been indicated only in sclerosing chronic pancreatitis limited to the pancreatic body and tail (36), will further be diminished. This procedure is effectively draining secondary and tertiary pancreatic ducts in small duct disease. For small duct disease, a rare form of chronic pancreatitis, this organ sparing operation seems to be a valuable alternative to resectional procedures.

4. Conclusion

Of the duodenum preserving pancreatic head resections, two methods can be considered standard procedures in chronic pancreatitis: the LPJ-LPHE and DPRHP. Both procedures can be performed in a "custom made" fashion to fit the individual situation. Crucial is the resection of peri-papillary pancreatic tissue in chronic pancreatitis, since neglecting this area leads to higher recurrences. Only these operations outlined above have undergone a critical evaluation in multiple trials confirming their superiority as surgical procedures for chronic pancreatitis. If this holds true in cases of benign or even malignant tumor entities remains to be seen. Since the resection of the pancreatic head is more radical in the DPRHP according to Beger, it might be the procedure of choice in these instances. All other modifications outlined above have so far not been compared to LPJ-LPHE and DPRHP in terms of mortality, morbidity, functional status etc.. Still, some technical aspects like the potential benefit of different reconstruction methods (pancreaticoduodenostomy, pancreaticogastrostomy or pancreaticojejunostomy) are probably worth while to be evaluated.

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