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 socioeconomic burden of the disease is closely related to recurrent disabling pain attacks which cause periodic sick leave 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 randomised trial. Both procedures managed to relief 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 complesse emergenze a carico degli organi adiacenti. Dopo l'introduzione della cefalopancreatocele con conservazione del duodeno da parte di Beger (circa 30 anni orsono), molte modificazioni sono state proposte, valutate e comparative. 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 morbidità 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, cefalopancreatomele 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).
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 scaring 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 mesoduodenal 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 fixing 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 Begers’ report on duodenum preserving pancreatic head resection, Warren et al. suggested a modification of this procedure. After performing the pancrea-
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 a 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

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Fig. 2: Warren’s modification from Surg Gynecol Obstet, 1984, 159:581-585.

Fig. 3: The longitudinal pancreaticojejunostomy combined with local pancreatic head excision according to Frey from Ann Surg, 1995, 221:350-358.


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.

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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 potion 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 extend the common bile duct was freed from pancreatic and connective tissue.
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 uncinate process and the superior mesenteric artery is preserved, so the inferior pancreatoduodenal artery is preserved. The posterior inferior pancreatoduodenal artery is ligated and divided. The anterior inferior pancreatoduodenal 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 pancreatoduodenal 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 pancreategastrostomy, 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 pancreateojunostomy 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 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 pancreateojunostomy 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 pancreato jejunoanostomy combined with local pancreatic head excision (LPJ-LPHE) according to Frey (17)

Duodenum preserving pancreatic head resection as intro-
of the exocrine secretory capacity of the common bile duct continues to be of utmost importance for regulation of the ductal system. The finding that patients undergoing the LPH procedure have less pain, greater weight gain, a better diabetic control, and fewer complications compared to those undergoing the LPL-HIE procedure suggests that the latter may be a superior procedure for the treatment of diabetes.

Two patients were treated according to the Warren modification (49). One patient (29, 30, 31, 32) was treated with PD (29, 30, 31, 32) and the other with PPID (30, 31, 32). Both patients were free of diabetes, but one had previously undergone a Whipple procedure for pancreatic cancer. The patient treated with PD showed a complete remission of diabetes, while the patient treated with PPID showed a partial remission. The patient treated with PD also showed a significant weight gain, while the patient treated with PPID showed no change in weight. The finding that patients undergoing the LPH-LIP procedure have less pain, greater weight gain, a better diabetic control, and fewer complications compared to those undergoing the LPL-HIE procedure suggests that the latter may be a superior procedure for the treatment of diabetes.

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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 papillary, 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 duodenumoduodenostomy 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 pancreaticoduodenal 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 pancreactectomy, 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 duodenal 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 worthy while to be evaluated.

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