Surgery for Chronic Pancreatitis

Azhar Perwaiz · Amanjeet Singh · Adarsh Chaudhary

Received: 10 November 2011 / Accepted: 10 November 2011 / Published online: 20 December 2011
© Association of Surgeons of India 2011

Abstract Chronic pancreatitis (CP) is progressive inflammatory process of the pancreas. Abdominal pain remains the most debilitating symptom affecting quality of life, apart from diabetes mellitus, steatorrhoea and weight loss. The treatment options have evolved over the past decades and are aimed to provide durable relief in pain with possible attempt to support or improve the failing endocrine and exocrine functions. Surgical treatment options have shown the potentials to provide superior long term results compared to the pharmacological and endoscopic modalities and are broadly divided in to drainage, resection and combination hybrid procedures. The choice is based on the morphology of the main pancreatic duct, presence of head mass and associated complication of CP. Knowing the basic nature of the disease, total pancreatectomy seems a curative option but not without significant morbidities. There is recent paradigm shift towards organ sparing surgical procedures with reasonable success. Despite recent advancement in the treatment modalities for CP the overall quality of life remains moderate which need further addressal.

Keywords Chronic pancreatitis · Surgical treatment · Drainage operation

Background

Chronic pancreatitis (CP) is characteristically a benign inflammatory process capable of causing severe pain,

diabetes mellitus, steatorrhoea and weight loss. All these cause significant reduction in the quality of life (QOL) in the patients with CP. With increasing understanding of the pathophysiology of CP, various therapeutic modalities have evolved over the last few decades. In addition to pharmacological and endoscopic modalities, the surgical drainage and resection procedures are increasingly being performed. When indicated, surgery can address wide range of clinical problems associated with CP and has the potential to provide a durable and adequate pain relief and improvement in the QOL.

Indications for Surgery

Intractable pain remains the commonest indication. Other established indications are complications of CP, which can be biliary obstruction, duodenal obstruction, symptomatic pseudocysts, internal pancreatic fistulae or pancreatic ascites that fail to resolve after adequate conservative or endoscopic treatment, symptomatic portal hypertension subsequent to splenic or portal vein thrombosis, bleeding pseudoaneurysms and pancreatic head mass or suspicion of malignancy. Other controversial indications for surgery are prevention of exocrine or endocrine deficiency.

Aim of Surgery

Surgery should deal with the pathomechanism of genesis of pain in CP to provide durable pain relief and simultaneously address the associated complication that may arise following CP. There are different hypotheses supporting the role of timely performed surgery in the preservation of endocrine and exocrine functions. By

A. Perwaiz · A. Singh · A. Chaudhary (✉)
Department of GI Surgery, GI Oncology and Bariatric Surgery,
Room No-10, 11th floor, OPD block, Medanta, The Medicity,
Sector-38,
12001, Gurgaon, Haryana, India
e-mail: adarsh_chaudhary@yahoo.com

durable and adequate symptomatic relief, surgery should contribute to social and occupational rehabilitation and improvement in QOL. Decision of selecting proper surgical procedure depends on the morphology of the gland, especially the size of the main pancreatic duct (MPD); presence of inflammatory head mass; associated complications such as biliary obstruction, duodenal stenosis and pseudocysts. Patients with history of gastrointestinal bleed or established portal hypertension need careful selection. Inflammatory head mass of CP is often difficult to differentiate from malignancy, both preoperatively by radiological investigation or during surgery. Negative tissue diagnosis from the head mass obtained during surgery should be interpreted with caution due to known peritumoral desmoplasia. Although resectional procedures such as pancreaticoduodenectomy (PD) can solve such issues, the selection of such radical procedures for head mass of uncertain potential remains a difficult decision.

Surgical Procedures

Surgical interventions are broadly grouped under either drainage or resection procedure and have evolved over time to the third category of combined drainage and resection procedures.

Drainage

- (A) Duval's procedure
- (B) Puestow–Gillesby procedure
- (C) Partington–Rochelle variant of the Puestow procedure

Resection

- (D) Kausch–Whipple PD
- (E) Pylorus-preserving pancreaticoduodenectomy (ppPD)
- (F) Beger operation (duodenum-preserving pancreatic head resection [DPPHR])

Resection and Drainage

- (G) Frey procedure
- (H) Izbicki procedure

Modified Procedures

Berne modification of Beger procedure
Hamburg's modification of Frey procedure

Others

Distal Pancreatectomy

Subtotal or total pancreatectomy with pancreatic autotransplantation

Rationale for Drainage Procedures

Surgical decompression of the pancreatic duct is based on the assumption that dilated duct represents intra-ductal or pancreatic parenchymal hypertension and is possibly one of the main reasons for pain in CP [1, 2]. The concept was first defined by Coffey [3] and Link [4]; however, the clinical applications were shown by Duval [5] and Zollinger [6] by performing distal pancreatectomy and splenectomy, and the duct at the pancreatic tail was drained via an end-to-side pancreaticojejunostomy (PJ) known as Duval procedure (A). This procedure was theoretically effective for dominant obstruction between pancreatic tail and the ampulla. 'Chain of lakes', which is characteristically known for CP, usually has multiple ductal strictures and possibly cannot be drained adequately by this procedure which was later realized by occurrence of recurrent episodes of severe pain postoperatively. In 1956, Puestow and Gillesby (B) [7] modified Duval's procedure by adding longitudinal pancreaticojejunostomy (LPJ) with the aim to effectively drain the pancreatic duct even in the presence of multiple strictures or stones. Partington and Rochelle (C) [8] later modified the Puestow–Gillesby procedure by avoiding splenectomy and distal pancreatectomy as the part of the procedure and showed that pain relief can be achieved with LPJ alone while the consequences of distal pancreatectomy and splenectomy can be avoided.

Rationale for Resectional Procedures

Inflammatory tumour of the pancreatic head is present in 30–50% of patients with CP and has been postulated as one of the possible reasons for pain in CP, apart from that it can produce distal common bile duct stenosis, duodenal stenosis and MPD obstruction [9]. Head of the pancreas has been referred to as the 'pacemaker' of the disease [10–12]. Resectional procedures deal with the pancreatic head mass, and hence Whipple procedure (D) was employed for the treatment for CP in the past. The disadvantages of such procedure were resection of otherwise normal organs such as distal stomach, duodenum and the common bile duct. Later, ppPD (E) was attempted where the part of stomach was preserved with the hope to improve nutritional outcomes. The radicality of the procedure to an extent

remained same as that of PD, although anticipated benefits were not reflected clinically. Although too radical for CP, these procedures at the same time can deal with the associated complications such as common bile duct stenosis, duodenal stenosis and internal pancreatic fistulae. Pancreatic head mass with suspicion of malignancy is best addressed by PD.

Beger (F) procedure includes resection of the pancreatic head following transection of the pancreas above the portal vein while bilioenteric continuity are preserved [11, 13]. The distal pancreas is drained by a Roux loop of jejunum via an end-to-end or end-to-side PJ, and the resectional cavity at the pancreatic head is drained by the same jejunal loop by a side-to-side anastomosis to the remnant of the pancreatic tissue.

Transection of the pancreas above the portal vein is required in almost all resectional procedures, which in CP remains the most challenging part due to displacement or compression of the portomesenteric vein axis. This lead to the evolution of ‘extended’ drainage procedures, which deals with the intraductal and intraparenchymal hypertension along with the morphological alterations in the pancreatic head while avoiding pancreatic transaction at the neck.

Frey (G) introduced a prototype procedure that consists of coring the head of pancreas combined with LPJ as described by Partington and Rochelle, and the procedure avoids transection of the neck above the portal vein [14, 15]. Being simple to perform, it has been accepted widely and has been modified with varying extent of resection of the head of the pancreas along with the uncinate process known as Hamburg’s modification. This procedure additionally deals with the duct to the uncinate process as well preserves the gastroduodenal passage and the continuity of the common bile duct, providing the physiological benefits of both Frey procedure and the duodenum-preserving PANCREATIC HEAD resection procedure described by Beger [16].

Drainage Procedure and Dilated MPD

The diameter of the MPD varies from 3 to 5 mm [1, 2]. Debate on the size of pancreatic duct to justify candidacy for drainage procedures is not new [1, 17]. Major pancreatic centres believe that the definition of a dilated duct depends on the view of the surgeon towards the technical feasibility to perform a PJ than on its actual size. Most consider duct size of at least 8 mm sufficient to justify a PJ, whereas others regard a duct size of 5 mm as the limit to perform a drainage operation by performing a pancreatojejunostomy rather than a PJ [1]. Recently Izbicki (H) has described longitudinal V-shaped excision of the ventral aspect of the pancreas combined with an LPJ

sewn to the capsule of the pancreas. It has the potential to address the rare cases of sclerosing ductal pancreatitis or ‘small duct disease’ with MPD diameter of less than 3 mm [18].

Outcome of Surgery

Drainage Procedure

Lateral PJ is a safe procedure with acceptable mortality below 5%, and the short-term pain relief is about 80%, especially in patients with dilated MPD [17, 19–25]. Exocrine and endocrine functions are well preserved after surgery, since the loss of functional pancreatic tissue is minimal, but overall improvement in these parameters are debatable [21, 22]. Ongoing inflammation may continue despite surgery, which can eventually lead to gland destruction. Long-term follow-up of these patients [26–28] suggests that the pain often recurs over the period of time and approximately 40% of them complain of pain 2 years after surgery. In addition, the manifestations of biliary or duodenal stricture become evident more often in large duct CP [29], which further limits the application of pure drainage procedures.

Resectional Procedure

Kausch–Whipple PD has evolved to be a safe procedure, especially at high volume centres with mortality rates of less than 3% [30–33]. Apart from achieving the reasonable short-term pain relief, pancreatic head-related complication can be dealt with simultaneously. The long-term results in CP, however, are poor. Postoperative morbidities range between 30% and 50% [33–36] with disappointing endocrine and exocrine functions as compared with other resection procedures [16, 32, 33, 35–40]. Thus, PD is no longer a preferred choice in patients with CP. Results of ppPD over those of the classical PD are mixed, concerning its actual benefits. Although randomized controlled trials (RCTs) are available for pancreatic head cancer showing comparable results [41–44], no randomized study exists to our knowledge comparing PD with ppPD in patients with CP. Jimenez et al. [32] retrospectively studied 72 patients undergoing PD or ppPD for CP, showing comparable long-term pain relief, nutritional status, incidences of diabetes mellitus and need of enzyme supplementation after surgery. Patients undergoing ppPD showed higher incidences of delayed gastric emptying (33% vs 12%). Both these procedures were originally designed to treat pancreatic head cancers, whereas CP is a benign disease and such radical resection might be counterproductive.

Beger procedure can potentially deal common bile duct obstructions, pancreatic duct stenosis and obstruction of the retropancreatic vessels by removing the inflammatory pancreatic head mass. Procedure-related mortality varies from 0% to 2% and the morbidity between 15% and 54%. At 5 years of follow-up, pain relieve is noticed in around 80% of patients and endocrine as well exocrine functions are well preserved [37, 45–47]. In terms of QOL, 69% of patients were professionally rehabilitated and in 72% of patients the Karnofsky index was between 90% and 100% [46]. Death rates in patients with CP who have undergone Beger procedure at 5 years of follow-up have been reported to be 9–12.6% [46, 47], which is in contrast to the reported mortality of 20–35% in patients of CP without treatment who were observed over a period of 6–10 years [48–50]. This supports the long-term benefits of Beger procedure.

Several RCTs have compared the Beger procedure with PD and ppPD [33–37]. Klempa et al. [33] reported comparable procedure-related mortality and morbidity rates, 100% of patients following DPPHR were pain free at the follow-up of 3.5–5 years compared to 69% following PD. Beger procedure led to a significant increase in body mass index (80% vs 29%, respectively). Büchler et al. [37] at 6 month follow-up favoured DPPHR over ppPD in terms of significant weight gain (4.4 ± 1.0 kg vs 2.1 ± 1.2 kg, respectively) and pain relief (74% vs 47%, respectively). Makowiec et al. [38] showed that operation time was significantly shorter for DPPHR than for PD or ppPD (368 min vs 435 min). Although better weight gain was seen in patients following DPPHR, QOL were the same between the two procedures. Whereas Witzigmann et al. [34, 35] reported better QOL in the DPPHR group, which was confirmed by Möbius et al. [51] in a non-randomized study with follow-up of 5 years. These results suggest the superiority of the organ-preserving DPPHR over PD and ppPD.

A randomized controlled study [39] comparing Frey procedure with ppPD shows significantly lower morbidity for the former (19% vs 53%), while after a median follow-up of 24 months both groups experienced comparable pain relief (94% vs 95%), but the QOL was better with Frey procedure (71% vs 43%). Comparing Beger procedure with Frey procedure (RCT) [16, 40, 52], the pain relief (ranging between 93% and 95%), control of complications to adjacent organs (91% Frey, 92% Beger) and improvement in the QOL (58–67% increase in the overall QOL index) were similar. Endocrine and exocrine functions of the pancreas were not different between the two groups. There was a tendency for lower overall morbidity for Frey procedure (Frey: 9–22% vs Beger: 20–32%, respectively) [16, 40]. Although long-term results seem to indicate that

both approaches might be equally effective [52], neither procedure can be favoured over the other based on the current report.. Recently, Gloor et al. [53] introduced a modification of the Beger and Frey procedures, which combines the advantages of both (Berne modification). Farkas et al. [54] reported the results of Berne procedure in 30 patients for a mean follow-up of 10 months. All patients were symptom free, had no severe surgery-related complications and showed enhanced exocrine function with unchanged endocrine function. These findings were supported by another study by Andersen and Topazian [55]. An RCT is ongoing to compare this procedure with other forms of DPPHR (Beger and Frey), and the reports are awaited [56].

Izbicki procedure in 13 patients with a mean follow-up of 30 months shows that it is a safe (mortality 0%, morbidity 15.4%) and effective (92% relief of symptoms) alternative to other resection procedures and provides pain relief (median pain score decreased by 95%) and improvement in global QOL index by 67%) [18].

The above-mentioned procedures are designed to treat CP with head mass. However, rare cases of CP in the pancreatic body or tail can be successfully treated by distal pancreatectomy [57, 58], while reports of total pancreatectomy in CP have shown overall poor results [59, 60].

Salvage Operation

Even with excellent initial outcome following surgery for CP, recurrences do occur. It raises question of proper patient selection and choice of procedure. Most of the recurrences arise in the remnant of the pancreatic head, indicating that either the surgical resection was inadequate or the disease was more aggressive. Revisional pancreatic head resection can be advised if the primary operation has left too much tissue in the pancreatic head area or alternatively ppPD/PD can be performed for definite control of the disease confined to the pancreatic head. Because none of the redo procedures are simple, they should be performed in experienced centres. Presence of biliary stricture in the pancreatic head remnant after Beger or Frey procedure without morphological proof of disease recurrence is likely due to ischaemia of the intra-pancreatic bile duct. In this situation, a bilioenteric anastomosis is the procedure of choice. In case of disease recurrence of the body and tail, either after Beger procedure or after PD/ppPD, a V-shaped drainage procedure as described by Izbicki is a viable option, since the alternative of total pancreatectomy is too severe for a benign disease.

Surgery vs Endotherapy

Since the advancement in the endoscopic instrumentations, there has been emergence of endoscopic therapy for the management of pain in CP. Several reports have suggested that endoscopic therapy aimed at decompressing an obstructed pancreatic duct can be associated with pain relief [61, 62]. Few studies have compared endoscopic approaches with surgery. A recent randomized controlled Dutch trial compared endoscopic therapy with surgical drainage and suggested that surgical drainage was more effective in relieving obstruction and achieving pain relief [63]. However, most centres still attempt endoscopic therapy prior to surgery unless there is suspicion for pancreatic cancer possibly due to referral biases.

Surgery vs Neuroablative Procedures

Data of celiac ganglion neurolysis for the management of pain in CP are limited and the exact role is not clear. Endoscopic ultrasound-guided procedure has shown reasonable success and is considered least invasive and relatively safe. One-third to half of these patients have shown good reduction of pain in a short-term follow-up; however, only 10% of them seem to show a benefit at 24 weeks [64]. Many studies [64–66] show that the early good results achieved by neuroablative procedure decline with time elapsed as compared with the durable relief obtained from conventional surgical procedures. Over two-thirds of patients would ultimately need surgery again [66]. Patients who are at a high risk for surgery or deny it and who those have failed to respond to surgical management can be offered neuroablative procedure, although larger data are needed to support its routine role.

Role of Pancreatic Autotransplantation

Surgery for CP has evolved towards organ-sparing procedures, preserving the body and tail of the gland. The need for extensive subtotal or total pancreatic resection is therefore very limited and should be used as a treatment of last resort because of the known severe endocrine insufficiency [50]. In the small groups of patients undergoing extensive pancreatectomy, an attempt should be made to preserve islet function by offering them pancreatic segmental autotransplantation or islet cell autotransplantation. The functional outcome of the procedure depends on the amount of residual functional islet cell mass, loss of cells during the transplant technique used and the success of the procedure itself [67]. Segmental grafts have shown better long-term function than islet cell autotransplantation; however, both

techniques are evolving and more experience with them is required [68]. Although a high percentage of these patients eventually need insulin, diabetes mellitus can be prevented in some and delayed in others. Most of these diabetics are stable and easier to manage as compared with the patients undergoing total pancreatectomy and no autotransplant [68, 69].

Quality of Life after Surgery for CP

Data on QOL following surgery for CP are sparse and the results are difficult to interpret for the reason that different and non-specific questionnaires are used. A recent Dutch report [70] analyzed 155 patients following surgery for CP using validated questionnaires for a median follow-up of 5–6 years. A total of 111 resections and 46 drainage procedures were performed. Fifty-seven patients had major complications, and the hospital mortality rate was 1–3%. After surgery the number of patients needing analgesics was reduced ($P<0.001$). Alcohol consumption significantly reduced pain coping mechanisms ($P=0.032$). In general, the QOL after surgery for CP remains poor, owing to pre-existing lifestyle and comorbidity. Patients selected for a pancreatic duct drainage procedure have a better postoperative QOL than those undergoing resectional procedures. Alcohol consumption was associated with poor ability to cope with pain after surgery.

Operative Diagrams

(A) Duval's procedure

(B) Puestow–Gillesby procedure

(C) Partington–Rochelle variant of the Puestow procedure

(G) Frey procedure

(D) Kausch–Whipple pancreaticoduodenectomy

Kausch–Whipple pancreaticoduodenectomy

(E) Pylorus-preserving pancreaticoduodenectomy

(H) Izbicki procedure

(F) Beger procedure

Izbicki procedure

References

1. Frey CF (1990) Why and when to drain the pancreatic ductal system. In: Beger HG, Buechler MW, Ditschuneit H, Malfertheiner P (eds) *Chronic pancreatitis*. Springer, Berlin, pp 415–425
2. Markowitz JS, Rattner DW, Warshaw AL (1994) Failure of symptomatic relief after pancreaticojejunal decompression for chronic pancreatitis. Strategies for salvage. *Arch Surg* 129:374–379
3. Coffey R (1909) Pancreaticojunostomy and pancreatectomy. *Ann Surg* 50:1238–1264
4. Link G (1911) Treatment of chronic pancreatitis by pancreatectomy. *Ann Surg* 53:768–782
5. Duval MK (1954) Caudal pancreaticojejunostomy for chronic relapsing pancreatitis. *Ann Surg* 140:775–785
6. Zollinger RM, Keith LM, Ellison EH (1954) Pancreatitis. *N Engl J Med* 251:497–502
7. Puestow CB, Gillesby WJ (1958) Retrograde drainage of pancreas for chronic pancreatitis. *Arch Surg* 76:898–906
8. Partington PF, Rochelle REL (1960) Modified Puestow procedure for retrograde drainage of the pancreatic duct. *Ann Surg* 152:1037–1043
9. Buechler M, Friess H, Isenmann R, Bittner R, Beger HG (1993) Duodenum-preserving resection of the head of the pancreas: the Ulm experience. In: Beger HG, Buechler M, Malfertheimer P (eds) *Standards in pancreatic surgery*, 1st edn. Springer, Berlin, pp 436–449
10. Buechler MW, Friess H, Bittner R, Roscher R, Krautberger W, Mueller MW et al (1997) Duodenum-preserving pancreatic head resection: long-term results. *J Gastrointest Surg* 1:13–19
11. Beger HG, Buechler M (1990) Duodenum preserving resection of the head of the pancreas in chronic pancreatitis with inflammatory mass in the head. *World J Surg* 14:83–87
12. Buechler M, Friess H, Mueller MW, Wheatley AM, Beger HG (1995) Randomized trial of duodenum preserving pancreatic head resection versus pylorus preserving Whipple in chronic pancreatitis. *Am J Surg* 169:65–70
13. Izbicki JR, Bloechle C, Knoefel WT, Wilker DK, Dornschneider G, Seifert H et al (1994) Complications of adjacent organs in chronic pancreatitis managed by duodenum-preserving resection of the head of the pancreas. *Br J Surg* 81(9):1351–1355
14. Frey CF, Amikura K (1994) Local resection of the head of the pancreas combined with longitudinal pancreaticojejunostomy in the management of patients with chronic pancreatitis. *Ann Surg* 220:492–507
15. Frey CF, Smith GJ (1987) Description and rationale of a new operation for chronic pancreatitis. *Pancreas* 2:701–707
16. Izbicki JR, Bloechle C, Knoefel WT, Binmoeller KF, Soehendra N, Broelsch CE (1997) Drainage versus resection in surgical therapy of chronic pancreatitis of the head of the pancreas: a randomized study. *Chirurg* 68(4):369–377
17. Delcore R, Rodriguez FJ, Thomas JH, Forster J, Hermreck AS (1994) The role of pancreaticojejunostomy in patients without dilated pancreatic ducts. *Am J Surg* 168(6):598–601, discussion 601–602
18. Izbicki JR, Bloechle C, Broering DC, Kuechler T, Broelsch CE (1998) Longitudinal V-shaped excision of the ventral pancreas for small duct disease in severe chronic pancreatitis: prospective evaluation of a new surgical procedure. *Ann Surg* 227(2):213–219
19. Ebbelhøj N, Borly L, Bülow J, Rasmussen SG, Madsen P, Matzen P et al (1990) Pancreatic tissue fluid pressure in chronic pancreatitis. Relation to pain, morphology, and function. *Scand J Gastroenterol* 25(10):1046–1051
20. Jalleh RP, Aslam M, Williamson RC (1991) Pancreatic tissue and ductal pressures in chronic pancreatitis. *Br J Surg* 78(10):1235–1237
21. Nealon WH, Thompson JC (1993) Progressive loss of pancreatic function in chronic pancreatitis is delayed by main pancreatic duct decompression. A longitudinal prospective analysis of the modified Puestow procedure. *Ann Surg* 217(5):458–466, discussion 466–468
22. Prinz RA, Greenlee HB (1981) Pancreatic duct drainage in 100 patients with chronic pancreatitis. *Ann Surg* 194(3):313–320
23. Schnellendorfer T, Lewin DN, Adams DB (2007) Operative management of chronic pancreatitis: long-term results in 372 patients. *J Am Coll Surg* 204(5):1039–1045, discussion 1045–1047
24. Wilson TG, Hollands MJ, Little JM (1992) Pancreaticojunostomy for chronic pancreatitis. *Aust N Z J Surg* 62(2):111–115
25. Adloff M, Schloegel M, Arnaud JP, Ollier JC (1991) Role of pancreaticojejunostomy in the treatment of chronic pancreatitis. A study of 105 operated patients. *Chirurgie* 117(4):251–256, discussion 257
26. Bradley EL 3rd (1987) Long-term results of pancreaticojejunostomy in patients with chronic pancreatitis. *Am J Surg* 153(2):207–213
27. Holmberg JT, Isaksson G, Ihse I (1985) Long-term results of pancreaticojejunostomy in chronic pancreatitis. *Surg Gynecol Obstet* 160(4):339–346
28. Greenlee HB, Prinz RA, Aranha GV (1990) Long-term results of side-to-side pancreaticojejunostomy. *World J Surg* 14(1):70–76
29. Warshaw AL (1985) Conservation of pancreatic tissue by combined gastric, biliary, and pancreatic duct drainage for pain from chronic pancreatitis. *Am J Surg* 149(4):563–569
30. Traverso LW, Kozarek RA (1997) Pancreatoduodenectomy for chronic pancreatitis: anatomic selection criteria and subsequent long-term outcome analysis. *Ann Surg* 226(4):429–435, discussion 435–438
31. Sakorafas GH, Farnell MB, Nagorney DM, Sarr MG, Rowland CM (2000) Pancreatoduodenectomy for chronic pancreatitis: long-term results in 105 patients. *Arch Surg* 135(5):517–523, discussion 523–524
32. Jimenez RE, Fernandez-del Castillo C, Rattner DW, Chang Y, Warshaw AL (2000) Outcome of pancreaticoduodenectomy with pylorus preservation or with antrectomy in the treatment of chronic pancreatitis. *Ann Surg* 231(3):293–300
33. Klempa I, Spatny M, Menzel J, Baca I, Nustede R, Stöckmann F et al (1995) Pancreatic function and quality of life after resection of the head of the pancreas in chronic pancreatitis. A prospective, randomized comparative study after duodenum preserving resection of the head of the pancreas versus Whipple's operation. *Chirurg* 66(4):350–359
34. Witzigmann H, Max D, Uhlmann D, Geissler F, Ludwig S, Schwarz R et al (2002) Quality of life in chronic pancreatitis: a prospective trial comparing classical Whipple procedure and duodenum-preserving pancreatic head resection. *J Gastrointest Surg* 6(2):173–179, discussion 179–80
35. Witzigmann H, Max D, Uhlmann D, Geissler F, Schwarz R, Ludwig S et al (2003) Outcome after duodenum-preserving pancreatic head resection is improved compared with classic Whipple procedure in the treatment of chronic pancreatitis. *Surgery* 134(1):53–62
36. Belina F, Fronek J, Ryska M (2005) Duodenopancreatectomy versus duodenum-preserving pancreatic head excision for chronic pancreatitis. *Pancreatol* 5(6):547–552
37. Buechler MW, Friess H, Müller MW, Wheatley AM, Beger HG (1995) Randomized trial of duodenum-preserving pancreatic head resection versus pylorus-preserving Whipple in chronic pancreatitis. *Am J Surg* 169(1):65–69, discussion 69–70

38. Makowiec FR, Hopt UT, Adam U (1995) Randomized controlled trial of Whipple vs. duodenum-preserving pancreatic head resection in chronic pancreatitis. *Am J Surg* 169:65–69
39. Izbicki JR, Bloechle C, Broering DC, Knoefel WT, Kuechler T, Broelsch CE (1998) Extended drainage versus resection in surgery for chronic pancreatitis: a prospective randomized trial comparing the longitudinal pancreaticojejunostomy combined with local pancreatic head excision with the pylorus-preserving pancreatoduodenectomy. *Ann Surg* 228(6):771–779
40. Izbicki JR, Bloechle C, Knoefel WT, Kuechler T, Binmoeller KF, Broelsch CE (1995) Duodenum-preserving resection of the head of the pancreas in chronic pancreatitis. A prospective, randomized trial. *Ann Surg* 221(4):350–358
41. Diener MK, Knaebel HP, Heukauf C, Antes G, Büchler MW, Seiler CM (2007) A systematic review and meta-analysis of pylorus-preserving versus classical pancreaticoduodenectomy for surgical treatment of periampullary and pancreatic carcinoma. *Ann Surg* 245(2):187–200
42. Tran KT, Smeenk HG, van Eijck CH, Kazemier G, Hop WC, Greve JW et al (2004) Pylorus preserving pancreaticoduodenectomy versus standard Whipple procedure: a prospective, randomized, multicenter analysis of 170 patients with pancreatic and periampullary tumors. *Ann Surg* 240(5):738–745
43. Karanicolas PJ, Davies E, Kunz R, Briel M, Koka HP, Payne DM et al (2007) The pylorus: take it or leave it? Systematic review and meta-analysis of pylorus preserving versus standard Whipple pancreaticoduodenectomy for pancreatic or periampullary cancer. *Ann Surg Oncol* 14(6):1825–1834
44. Lin PW, Lin YJ (1999) Prospective randomized comparison between pylorus-preserving and standard pancreaticoduodenectomy. *Br J Surg* 86(5):603–607
45. Beger HG, Büchler M, Bittner RR, Oettinger W, Roscher R (1989) Duodenum-preserving resection of the head of the pancreas in severe chronic pancreatitis. Early and late results. *Ann Surg* 209(3):273–278
46. Beger HG, Schlosser W, Friess HM, Büchler MW (1999) Duodenum-preserving head resection in chronic pancreatitis changes the natural course of the disease: a single-center 26-year experience. *Ann Surg* 230(4):512–519, discussion 519–523
47. Büchler MW, Friess H, Bittner R, Roscher R, Krautzberger W, Müller MW et al (1997) Duodenum-preserving pancreatic head resection: long-term results. *J Gastrointest Surg* 1(1):13–19
48. Lankisch PG (2001) Natural course of chronic pancreatitis. *Pancreatol* 1(1):3–14
49. Miyake H, Harada H, Kunichika K, Ochi K, Kimura I (1987) Clinical course and prognosis of chronic pancreatitis. *Pancreas* 2(4):378–385
50. Ammann RW, Akovbiantz A, Largiader F, Schueler G (1984) Course and outcome of chronic pancreatitis. Longitudinal study of a mixed medical-surgical series of 245 patients. *Gastroenterology* 86(5 Pt 1):820–828
51. Möbius C, Max D, Uhlmann D, Gump K, Behrbohm J, Horvath K et al (2007) Five-year follow-up of a prospective non-randomized study comparing the duodenum-preserving pancreatic head resection with the classical Whipple procedure in the treatment of chronic pancreatitis. *Langenbecks Arch Surg* 392(3):359–364
52. Strate T, Taherpour Z, Bloechle C, Mann O, Bruhn JP, Schneider C et al (2005) Long-term follow-up of a randomized trial comparing the Beger and Frey procedures for patients suffering from chronic pancreatitis. *Ann Surg* 241(4):591–598
53. Gloor B, Friess H, Uhl W, Büchler MW (2001) A modified technique of the Beger and Frey procedure in patients with chronic pancreatitis. *Dig Surg* 18(1):21–25
54. Farkas G, Leindler L, Daróczy M, Farkas G Jr (2003) Organ-preserving pancreatic head resection in chronic pancreatitis. *Br J Surg* 90(1):29–32
55. Andersen DK, Topazian MD (2004) Pancreatic head excavation: a variation on the theme of duodenum-preserving pancreatic head resection. *Arch Surg* 139(4):375–379
56. Königer J, Seiler CM, Wente MN, Reidel MA, Gazayakan E, Mansmann U et al (2006) Duodenum preserving pancreatotomy in chronic pancreatitis: design of a randomized controlled trial comparing two surgical techniques [ISRCTN50638764]. *Trials* 7:12
57. Rattner DW, Fernandez-del Castillo C, Warshaw AL (1996) Pitfalls of distal pancreatectomy for relief of pain in chronic pancreatitis. *Am J Surg* 171(1):142–145, discussion 145–146
58. Sawyer R, Frey CF (1994) Is there still a role for distal pancreatectomy in surgery for chronic pancreatitis? *Am J Surg* 168(1):6–9
59. Braasch JW, Vito L, Nugent FW (1978) Total pancreatectomy of end-stage chronic pancreatitis. *Ann Surg* 188(3):317–322
60. Cooper MJ, Williamson RC, Benjamin IS, Carter DC, Cuschieri A, Linehan IP et al (1987) Total pancreatectomy for chronic pancreatitis. *Br J Surg* 74(10):912–915
61. Rosch T, Daniel S, Scholz M, Huibregtse K, Smits M, Schneider T et al (2002) Endoscopic treatment of chronic pancreatitis: a multicenter study of 1000 patients with long-term follow-up. *Endoscopy* 34(10):765–771
62. Gabbriellini A, Pandolfi M, Mutignani M, Spada C, Perri V, Petruzzello L et al (2005) Efficacy of main pancreatic-duct endoscopic drainage in patients with chronic pancreatitis, continuous pain, and dilated duct. *Gastrointest Endosc* 61(4):576–581
63. Cahen DL, Gouma DJ, Nio Y, Rauws EA, Boermeester MA, Busch OR et al (2007) Endoscopic versus surgical drainage of the pancreatic duct in chronic pancreatitis. *N Engl J Med* 356(7):676–684
64. Varadarajulu S, Wallace MB (2004) Applications of endoscopic ultrasonography in pancreatic cancer. *Cancer Control* 11:15–22
65. Baghdadi S, Abbas MH, Albouz F, Ammori BJ (2008) Systematic review of the role of thoracoscopic splanchnectomy in palliating the pain of patients with chronic pancreatitis. *Surg Endosc* 22(3):580–588
66. Maher JW, Johlin FC, Heitshusen D. Long-term follow-up of thoracoscopic splanchnectomy for chronic pancreatitis pain. *Surg Endosc* 15(7):706–709
67. Morrow CE, Cohen JI, Sutherland DER, Najarian JS (1984) Chronic pancreatitis: long-term surgical results of pancreatic duct drainage, pancreatic resection and near-total pancreatectomy and islet autotransplantation. *Surgery* 96:608–616
68. Gooszen HG (1992) Surgical treatment of painful chronic pancreatitis: an unresolved problem? *Dig Dis* 10:345–353
69. White SA (2001) Pancreas resection and islet autotransplantation for end stage chronic pancreatitis. *Ann Surg* 233:423–431
70. van Loo ES, van Baal MC, Gooszen HG, Ploeg RJ, Nieuwenhuijs VB (2010) Long-term quality of life after surgery for chronic pancreatitis. *Br J Surg* 97:1079–1086