

### 8.1 Relevant Basic Information, Indications, and Contraindications

Surgical techniques for chronic pancreatitis may be divided into resections and drainage procedures. From a functional point of view, drainage operations in patients with chronic pancreatitis are superior, because less parenchyma is removed. Due to the frequency of local complications in chronic pancreatitis, however, the majority of operations in our hospital are resections. The most frequent indication for resection is pancreatic head enlargement with stenosis of the bile duct, pancreatic duct, and/or duodenum. Resection of the pancreatic body and/or tail is indicated only rarely in chronic pancreatitis. Drainage procedures include enteric drainage of pseudocysts or a dilated pancreatic duct into the jejunum or stomach. We prefer an anastomosis

to Roux-en-Y jejunal limb which will protect the pancreatic duct or pseudocyst from entry of intestinal content. Both approaches, resection and drainage, can be combined. Total pancreatectomy for chronic pancreatitis is performed only in very selected patients because of its overriding metabolic sequelae in these often difficult patients, especially if they are alcoholics.

Chronic pancreatitis is not a primary surgical disease. Resection of pancreatic parenchyma may lead to deterioration of exocrine and endocrine function of the gland. The major aims of operative intervention are to relieve pain and to treat the local complications of this chronic inflammatory disease that may develop as sequelae of narrowing, stenosis, or even occlusion of the pancreatic duct and/or focal enlargement of the head of the pancreas with compression of neighboring organs, such as the bile duct, duodenum, portal venous system, stomach, or colon.

General indications for operative intervention include extrinsic compression or inflammatory sclerotic stenosis of the bile duct, pancreatic duct, duodenum, or portal/splenic vein as well as the development of symptomatic pseudocysts. Carcinoma is often part of the differential diagnosis and is best ruled out by resection. Rarely, pancreatic ascites, pancreaticopleural fistula, and bleeding complications lead to operation. Every patient needs an individual treatment plan, which should be developed through an interdisciplinary approach by surgeons, gastroenterologists, and, in special situations, interventional radiologists.

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**Table 8.1** Diagnostic preoperative setup in patients with chronic pancreatitis

| Diagnostic method  | Questions   |
|--|---|
| Clinic   | Pain, nausea, weight loss, glucose intolerance, new diabetes, steatorrhea, duodenal stenosis, bile duct stenosis, pancreatic duct stenosis, pseudocyst  |
| Laboratory evaluation  | Standard parameters, CA 19-9  |
| Standard chest X-ray   | Pulmonary lesions   |
| Ultrasound   | Pancreatic tumor, ascites, liver metastases   |
| MRT + MRCP + angio-MRI   | All-in-one procedure, exclusion of a malignant tumor, pathology of the mesenteric and portal vein and hepatic and superior mesenteric artery, strictures and obstruction of pancreatic or bile duct |
| <i>Endoscopic ultrasonography</i>  | <i>Strictures and obstruction of pancreatic or bile duct, exclusion of a malignant tumor, pathology of the mesenteric and portal vein and hepatic and superior mesenteric artery</i>                |
| <i>Preoperative biopsy</i>   | <i>Unnecessary, in case of tumor suspicion oncological resection is indicated</i>   |
| <i>In case of all- in- one MRI is not possible:</i>                                      |   |
| <i>CT + ERCP is used</i>   |   |
| <i>CT (high-quality multiphase contrast-enhanced, thin-section helical CT), angio-CT</i> | <i>Exclusion of a malignant tumor, pathology of the mesenteric and portal vein and hepatic and superior mesenteric artery, ascites</i>  |
| <i>ERCP</i>  | <i>Strictures and obstruction of pancreatic or bile duct, endobiliary stenting, biopsy – cytologic investigations</i>   |

*Italic = optional tests for specification of the diagnosis*

Thrombosis or stenosis (compression) of portal or superior mesenteric veins due to pancreatic head enlargement may lead to severe portal hypertension which, in turn, will become a relative contraindication for aggressive resection because of the high risk for bleeding. When pancreatic head resection is planned, patency of the celiac trunk and superior mesenteric artery should be checked by computed tomography angiography (angio-CT) or magnetic resonance imaging (MRI). When occlusion/stenosis of the celiac trunk or common hepatic artery and the associated variations in arterial supply to the liver is not appreciated, liver ischemia may result. We do not yet perform prophylactic pancreatic resections in patients with hereditary pancreatitis because data supporting such an aggressive procedure is scarce and the sequelae of total pancreatectomy currently outweigh the benefits. In patients with chronic pancreatitis, the often substantial co-morbidity due to chronic alcohol or nicotine abuse should always be taken into consideration. In patients with concomitant liver cirrhosis, cardiomyopathy, pulmonary emphysema, or severe arteriosclerosis, thorough preoperative evaluation is necessary. We will not perform elective pancreatic surgery in patients with severe liver or respiratory insufficiency or in those patients with a left ventricular ejection fraction below 35 %. A thorough preoperative evaluation with correction

of abnormalities of electrolytes, nutrition, and coagulation are essential. A strict indication for operative intervention is mandatory to avoid unnecessary risk of complications to the patient.

In general, only patients with a long-standing history of chronic pancreatitis are referred to the surgeon. For this reason, a lot of investigations have usually already been done at this time. To plan an operation, a recent contrast-enhanced, three-phase, thin-layer (1 mm), multidetector computed tomography (MD-CT) or high-quality MRI is required to image the entire pancreatic parenchyma, duct pathology, and vascular anatomy (Table 8.1). In addition, liver (cirrhosis), vessel (thrombosis, stenosis), peritoneal (ascites), and pleural (effusions) pathology should be sought for and excluded or at least acknowledged. 3D reconstruction should allow the recognition of either anatomic vascular abnormalities or functional variant arterial blood supply to the liver related to arteriosclerotic stenosis of the celiac and mesenteric arteries, respectively. Imaging of the pancreatic duct by magnetic resonance cholangiopancreatography (MRCP) or endoscopic retrograde cholangiopancreatography (ERCP) is obligatory. Endoscopic ultrasonography (EUS) has lost some of its value with the introduction of MD-CT and high-resolution MRI but offers advantages in patients who present with a conventional helical

CT or MRI performed on a scanner of older generation. There is no specific need for angiography or positron emission tomography (PET). Routine laboratory parameters (blood count, electrolytes, coagulation, renal, liver enzymes, and albumin) serve to evaluate relevant organ functions and allow correction of deficits preoperatively. The tumor marker CA 19-9 is always determined, and a clinically important increase (>200 U/ml) leads us to a more aggressive surgical approach, keeping in mind that jaundice may increase CA 19-9 serum level as well. A conventional chest x-ray is performed only when the thoracic organs were not visualized previously by CT or MRI. Any suggestions of cardiac or pulmonary insufficiency are evaluated by echocardiography and spirometry, respectively.

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## 8.2 Surgical Technique

Two units of packed red blood cells are ordered for each patient on the day of operation. In general, the patient is placed supine on a flexible operation table. The table is adjusted to bring the patient into hollowback hyperextended position and rotated slightly to the right. A curved, right subcostal incision allows for convenient exposure of the pancreas and all other relevant structures. If required, this incision may be extended to the left to improve exposure of the pancreatic tail and spleen. For patients with a prior midline incision or those with a narrow costal margin, a vertical midline incision extending from the xiphoid to just below the umbilicus is equally appropriate. We prefer a Stieber self-retaining retractor to keep the incision open wide and to protect the left lobe of the liver from falling into the operative site. Every operation starts with thorough exploration of the entire peritoneal cavity to detect concomitant pathology of the liver, bowel, and other organs. If indicated, representative tissue specimens are taken for frozen section analysis.

### 8.2.1 Pancreatic Resection Procedures

Traditionally, pancreatic head resection in chronic pancreatitis follows the same operative

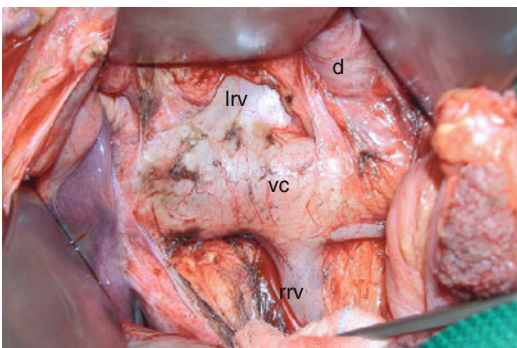
rules as in pancreatic cancer, i.e. pancreatoduodenectomy in combination with subtotal resection of the stomach. In contrast, organ-sparing resections have been developed over the past several decades that include pylorus preservation and several techniques for preservation of the duodenum and distal bile duct. The classic Kausch-Whipple (KW) procedure is used typically in patients with chronic pancreatitis who have had a prior gastric resection for ulcer, in rare situations of extensive adhesions between the pancreatic head and the pyloric region, and if the duodenum stump becomes ischemic during an attempted pylorus preservation. Pylorus-preserving pancreatoduodenectomy is indicated in patients who present with suspicion of cancer and those with combined stenoses of the intrapancreatic bile duct, pancreatic duct, and duodenum due to inflammatory pancreatic head enlargement.

The Longmire-Traverso, Frey, and Kausch-Whipple procedures are used frequently in our department in patients with chronic pancreatitis. These methods following this chapter (Table 8.4).

The *classic pancreatoduodenectomy* or Kausch-Whipple procedure begins with mobilization of the hepatic flexure and transverse colon (Table 8.2). The duodenocolic ligament is divided and the superior mesenteric vein identified. An extended Kocher maneuver is then performed so that the common bile duct, the vena cava, and both renal veins become visible (Fig. 8.1). This maneuver allows for palpation of the pancreatic head and uncinate process and evaluation of the retroperitoneal space for pathology, such as enlarged lymph nodes. Next the lesser sac is entered by transection of the right portion of the gastrocolic ligament but with preservation of the gastroepiploic vessels. Use of the harmonic scalpel (SonoSurg®, Olympus, Hamburg, Germany) can be extremely beneficial, because operation time can be reduced. After division of fibrous adhesions between the pancreas and the posterior wall of the stomach, the entire anterior surface of the pancreas is freed up. Care must be taken to avoid injury to the blood vessels and branches of the vagus nerve along the lesser curve of the stomach and the splenic artery at the superior margin of the pancreas.

**Table 8.2** Steps of a standard Kausch-Whipple procedure

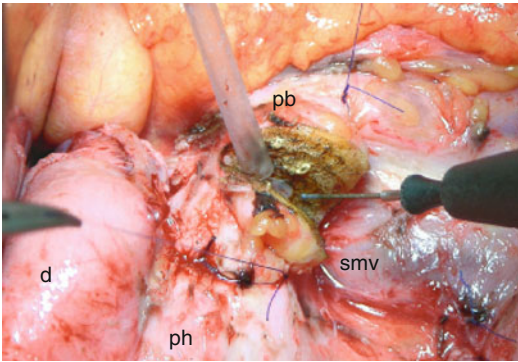
| Resection |   |
|-----------|---|
| 1         | Exploration   |
| 2         | Biopsy of liver or peritoneal metastases if necessary   |
| 3         | Elevation of the duodenum and pancreatic head (Kocher maneuver)   |
| 4         | Mobilization of the right colon flexure   |
| 5         | Division of the duodenocolic ligament   |
| 6         | Division of the right portion of the gastroduodenal artery  |
| 7         | Division of adhesions between pancreas and the posterior gastric wall   |
| 8         | Identification and banding of the gastroduodenal artery and identification of the portal vein on the superior border of the pancreas                      |
| 9         | Exposure of the SMV at the inferior border of the pancreas  |
| 10        | Division of the gastroduodenal artery   |
| 11        | Division of the pancreas  |
| 12        | Resection of the gastric antrum   |
| 13        | Division of the jejunum distal the ligament of Treitz and delivery of the jejunum and the distal duodenum to the right of the superior mesenteric vessels |
| 14        | Freeing the uncinate process and division of the lateral branches of the SMV and SMA  |
| 15        | Freeing of the gallbladder and transection of the common hepatic bile duct  |
| 16        | Pancreaticojejunostomy  |
| 17        | Hepaticojejunostomy   |
| 19        | Gastrojejunostomy   |
| 20        | Braun's entero-enterostomy  |
| 21        | Drainage and closure of the abdominal wound   |



**Fig. 8.1** Kocher maneuver. Following mobilization of the duodenum, the inferior vena cava and both renal veins become visible (*vc* vena cava, *rrv* right renal vein, *lrv* left renal vein, *l* liver, *d* duodenum)

Next, the hepatoduodenal ligament is dissected so that the common hepatic artery becomes visible. The origin of the gastroduodenal artery is identified, and the vessel is encircled and retracted to the left. Identification of the portal vein is easy now, because it is situated in the triangle between the common hepatic artery, gastroduodenal artery, and superior margin of the pancreas. Next, starting at the caudal margin of the neck of the pancreas and the superior mesenteric vein, the groove of the portal vein on the dorsal surface of the pancreas is carefully dissected bluntly using an Overholt clamp. In the presence of severe inflammatory adhesions or a large pancreatic head compressing the portal vein, the groove of the portal vein may not be identifiable without causing potentially severe bleeding from the veins. In this situation, the pancreatic parenchyma is transected anterior to the presumed course of the superior mesenteric and portal veins behind the neck of the pancreas. After dissection of the superior mesenteric/portal vein groove from the dorsal pancreatic capsule is completed, a suture of 3/0 diameter (any material possible) is positioned around the neck of the pancreas at the right margin of the superior mesenteric vein and tightly tied. This suture ligation compresses the pancreaticoduodenal arteries and enables the neck of the pancreas to be lifted. Two stay sutures (4/0 monofilament resorbable, e.g. PDS®, Ethicon, Norderstedt, Germany) are placed and tied in the pancreatic neck, one each at the upper and lower margin of the organ (Fig. 8.2). In contrast to other groups, we do not dissect circumferentially and loop the portal and superior mesenteric veins for control of possible bleeding. In our hands, control of bleeding can be achieved easily by bidigital compression of the veins when a wide Kocher maneuver has been performed.

The next step consists of the ligation of the gastroduodenal artery near its origin at the common hepatic artery. The stump of the gastroduodenal artery is secured by a transfixion suture using 4/0 monofilament nonresorbable material (Prolene®, Ethicon). The pancreatic neck is now lifted by traction of the stay sutures and the pancreatic parenchyma is transected using an



**Fig. 8.2** Following the placement of stay sutures, the pancreas is transected in front of the superior mesenteric vein using a cautery needle (*ph* pancreas head, *pb* pancreas body, *smv* superior mesenteric vein, *d* duodenum)

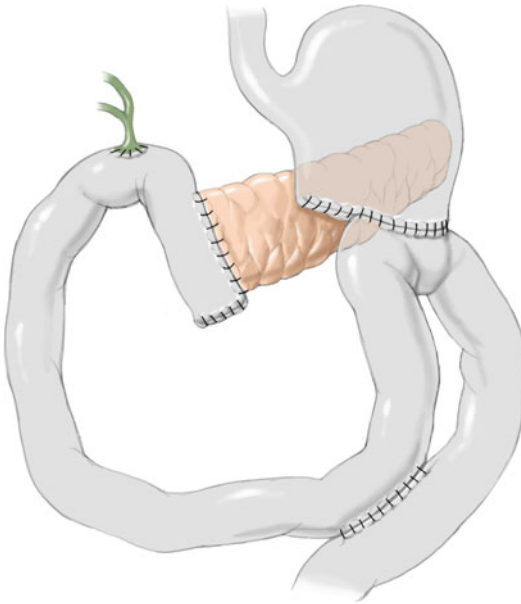
electrocautery needle beginning anteriorly at the right margin of the portal vein, starting at the uncinate edge of the superior mesenteric vein. Details of this transection have been described and illustrated in Chap. 1. Bleeding from small, intrapancreatic vessels is controlled immediately by bipolar coagulation. After transection of the pancreas, the gastric antrum is resected. We never perform the classic 2/3 Billroth resection when resecting a pancreatic head. Transection of the antrum is performed using two firings of a 75-mm, reloadable linear cutter (TLC 75 Proximate<sup>®</sup>, blue magazine, Ethicon, Norderstedt, Germany). The jejunum is transected about 15 cm distal to the ligament of Treitz also using a TLC 75 Proximate<sup>®</sup> linear cutter, and the vessels in its mesentery and the mesentery of the fourth portion of the duodenum are transected using a harmonic scalpel. The jejunum is then pulled behind the mesenteric root and into the right subhepatic region. By gently retracting the gastric antrum and the jejunal loop to the right, the superior mesenteric and portal veins become better exposed allowing removal of the pancreatic head from its retroperitoneal surroundings. Resection of the uncinate and head of the pancreas along the right side of the mesentericoportal vessel axis using a harmonic scalpel. Bleeding is controlled by bipolar coagulation and placement of titanium clips (Ligaclip<sup>®</sup> Multiple Clip Applier MCM-30, Ethicon). After ligation and transection of cystic artery, the gallbladder is mobilized subserously

from the liver. In the final step of the resection, the common hepatic duct is transected just proximal to the cystic duct using a cautery needle.

Reconstruction starts by creating a window in the right transverse mesocolon through which the jejunum is pulled through. First, an end-to-side anastomosis between the remnant left pancreas and the jejunal loop is created using the Warren-Cattell technique as described in Chap. 1. The inner duct-to-mucosa layer of the anastomosis is performed using 4–6 (seldom more) single stitches of 5/0 monofilament resorbable sutures (PDS<sup>®</sup>, Ethicon). For completion of the anastomosis, an outer layer of single stitches of 4/0 monofilament resorbable sutures (PDS<sup>®</sup>, Ethicon) is carried out with seromuscular sutures in the jejunum and sutures through the capsule and pancreatic parenchyma. We do not perform intraoperative stenting of the pancreatic duct.

The bile duct is then anastomosed to the same jejunal limb about 6–8 cm distal to the pancreatic anastomosis. This biliodigestive anastomosis is created using two running sutures of 5/0 or 4/0 monofilament resorbable material (PDS<sup>®</sup>, Ethicon). We do not routinely place a Kehr T-tube. When the bile duct lumen is small, reconstruction using the Goetze-Gutgemann technique (for a comparison, see Chap. 1) is advantageous. For this technique, the anterior part of the anastomosis is performed with interrupted stitches instead of a running suture. Monofilament resorbable 5/0 material (PDS<sup>®</sup>, Ethicon) is used for these cases involving a small bile duct and a small diameter t-tube or transhepatic drain is inserted if deemed necessary by the surgeon.

Next, the stomach stump is anastomosed using an omega-shaped jejunal loop positioned anterior to the transverse colon (antecolic). The distance between biliodigestive and gastric anastomosis is about 60 cm. A Braun anastomosis is created about 10 cm distal to the defect in the transverse mesocolon through which jejunal limb was passed. Both enteric anastomoses are performed using two layers of polyfilamentous resorbable 4/0 (jejunum) or 3/0 (stomach) running sutures (Vicryl<sup>®</sup>, Ethicon). Figure 8.3 illustrates the reconstruction used. Finally, one silicone drain (Easy Flow Drainage, P. J. Dahlhausen & Co.,

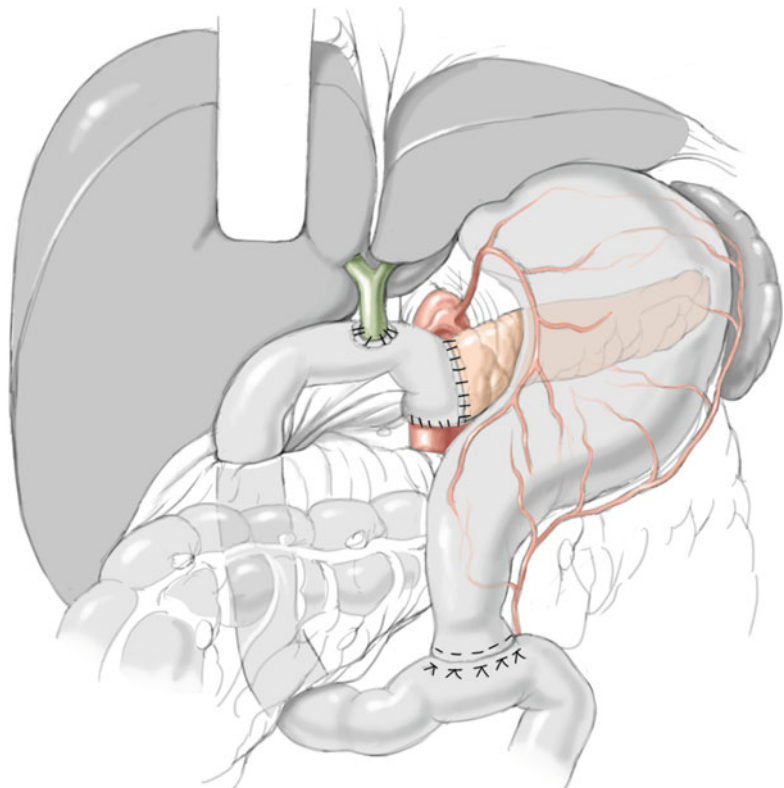


**Fig. 8.3** Reconstruction following classical Kausch-Whipple procedure. End-to-side duct-to-mucosa pancreaticojejunostomy using Warren-Cattell's technique is performed followed by end-to-side hepaticojejunostomy. Antecolic gastrojejunostomy is performed next and reconstruction is completed by side-to-side entero-enterostomy in accordance with Braun

GmbH, Cologne, Germany) is placed into the subhepatic region with its tip in the former epiploic foramen about 2 cm from the pancreatic anastomosis.

*Pylorus-preserving pancreatic head resection (PPPHR)* is performed in cases where there is a serious concern about pancreatic head carcinoma or when there is a long intrapancreatic stenosis of the bile duct. Longmire's surgical technique for this procedure (Fig. 8.4) was described in Section 1.1.2.

The *Frey procedure* is a combination of a non-anatomic, subtotal resection of the pancreatic head with longitudinal opening (filleting) and drainage of the pancreatic ducts. Pancreatic duct pathology is associated with pancreatic head enlargement in about 30 % of our patients with chronic pancreatitis. Pancreatic head resection alone is inadequate if there is associated pathology of the pancreatic duct (e.g., stones, strictures, retention cysts) in the remnant body or tail of the gland. In contrast, it is unlikely that an enlarged pancreatic head can be drained sufficiently by standard, longitudinal pancreaticojejunostomy



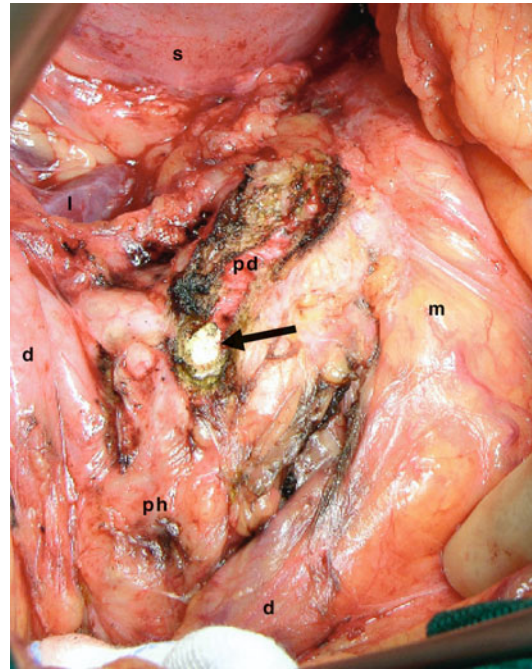
**Fig. 8.4** Reconstruction following pylorus-preserving cephalic pancreatectomy. As in the Kausch-Whipple procedure, the first step consists of end-to-side duct-to-mucosa pancreaticojejunostomy using Warren-Cattell's technique. End-to-side hepaticojejunostomy follows. Antecolic duodenojejunostomy is performed next. In contrast to the classical Kausch-Whipple operation, no entero-enterostomy is needed

**Table 8.3** Steps of the Frey procedure

| Resection      |  |
|----------------|--|
| 1              | Exploration  |
| 2              | Biopsy of liver or peritoneal metastases if necessary  |
| 3              | Elevation of the duodenum and pancreatic head (Kocher maneuver)  |
| 4              | Mobilization of the right and left colon flexure   |
| 5              | Division of the duodenocolic ligament and gastrocolic ligament   |
| 6              | Identification and transection of the gastroduodenal artery and identification of the portal vein on the superior border of the pancreas |
| 7              | Exposure of the SMV at the inferior border of the pancreas   |
| 8              | Complete opening of the main pancreatic duct, starting in the body of the pancreas   |
| 9              | Subtotal resection of the pancreatic head  |
| 10             | If indicated, drainage of the bile duct into the resection cavity  |
| Reconstruction |  |
| 11             | Pancreaticojejunostomy using Y-Roux limb   |
| 12             | Jejunojejunostomy  |

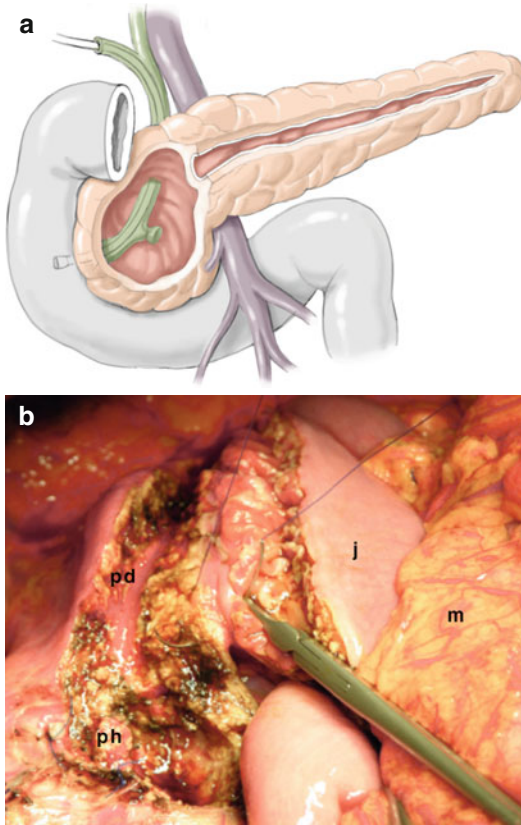
(Partington-Rochelle procedure). For these reasons, pancreatic resection and drainage techniques should be entertained and are often combined. In all standard pancreatic head resections (e.g., Kausch-Whipple, Longmire-Traverso, Beger), it is possible to fillet open the pancreatic ductal system in its entire course and perform a side-to-side instead of end-to-side pancreaticojejunostomy to drain the ducts completely. An alternative approach combining the classic longitudinal pancreaticojejunostomy with subtotal coring of fibrous pancreatic head tissue was proposed by Frey and Smith in 1987. Because the neck of the pancreas is not transected completely over the superior mesenteric vein, portal hypertension is not a contraindication for this operation as it is for a classic Kausch-Whipple resection.

Technically, the pancreas is exposed in the same manner as in other types of pancreatic surgery (Table 8.3). Briefly, the hepatic flexure of the colon is mobilized, a Kocher maneuver is performed (Fig. 8.1) and the lesser sac is opened by transection of the gastrocolic ligament. In our experience, it seems more advantageous to resect the enlarged pancreatic head subtotally



**Fig. 8.5** First step of the Frey procedure. The duct of Wirsung is opened in the body of the pancreas using a cautery needle. Note the appearance of a stone within the duct (arrow). All stones and strictures must be removed to achieve efficient duct drainage. For this reason, the incision of the duct is carried out as far as possible in both directions to the splenic hilum and to the duodenum (*pd* opened pancreatic duct, *s* stomach, *d* duodenum, *ph* pancreatic head, *l* liver, *m* mesocolon transversum)

instead of only partially coring it out. For this reason, the gastroduodenal artery is ligated and transected at the superior margins of the pancreas using 4/0 monofilamentous non-resorbable sutures (Prolene®, Ethicon). To prevent damage to the superior mesenteric and portal veins during pancreatic head resection, these vessels must be identified and kept under direct vision. The main pancreatic duct is incised in the body of the organ (Fig. 8.5). This ductal incision is extended as far as possible in both directions to the splenic hilum and the duodenum. All strictures must be incised and all calculi removed carefully to achieve effective drainage of the ductal system. The pancreatic head is resected subtotally using a cautery needle. We preserve about 6–8 mm of pancreatic tissue near the duodenum and about 5 mm of pancreas near the superior mesenteric and portal veins, respectively (Fig. 8.6a). In contrast to other types of anatomic resections of the



**Fig. 8.6** (a, b) In the Frey procedure, the pancreatic head is resected subtotally so that the bile duct becomes visible at the ground of the resection cavity (a). A Teflon or metal probe inserted via the cystic duct may help to identify the course of the bile duct. For reconstruction, side-to-side pancreaticojejunostomy (b) using a Y-Roux loop is performed with one layer of running suture of monofilamentous, resorbable material (*ph* resected pancreatic head, *pd* opened pancreatic duct, *j* jejunum, *m* mesocolon transversum)

pancreatic head, the pancreas is not transected completely. Monofilamentous absorbable 4/0 sutures (PDS®, Ethicon) are used for hemostasis when bipolar coagulation is ineffective. As in the Beger and Berne procedures, the bile duct may be incised in its intrapancreatic portion and drained into the resection cavity. A one-layer, longitudinal pancreaticojejunostomy is performed with 50-cm long Roux-en-Y limb using running 4/0 monofilamentous absorbable sutures (PDS®, Ethicon) (Fig. 8.6b). Finally, an end-to-

side jejunojejunostomy is performed in two layers (4/0 Vicryl®, Ethicon). One silicone drain (Easy Flow Drainage, P. J. Dahlhausen & Co., GmbH, Cologne, Germany) is placed alongside the pancreaticojejunostomy.

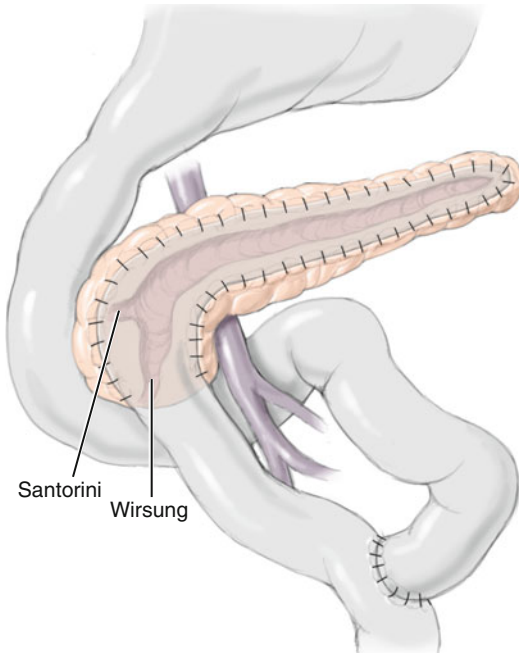
*Duodenum-preserving pancreatic head resection* (Beger procedure) and the *Berne technique* are described in other chapters as well as the technique of *Left-sided, distal pancreatectomy*.

## 8.2.2 Drainage Procedures

Surgical drainage procedures have been performed much less frequently in recent years due to excellent endoscopic techniques for drainage. For problematic cases, primary ductal procedures are safe and efficient. The indication for operative care should be discussed with an interdisciplinary approach.

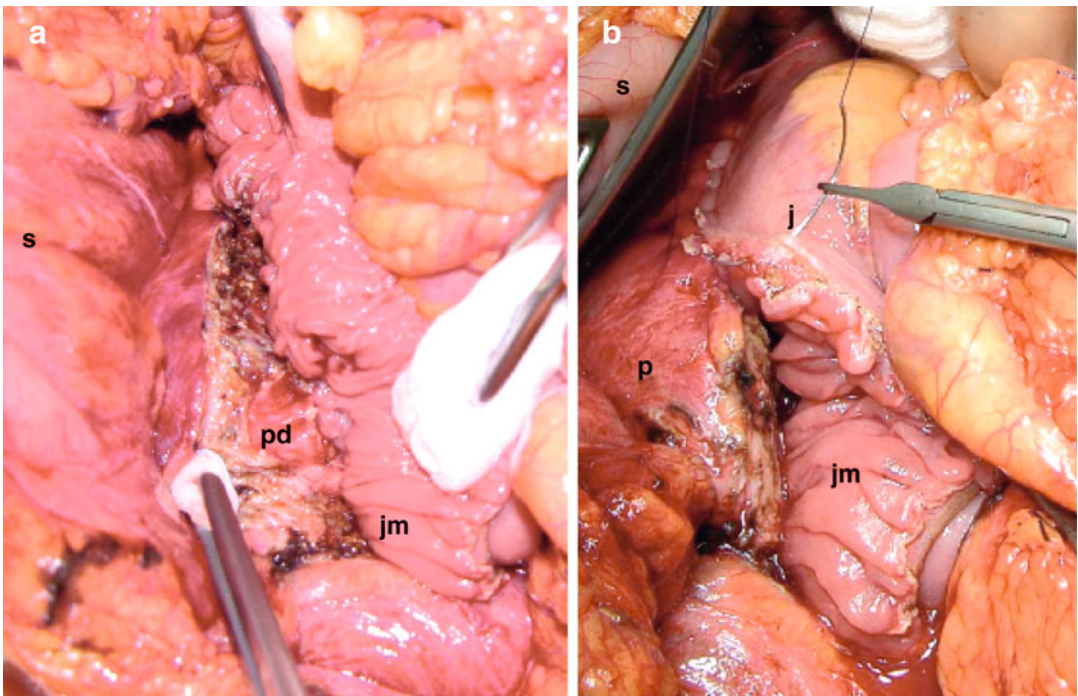
*Lateral Pancreaticojejunostomy* is performed to drain enterically a dilated pancreatic duct in patients without chronic inflammatory enlargement of the pancreatic head, using the Partington and Rochelle procedure. To expose the entire anterior surface of the pancreas, the gastrocolic ligament is divided, and both colonic flexures are mobilized. Fibrous adhesions between the pancreas and the posterior surface of the stomach are cut. When dilated, the main pancreatic duct can usually be visualized or palpated as a soft fluctuant depression or trough in the body of the gland. If the duct cannot be localized, intraoperative ultrasonography can aid localization of the duct. Once the duct is identified, it is incised longitudinally alongside the needle (which is left in place to aid this ductal incision) using a cautery needle. Once the duct is entered, its precise course is determined using a Teflon probe or an Overholt clamp. To identify all pathologic findings, it is important to unroof the pancreatic duct over its entire length from as close as possible to its entry into the duodenum out to the splenic hilum. Care is taken to avoid injury to the gastroduodenal and pancreatoduodenal arcade. In the head of the pancreas, both the duct of Wirsung and the duct of Santorini are unroofed and drained (Fig. 8.7). Bleeding from the cut edges of the pancreas can





**Fig. 8.7** Techniques of pancreatic duct drainage procedure by latero-lateral pancreaticojejunostomy. In the case of a dilated pancreatic duct, both the duct of Wirsung and the duct of Santorini are unroofed and freed from stones and strictures

be controlled by bipolar coagulation. Suture ligatures of 5/0 monofilamentous non-resorbable material (Prolene PDS®, Ethicon) are needed on occasion. Stones are removed meticulously using forceps or an Overholt clamp. In general, we avoid creating a short anastomosis of the pancreatic duct but rather plan on a long pancreaticoenteric anastomosis. For reconstruction, the jejunum is transected approximately 45 cm distal to the ligament of Treitz using a linear cutter (TLC 75 Proximate®, Ethicon). A defect is created in the avascular space of transverse mesocolon to the right of the middle colonic vessels through which the jejunal limb is passed. The stapled end of the distal jejunum is positioned at the splenic hilum and jejunum opened along its anterior mesenteric border. A single layer, side-to-side pancreaticojejunostomy is performed with running sutures of 4/0 monofilamentous resorbable material (PDS®, Ethicon) starting at the splenic flexure. The caudal inferior portion of the anastomosis is performed first (Fig. 8.8) followed by the rostral



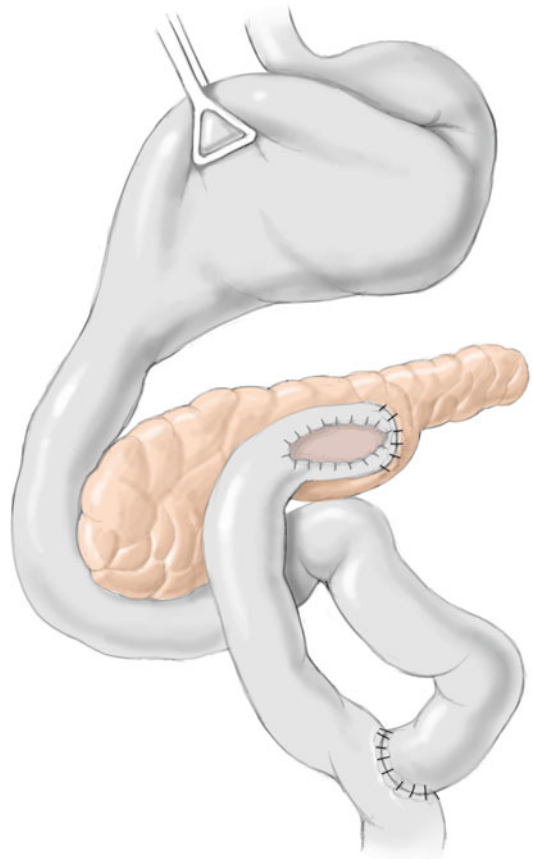
**Fig. 8.8** (a, b) A jejunal Y-Roux limb is used for reconstruction in laterolateral pancreaticojejunostomy. The inferior portion of the anastomosis is performed first

(a) followed by the superior portion (b) (*pd* pancreatic duct, *jm* jejunal mucosa, *s* stomach, *j* jejunum, *p* pancreas)

superior portion. Sutures are passed through the serosa and muscularis of the jejunum (i.e., extramucosally) but through the full thickness of pancreatic parenchyma between fibrous capsule and unroofed duct. We do not attempt necessarily to perform mucosa-to-mucosa apposition. An end-to-side jejunojejunostomy is performed 50 cm distal to the pancreaticojejunostomy to re-establish intestinal continuity (4/0 Vicryl PDS®, Ethicon). One silicone drain (Easy Flow Drainage, P. J. Dahlhausen & Co., GmbH, Cologne, Germany) is placed alongside the length of the pancreaticojejunostomy. In the case of pancreatogenic pain in patients with a non-dilated main pancreatic duct, so-called “small duct disease”, longitudinal V-shaped resection of the ventral part of the pancreas may be performed as proposed by Izbicki.

*Lateral Pancreaticogastrostomy* has only rare indications. This form of enteric drainage may be performed in selected patients of massive adhesions or unsuspected pancreatic necrosis found at operation. Technically, such an operation should follow the same rules as lateral pancreaticojejunostomy.

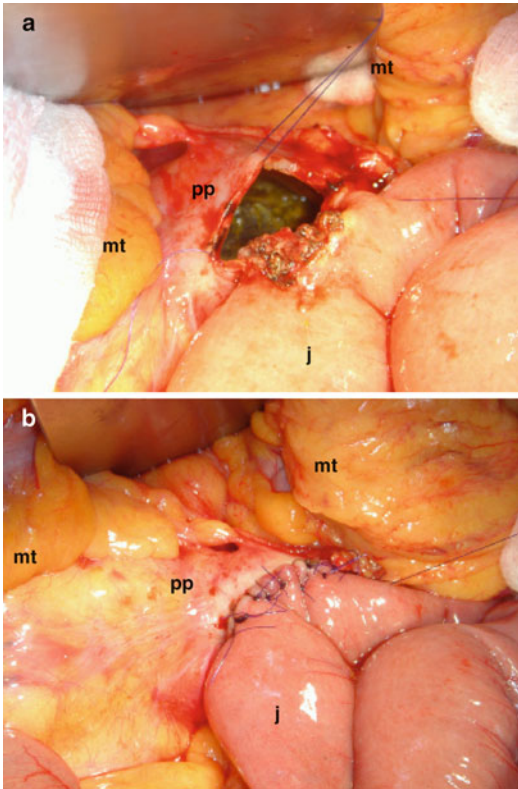
*(Pseudo) cystojejunostomy* is performed in similar fashion to a lateral pancreaticojejunostomy (Fig. 8.9). A pre-requisite for safe, successful operative internal drainage of a pancreatic pseudocyst is a mature fibrous wall of the pseudocyst. In general, a wide incision (at least 3 cm) is made in the pseudocyst wall allowing for exploration of the entire cavity and evacuation of any sequestered material (Fig. 8.10). A frozen section to exclude malignancy is done intraoperatively. A one-layer, side-to-side, Roux-en-Y pseudocysto-jejunosomy with 4/0 resorbable monofilamentous sutures (PDS®, Ethicon) is our method of choice. In general, we do not drain a pseudocyst enterically if there is a previous history of hemorrhage, because this will eliminate the self-tamponade potential in the case of rebleeding. Under such circumstances, we prefer resection of the portion of the pancreas bearing the pseudocyst. Alternatively, radiologic embolization or stenting of pseudoaneurysms or operative ligation



**Fig. 8.9** Pseudocystojejunostomy using a one-layer side-to-side Roux-en-Y anastomosis

of bleeding vessels may be appropriate to prevent rebleeding in selected patients.

*(Pseudo) cystogastrostomy* may be suitable for patients with pseudocysts located in the body or tail of the pancreas with firm adherence to the posterior wall of the stomach. A longitudinal, anterior gastrotomy is made using electrocautery. Next, the posterior wall of the stomach and the pseudocyst are opened by a transgastric transcystic incision (Fig. 8.11). Necrotic material is evacuated, and the entire cavity of the pseudocyst is explored. The wall of the pseudocyst adherent to the posterior wall of the stomach is oversewn (“reefed”) with 4/0 monofilamentous resorbable material (PDS®, Ethicon) using continuous or interrupted sutures. Alternatively, an anastomosis may be created

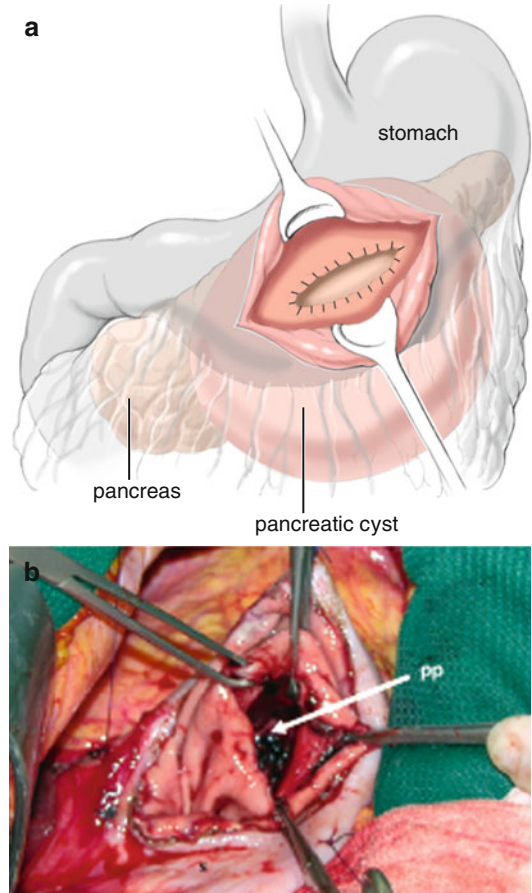


**Fig. 8.10** (a, b) Drainage procedure of a pseudocyst in the pancreas tail (pseudocystojejunostomy) using a jejunal loop and a transmesocolic approach. Single-layer continuous suture (PDS 4/0) at the posterior wall (a) and single layer interrupted sutures (PDS 4/0) for the anterior wall (b) were used (*pp* pancreatic pseudocyst, *j* jejunum, *mt* mesocolon transversum)

using a circular stapler of 33 mm diameter (ILS-33, Ethicon Endo-Surgery, Norderstedt, Germany). Finally, the incision in the anterior wall of the stomach is closed using 2–3 firings of a linear stapler (TLC 75 Proximate®, Ethicon).

### 8.3 Additional Medications and Procedures

- Single dose perioperative antibiotic prophylaxis is given intravenously about 30 min prior to skin incision. Because infectious complications after pancreatic surgery originate from bowel flora, the antibiotic chosen must cover the range



**Fig. 8.11** (a, b) Pseudocystogastrotomy using a longitudinal anterior gastrotomy. The pseudocyst is opened by a transgastric incision. The wall of the pseudocyst is anastomized with the posterior wall of the stomach with 4/0 PDS using interrupted or continuous sutures (*s* anterior gastric wall, *pp* opened pancreatic pseudocyst containing sequestered necrotic material)

of suspected bowel microorganisms. In addition, specific hospital-acquired bacteria and the capacity for pancreatic penetration of the compound should be considered when choosing an antibiotic. In our experience, a combination of 4 g mezlocillin (Baypen®, Bayer, Leverkusen, Germany) and 1 g sulbactam (Combactam®, Pfizer, Karlsruhe, Germany) is effective. In patients with penicillin allergy, we use 1 g imipenem (Zienam®, MSD, Munich, Germany). For lengthy operations, a second antibiotic dose is given 4–5 h after the first application.

**Table 8.4** Patients with chronic pancreatitis who underwent pancreatic resection (2006, 2007)

| Parameter                              | Number      | %    |
|--|-------------|------|
| Patients                               | 42          | 100  |
| Hospital mortality                     | 3           | 7.1  |
| Hospital stay (median, days)           | 17.2 (7–59) |      |
| Relaparotomy                           | 7           | 16.7 |
| Death without local complications      | 1           | 2.4  |
| Kausch-Whipple procedure               | 4           | 9.6  |
| Traverso-Longmire procedure            | 17          | 40.4 |
| Frey procedure                         | 1           | 26.2 |
| Beger procedure                        | 2           | 4.8  |
| Berne procedure                        | 2           | 4.8  |
| Pancreatic left resection              | 5           | 1.8  |
| Total pancreatectomy                   | 1           | 2.4  |
| Postoperative local morbidity          |             |      |
| Postoperative bleeding <sup>a</sup>    | 1           | 2.4  |
| Delayed gastric emptying <sup>b</sup>  | 7           | 16.7 |
| Pancreatic fistula <sup>c</sup>        | 5           | 11.8 |
| Biliary fistula <sup>d</sup>           | 2           | 4.8  |
| Wound infection                        | 5           | 11.8 |
| Other (i.e. abscess, pleural effusion) | 8           | 19.0 |
| Postoperative systemic morbidity       |             |      |
| Systemic complications <sup>e</sup>    | 6           | 14.3 |

<sup>a</sup>Need for relaparotomy

<sup>b</sup>Nasogastric intubation >10 days, or its reinsertion because of vomiting, or the inability to tolerate a solid diet after the 14th postoperative day. *Other definitions:* No normal oral feeding after 10 postoperative days; intolerance to oral intake and need for nasogastric decompression after the seventh postoperative day

<sup>c</sup>Drain output of any measurable volume of fluid on or after the third postoperative day with an amylase content greater than three times the serum amylase activity. *Other definitions:* Persistent drainage of more than 30 ml amylase-rich fluid (>5,000 units) per day for more than 10 days; drainage of more than 30 ml amylase-rich fluid (at least three times the upper normal limit of serum amylase concentration) per 24 h after the fifth postoperative day

<sup>d</sup>Bilirubin-rich fluid was drained for more than 5 days

<sup>e</sup>Cardiopulmonary, renal, sepsis, neural, other

- In surgery for chronic pancreatitis, inhibitors of pancreatic secretion, such as somatostatin or octreotide, are not given routinely, because the postoperative fistula rate is low due to the hard texture of fibrotic pancreatic parenchyma.

**Table 8.5** Patients with chronic pancreatitis who underwent drainage operation (2006, 2007)

| Parameter                              | Number      | %   |
|--|-------------|-----|
| Patients                               | 10          | 100 |
| Hospital mortality                     | 0           | 0   |
| Hospital stay (median, days)           | 12.4 (9–22) |     |
| Relaparotomy                           | 0           | 0   |
| Death without local complications      | 0           | 0   |
| Pancreaticojejunostomy                 | 1           | 10  |
| Pancreaticogastrostomy                 | 1           | 10  |
| Pseudocystojejunostomy                 | 4           | 40  |
| Pseudocystogastrostomy                 | 4           | 40  |
| Postoperative local morbidity          |             |     |
| Postoperative bleeding <sup>a</sup>    | 0           | 0   |
| Delayed gastric emptying <sup>b</sup>  | 0           | 0   |
| Pancreatic fistula <sup>c</sup>        | 0           | 0   |
| Biliary fistula <sup>d</sup>           | 0           | 0   |
| Wound infection                        | 1           | 10  |
| Other (i.e. abscess, pleural effusion) | 0           | 0   |
| Postoperative systemic morbidity       |             |     |
| Systemic complications <sup>e</sup>    | 0           | 0   |

<sup>a</sup>Need for relaparotomy

<sup>b</sup>Nasogastric intubation >10 days, or its reinsertion because of vomiting, or the inability to tolerate a solid diet after the 14th postoperative day. *Other definitions:* No normal oral feeding after 10 postoperative days; intolerance to oral intake and need for nasogastric decompression after the seventh postoperative day

<sup>c</sup>Drain output of any measurable volume of fluid on or after the third postoperative day with an amylase content greater than three times the serum amylase activity. *Other definitions:* Persistent drainage of more than 30 ml amylase-rich fluid (>5,000 units) per day for more than 10 days; drainage of more than 30 ml amylase-rich fluid (at least three times the upper normal limit of serum amylase concentration) per 24 h after the fifth postoperative day

<sup>d</sup>Bilirubin-rich fluid was drained for more than 5 days

<sup>e</sup>Cardiopulmonary, renal, sepsis, neural, other

- If possible, patients get an epidural catheter for postoperative pain control.
- During operation, all patients receive a nasogastric tube, which is removed at the completion of anesthesia.
- Enteral nutrition is started on the first postoperative day.
- All patients are given prophylaxis against deep vein thrombosis with a low molecular

weight heparin (enoxaparin, Clexane<sup>®</sup>, 40 mg, Sanofi-Aventis, Frankfurt, Germany) once daily starting on the evening of the admission day and until discharge.

- Prophylaxis against gastric stress ulcer and anastomotic ulcer is given using 40 mg pantoprazole daily as an intravenous injection (Pantozol<sup>®</sup>, Nycomed, Constance, Germany).
- Postoperative ICU admission with invasive monitoring is routine.
- The intraoperative drain(s) is removed 48 h postoperatively unless drainage volume is >50 ml/day. Drain output is not measured routinely for amylase activity. Only when the output is high or the color is typical for pancreatic fistula the fluid is checked for amylase activity. In the case of fistula, the drain is maintained in place until the output volume has decreased. In the case of a persistent pancreatic fistula (>3 weeks) without clinically relevant symptoms, the drain is removed

incrementally on an every day basis (2–3 cm/day). Usually, the fistula is controlled by a dermal drainage bag and will close by itself over time. In the case of clinical symptoms (e.g., pain, fever, leukocytosis), an abdominal CT should be obtained to exclude gross peripancreatic fluid collection or an abscess, which would require some form of interventional drainage. Reoperation is rarely necessary because of a pancreatic fistula. A biliary fistula requires reoperation if the output is high. Patient discharge with drains in situ is appropriate in patients tolerating enteric or oral nutrition and without signs of organ dysfunction.

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## 8.4 Results

The results of pancreatic surgery in chronic pancreatitis are contained in Tables 8.4 and 8.5.