ORIGINAL ARTICLE

# Pancreas-preserving total duodenectomy: a 10-year experience

**Luit Penninga · Lars Bo Svendsen**

## Abstract

*Background*  Traditionally, severe pathology of the duodenum has been treated by a pancreaticoduodenectomy using Whipple's operation. Pancreas-preserving total duodenectomy (PPTD) was introduced in the late 1990s as an alternative to Whipple's operation for selected diseases of the duodenum. We report our 10 years' experience with this operation.

*Methods*  In the period from 1999 to 2010 13 patients (mean age 50 years) underwent PPTD. Ten patients had duodenal adenomatosis (Spigelman stage IV). Two patients had large solitary tubulovillous adenomas, and one patient had multiple duodenal gastrointestinal stromal tumor lesions.

*Results*  No mortality was observed. Six patients (46%) had a total of ten postoperative complications. Three patients (23%) had leakage of the ampullo-jejunostomy anastomosis, and one patient (8%) had leakage of the duodeno-jejunostomy anastomosis; all were treated conservatively with good results. One patient had recurrent episodes of pancreatitis, which disappeared spontaneously 3 months after operation. Three patients suffered from wound dehiscence, and two patients had postoperative pneumonia. Mean hospital admittance was 19 days (range 9–50 days). All patients were well at a mean follow-up of 56 months (range 2–134 months).

*Conclusion*  Pancreas-preserving total duodenectomy appears to be a safe and valuable treatment option for patients with selected diseases of the duodenum.

**Keywords**  Pancreas · Duodenectomy · Adenomatosis

L. Penninga · L. B. Svendsen
Surgery and Transplantation, Dept C-2122, Rigshospitalet,
Copenhagen University Hospital, Copenhagen, Denmark

L. Penninga (✉)
Copenhagen Trial Unit, Centre for Clinical Intervention
Research, Department 3344, Rigshospitalet,
Copenhagen University Hospital, Blegdamsvej 9,
2100 Copenhagen, Denmark
e-mail: LP@ctu.rh.dk

## Introduction

Traditionally, severe pathology of the duodenum has been treated by a pancreaticoduodenectomy using Whipple's operation, which either can be pylorus-preserving or not [1, 2]. Whipple's operation causes a high degree of morbidity and a low degree of mortality (0.1–10%) [1]. Furthermore, the head of the pancreas is removed even though the disease is located only in the duodenum [3].

In patients with premalignant or severe benign lesions, an alternative to Whipple's operation is pancreas-preserving total duodenectomy (PPTD) [3, 4]. This operation was first described in 1995 by Chung [4] and consists of total duodenal resection with sparing of adjacent tissues, particularly pancreas parenchyme and the distal biliary and pancreatic ducts. In addition, anatomic reconstruction of the digestive system is performed, facilitating postoperative endoscopic surveillance. However, as this operation is relatively new, both experience with and long-term follow-up of this surgical procedure is limited [2]. In this paper we describe our 10 years' experience with this operation.

## Methods

### Surgical technique

The procedure is performed through an upper midline-incision or a transverse laparotomy [5]. As the majority of

our patients previously had had a midline incision due to a familial adenomatosis polyposis (FAP)-related proctocolectomy, we predominantly chose this incision in these patients.

The duodenum is mobilised by Kocher's maneuver. The stomach is transected 5 cm to the proximal side from the pylorus or 1 cm distal from the pylorus, depending on the nature and extension of the disease. The upper part of the duodenum is densely attached to the pancreas, and the proximal part of the duodenum is divided from the pancreas leaving a minimal part of the outer serosal muscle layer of the duodenum on the pancreas (Fig. 1). The accessory pancreatic duct (papilla duodeni minor) is identified and ligated. Distally from the papilla of Vater, the duodenum is dissected from the pancreas and the jejunum is transected near the ligament of Treitz. Subsequently the duodenum is removed and anatomic reconstruction of the digestive system is performed, creating a gastro-
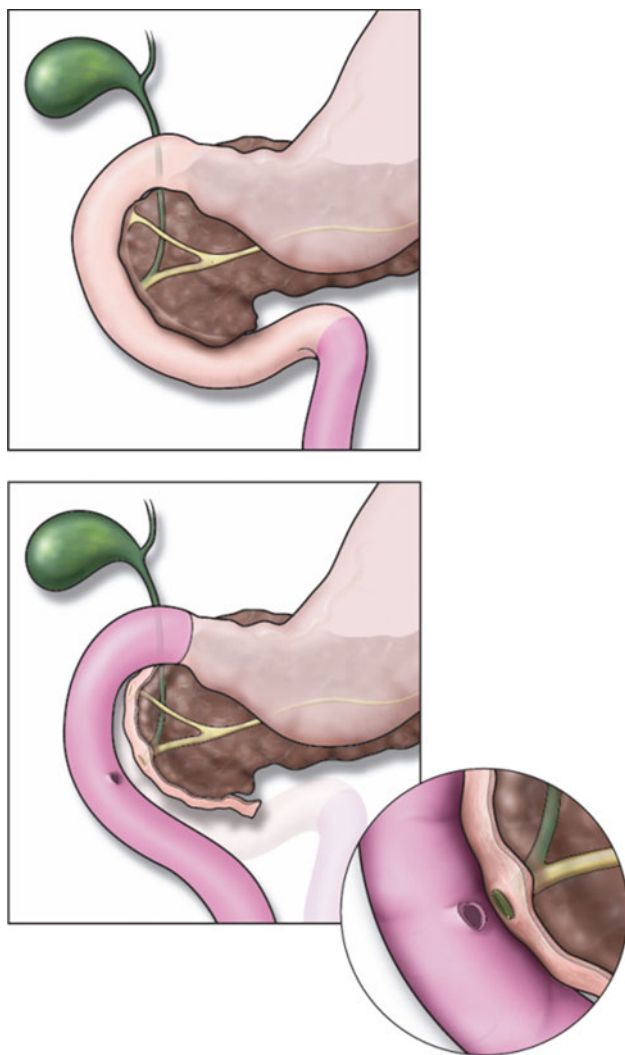
jejunostomy or alternatively a duodeno-jejunostomy 1 cm distal from the pylorus in 2 layers with 3-0 PDS (Polydioxanone, Ethicon) absorbable interrupted sutures. Subsequently a broad ampullo-jejunostomy is performed as an end-to-side-anastomosis using 4-0 PDS absorbable interrupted sutures (Fig. 2). The ampullo-jejunostomy secures adequate drainage of both the common bile duct and pancreatic duct by a common single anastomosis into the jejunum.

An endoscopical or surgical papillotomy was also done in all patients. In the most recent cases, we preferred to perform an endoscopic papillotomy rather than a surgical papillotomy. The endoscopic papillotomy is performed by a preoperative endoscopic retrograde cholangiopancreatography (ERCP) together with placement of a plastic stent. The placement of a stent before surgery facilitates the localization of the papilla of Vater during the surgical procedure. When ERCP is not performed before surgery, the pancreatic duct is temporarily stented during surgery with a plastic stent. Finally, cholecystectomy is performed and the wounds are closed.

Patients

In the period from 1999 to 2010 13 patients (6 males, 7 females) with a mean age of 50 years (range 26–73 years) underwent PPTD at our institution. Ten patients had duodenal adenomatosis (Spigelman stage IV) due to familial adenomatous polyposis, which was confirmed histologically in the surgical duodenectomy specimen. Two patients had large solitary tubulovillous adenomas, where endoscopic ablation was impossible due to the size or localisation of the adenomas. One patient had multiple duodenal gastrointestinal stromal tumor (GIST) lesions.
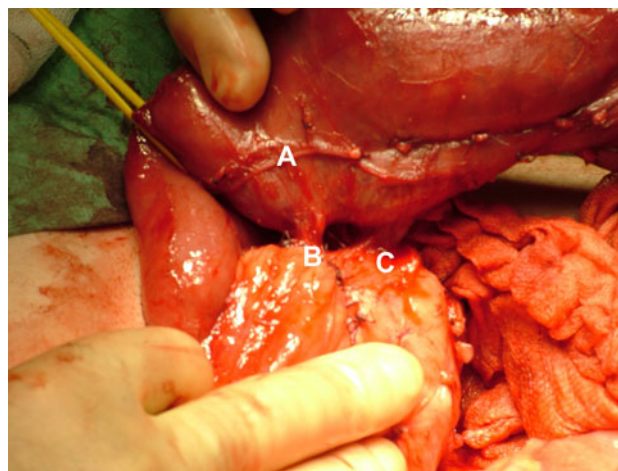


Fig. 1 Pancreas-preserving total duodenectomy [5]



Fig. 2 Intra-operative photograph of PPTD. *A* Cut edge of serosal area, *B* ampulla of pancreatic duct and common bile duct, *C* accessory pancreatic duct (papilla duodeni minor)

## Results

Seven (54%) of the 13 operated patients had an uncomplicated postoperative course. Six patients (46%) had a total of ten postoperative complications. Three patients (23%) had leakage of the ampullo-jejunostomy anastomosis, and one patient (8%) had leakage of the duodeno-jejunostomy anastomosis; all were treated conservatively with good results. None of the patients with leakage of the anastomosis developed septic shock. One patient had recurrent episodes of pancreatitis, which disappeared spontaneously 3 months after operation. Three patients suffered from wound dehiscence, and two patients had postoperative pneumonia. One patient suffered from an episode of cholangitis caused by a stone in the common bile duct. Endoscopic trans-anastomotic lithotomy was performed, the stone was removed and a temporary plastic stent was inserted. No mortality was observed among the operated patients and mean hospital admittance was 19 days (range 9–50 days). All patients were well at a mean follow-up of 56 months (range 2–134 months). Three of the 10 patients operated for FAP-related duodenal adenomatosis developed small polyps postoperatively in the jejunum (neo-duodenum) at endoscopic follow-up. In these patients, biopsies from the small polyps were taken and pathologic examination showed mild to moderate dysplasia. The polyps were treated endoscopically with argon plasma coagulation therapy. None of the patients developed polyps in the 1-cm long duodenal stump just distal from the pylorus.

All patients had normal postoperative endocrine pancreas function, and none of the patients developed diabetes mellitus. None of the patients reported discomfort in subjective feeling or physical fitness at their last follow-up.

## Discussion

PPTD can be performed for all benign and premalignant lesions of the duodenum [3, 6]. The majority of patients in our study underwent PPTD due to FAP-related duodenal adenomatosis, which accords with other studies [7–11]. For patients with FAP, it has been shown that the adenoma–carcinoma sequence exists for colonic adenomas as well as for duodenal adenomas [12]. In addition it is known that duodenal cancer is 100- to 300-fold more common in patients with FAP compared to the general population, making duodenal cancer together with desmoid tumours the leading cause of death in FAP-patients who have undergone colectomy [13–15]. FAP patients have an estimated lifetime risk of 3–5% of acquiring duodenal cancer [14, 16]. However the risk of developing duodenal cancer in patients who have duodenal adenomatosis Spigelman stage IV is higher than 20% [6].

Large duodenal adenomas can be resected by endoscopy or local resection via laparotomy; however, the risk of recurrence is high [17–19]. All FAP patients in our study who underwent PPTD had multiple duodenal adenomas and Spigelman stage IV.

Other indications described for PPTD are large benign villous tumours of the duodenum, mucosa-associated lymphoid tissue (MALT) lymphoma, retroperitoneal liposarcoma, giant multiple lymphoma, Crohn's disease, intestinal amyloidosis and duodenal gastrinomas and carcinoids [10, 20, 21]. In addition, PPTD can be performed in patients with isolated injuries of the duodenum and trauma [22, 23]. There is consensus that PPTD is a cancer-prophylactic operation and in the case of an invasive neoplasm pancreaticoduodenectomy using Whipple's operation should be performed to address sufficient resection of adjacent tissue and locoregional lymphadenectomy. Therefore, as preoperative staging might not necessarily be adequate, intra-operative biopsies are taken and sent for intra-operative frozen histologic examination. If an invasive cancer is diagnosed, pancreaticoduodenectomy using Whipple's operation is performed [3]. One group has reported on their experience in performing pancreas-sparing proximal or distal duodenectomy in patients with invasive duodenal cancer. They found a high rate of deaths due to distant metastases, while the rate of locoregional recurrences was low [24]. Like others, we report PPTD performed in a patient with multiple duodenal GIST-lesions [25]. In this patient, we were careful to ensure complete resection of all tumor tissue, and microscopy did not reveal invasive growth. After surgery, the patient was controlled frequently to identify any recurrence.

In our 10 years' experience with PPTD we found that the operation can be performed without mortality; however, nearly half of the patients experienced postoperative complications. None of the patients had chronic problems caused by the complications and all patients were well at follow-up.

We have reviewed the articles on PPTD found in the literature (Table 1). Some reports are not mentioned in the Table, as the same patients are mentioned in different studies [4, 5, 9, 17]. These articles on PPTD each describe between 1 and 26 cases, and in total 128 patients undergoing PPTD are reported. Mortality rate in the literature varies between 0 and 50%, and in total three patients died within the first month after surgery, accounting for a total mortality of 2.3%. In addition, the postoperative complication rate ranged between 0 and 67% for the individual studies, and in total 56 out of 128 patients suffered from some kind of complication, accounting for a total morbidity rate of 44% (Table 1). As in our study, anastomotic leakage was the most frequent and severe postoperative surgical complication; however, all patients in our study could be

**Table 1** Studies reporting on pancreas preserving total duodenectomy

| Study | Year | Country | N | Diagnosis (N) | Mortality (%) | Morbidity (%) | Complications | Follow-up endoscopy | Follow-up (months) | Follow-up |
|---|---|---|---|---|---|---|---|---|---|---|
| Tsiotos [28] | 1998 | USA | 4 | FAP (2)<br>Villous adenoma (2) | 0 | 25 | Leakage ampullo-jejunostomy 25% | Unknown | 6.5 (1–11) | Well |
| Nagai et al. [29] | 1999 | Japan | 1 | MALT-lymphoma | 0 | 0 | None | Unknown | 7 (7) | Well |
| Lundell et al. [10] | 2002 | Sweden | 4 | FAP (2)<br>Villous adenoma (2)<br>Giant lipoma (2) | 0 | 25 | Re-operation for ampullo-jejunostomy leakage 25% | Unknown | 6 (6) | Well |
| Sarmiento et al. [11] | 2002 | USA | 8 | FAP (5)<br>Villous adenoma (3) | 0 | 63 | Leakage ampullo-jejunostomy 38%<br>Re-laparotomy for bleeding 13%<br>Wound infection 13% | Small jejunal adenomas 25%<br>Anastomotic ulcerations 25% | 23 (6–44) | Recurrent episodes of pancreatitis (25%) |
| Kalady et al. [8] | 2002 | USA | 3 | FAP (3) | 0 | 67 | Leakage ampullo-jejunostomy 33%<br>Wound infection 33% | Small jejunal adenomas 33% | 26 (6–60) | Well |
| Takagi et al. [21] | 2003 | Japan | 1 | Duodenal carcinoid | 0 | 0 | None | Unknown | 1 | Well |
| Eisenberger et al. [25] | 2004 | Germany | 2 | Gardner syndrome (1)<br>Multiple villous adenomas (1) | 0 | 50 | Necrotising pancreatitis (50%)<br>Wound infection (50%) | No recurrence | 24 | Well |
| Mackey et al. [7] | 2005 | USA | 21 | FAP (21) | 0 | 38 | Delayed gastric emptying (29%)<br>Leakage ampullo-jejunostomy (19%)<br>Acute pancreatitis (5%)<br>Deep wound infection (5%) | Jejunal adenomas 10% | 79 (3–152) | Small bowel obstruction requiring operation (5%)<br>Peptic ulcer (5%) |
| Imamura et al. [30] | 2005 | Japan | 3 | FAP (1)<br>Bleeding/intestinal amyloidosis (1)<br>Multiple duodenal gastrinomas (1) | 0 | 0 | None | No recurrence | 11 (7–18) | Well |
| Koshariya et al. [31] | 2007 | Japan | 3 | Duodenal adenomatosis (2)<br>Recurrence of ampullary adenoma (1) | 0 | 33 | Acute pancreatitis (33%) | Unknown | 9 (2–18) | Well |
| Al-Sarireh et al. [6] | 2008 | UK | 12 | FAP (5)<br>FAP/adenocarcinoma (1)<br>Duodenal GIST (3)<br>Duodenal adenomas (3) | 0 | 50 | Acute pancreatitis (8%)<br>Anastomotic leakage (16%)<br>Small bowel fistula (8%)<br>Intra-abdominal abscess (16%)<br>Wound infection (8%)<br>Delayed gastric emptying (8%) | New adenocarcinoma in jejunum (1) | 20 (8–41) | Incisional hernia<br>Episodes of pancreatitis (1)<br>Small bowel obstruction, treated conservatively (1) |

Table 1 continued

| Study | Year | Country | N | Diagnosis (N) | Mortality (%) | Morbidity (%) | Complications | Follow-up endoscopy | Follow-up (months) | Follow-up |
|---|---|---|---|---|---|---|---|---|---|---|
| De Castro et al. [2] | 2008 | Netherlands | 26 | FAP (26) | 4 | 62 | Leakage ampullo-jejunostomy (27%) Delayed gastric emptying (8%) Bleeding (4%) Intra-abdominal abscess (8%) Wound infection (12%) Myocardial infarction (4%) Re-laparotomy (15%) | Jejunal ulceration 19% Recurrent adenomas 15% | 3 | Well |
| Muller et al. [3] | 2008 | Germany | 23 | FAP (13) Duodenal adenomas (9) Duodenal neuroendocrine tumor (1) | 4 | 30 | Myocardial infarction (4%) Pancreatic fistula (13%) Acute pancreatitis (4%) Wound infection (4%) Anastomotic leakage (4%) Pulmonary problem (4%) | Unknown | 23 | 16 patients: well Episode of pancreatitis (1) Small bowel obstruction treated conservatively (1) |
| Wig et al. [22] | 2009 | India | 2 | Trauma (2) | 0 | 50 | Bleeding (50%) | Not relevant | 22 (20–24) | Well |
| Paluszkiewicz et al. [23] | 2009 | Poland | 2 | Trauma (1) Gut bleeding (1) | 50 | 50 | Myocardial infarction 50% | Unknown | 1 | Unknown |
| Current study | 2010 | Denmark | 13 | FAP (10) | 0 | 46 | See text | Jejunal adenomas in 30% of FAP | 56 | Well |
| Total | | | 128 | | 2 | 44 | | | | |

**Table 2** Definitions of terms

Pancreas-preserving total duodenectomy (PPTD): also called pancreas-sparing total duodenectomy. PPTD can either be pylorus-preserving or not, depending on the number and localization of the adenomas. Furthermore, the extent of the resection of the papilla of Vater can be different, consisting of either

(1) a common single anastomosis into the jejunum (i.e., an ampullo-jejunostomy) or

(2) a separate anastomosis for both the common bile duct and the pancreatic duct into the jejunum

Pancreas-sparing duodenectomy: this term includes both PPTD, but also operations where the duodenum is only removed partially and not totally (i.e., pancreas-sparing distal duodenectomy or pancreas-sparing proximal duodenectomy)

Recurrence: the occurrence of polyps in the jejunum or any other part of the small bowel after earlier surgical resection of polyps in parts of the gastrointestinal system

Delayed gastric emptying: also called gastroparesis is a disorder in which the stomach takes too long to empty its contents

Leakage: discontinuation of the anastomosis causing leakage of gastrointestinal contents

managed conservatively and no re-laparotomy for anastomotic leakage was performed.

The following question is raised: what advantages has PPTD compared to pancreaticoduodenectomy using Whipple's operation? Studies reporting on FAP patients undergoing Whipple's operation for duodenal adenomatosis have found mortality rates between 0 and 6.7% [26]. It is assumed that outcome after Whipple's operation for FAP patients is worse compared to patients undergoing Whipple's operation for other indications, which might be related to previous surgery, such as proctocolectomy and adhesions [3]. In addition, the soft pancreatic parenchyma and the normal-sized common bile duct in FAP patients might predispose to complications [3, 26].

Compared to Whipple's operation, PPTD has the advantage of preserving the unaffected pancreas and biliary tree, and creating anatomic reconstruction of the digestive tract. A study comparing PPTD and Whipple's operation showed an increase in perioperative blood loss and the need for pancreatic enzyme substitution (75%) associated with Whipple's operation [3]. Normally during Whipple's operation, up to 50% of pancreatic tissue is resected, and it is assumed that 10% of normal pancreatic enzyme secretion is sufficient for normal digestion [3]. Why patients need pancreatic enzyme substitution after Whipple's operation is probably explained by the non-anatomic reconstruction of the digestive system causing a delay in contact between food and pancreatic enzymes (Table 2).

Probably the most important advantage of PPTD is the anatomic reconstruction of the digestive system which facilitates endoscopic surveillance compared to the non-anatomic reconstruction performed with Whipple's operation [5, 25]. Endoscopic surveillance after duodenectomy in FAP patients is important, as adenomas in the jejunum can occur [5].

Before PPTD is performed in patients with premalignant lesions, endoscopic ultrasound is recommended to clarify invasive growth. In addition, preoperative magnetic resonance cholangiopancreatography can clarify the pancreatic duct system and identify a pancreas divisum, which is assumed to be prevalent in 10% of the normal population [11]. With PPTD, the accessory pancreatic duct (papilla duodeni minor) is normally ligated; however, in patients with a pancreas divisum ligature of the accessory pancreatic duct is presumed to cause severe consequences [27], and has also been described as a cause of death [2]. In the case of a pancreas divisum, either PPTD with an extra-pancreatic duct–jejunal anastomosis or a pancreaticoduodenectomy using Whipple's operation should be performed [2, 11].

During the PPTD procedure, it is recommended to perform a simultaneous cholecystectomy, as patients without a duodenum are at an increased risk of developing gallstones due to the lack of cholecystine production in the duodenum [11]. Postoperatively, one of our patients suffered from stones in the common bile duct, and was treated by endoscopic trans-anastomotic lithotomy.

In our series we have decided to perform the procedure pylorus-preserving or not based on the number and localization of the adenomas. This means that we resected the pylorus in patients with FAP and adenomas located in the duodenum just distal from the pylorus. In cases where the pylorus was resected, the jejunum was anastomosed to the distal part of the stomach. In cases where the pylorus was preserved, we divided the duodenum 1 cm distal from the pylorus and anastomosed the duodenal stump to the jejunum. Before performing the anastomosis between the duodenal stump and jejunum, it is possible to resect the mucosa from the 1 cm long duodenal stump and to pull the gastric mucosa over the duodenal stump, in an attempt to avoid recurrence of duodenal adenomas.

## Conclusion

This study confirms that PPTD is a safe and valuable alternative to pancreaticoduodenectomy for patients with benign and pre-malignant lesions of the duodenum. The procedure can be performed without mortality and

acceptable morbidity, and preserves the pancreas. In addition PPTD facilitates endoscopic surveillance, which is important as polyps can develop in the jejunum of patients with FAP.

# References

1. Gouma DJ, van Geenen RC, van Gulik TM, de Haan RJ, de Wit LT, Busch OR, et al. Rates of complications and death after pancreaticoduodenectomy: risk factors and the impact of hospital volume. Ann Surg. 2000;232:786–95.
2. de Castro SM, van Eijck CH, Rutten JP, de Jong CH, van Goor H, Busch OR, et al. Pancreas-preserving total duodenectomy versus standard pancreatoduodenectomy for patients with familial adenomatous polyposis and polyps in the duodenum. Br J Surg. 2008;95:1380–6.
3. Muller MW, Dahmen R, Koninger J, Michalski CW, Hinz U, Hartel M, et al. Is there an advantage in performing a pancreas-preserving total duodenectomy in duodenal adenomatosis? Am J Surg. 2008;195:741–8.
4. Chung RS, Church JM, vanStolk R. Pancreas-sparing duodenectomy: indications, surgical technique, and results. Surgery. 1995;117:254–9.
5. Penninga L, Svendsen LB, Kirkegaard P, Bulow S. Pancreas-preserving total duodenectomy in familial adenomatous polyposis. Ugeskr Laeger. 2004;166:4588–91.
6. Al-Sarireh B, Ghaneh P, Gardner-Thorpe J, Raraty M, Hartley M, Sutton R, et al. Complications and follow-up after pancreas-preserving total duodenectomy for duodenal polyps. Br J Surg. 2008;95:1506–11.
7. Mackey R, Walsh RM, Chung R, Brown N, Smith A, Church J, et al. Pancreas-sparing duodenectomy is effective management for familial adenomatous polyposis. J Gastrointest Surg. 2005;9:1088–93.
8. Kalady MF, Clary BM, Tyler DS, Pappas TN. Pancreas-preserving duodenectomy in the management of duodenal familial adenomatous polyposis. J Gastrointest Surg. 2002;6:82–7.
9. Konsten JL, Kazemier G, Dees J, van Eijck CH. Pancreas-preserving total duodenectomy due to familial adenomatous polyposis in 4 patients. Ned Tijdschr Geneeskd. 2002;146:621–4.
10. Lundell L, Hyltander A, Liedman B. Pancreas-sparing duodenectomy: technique and indications. Eur J Surg. 2002;168:74–7.
11. Sarmiento JM, Thompson GB, Nagorney DM, Donohue JH, Farnell MB. Pancreas-sparing duodenectomy for duodenal polyposis. Arch Surg. 2002;137:557–62.
12. Jagelman DG, DeCosse JJ, Bussey HJ. Upper gastrointestinal cancer in familial adenomatous polyposis. Lancet. 1988;1:1149–51.
13. Arvanitis ML, Jagelman DG, Fazio VW, Lavery IC, McGannon E. Mortality in patients with familial adenomatous polyposis. Dis Colon Rectum. 1990;33:639–42.
14. Groves CJ, Saunders BP, Spigelman AD, Phillips RK. Duodenal cancer in patients with familial adenomatous polyposis (FAP): results of a 10 year prospective study. Gut. 2002;50:636–41.
15. Bulow S, Bjork J, Christensen IJ, Fausa O, Jarvinen H, Moesgaard F, et al. Duodenal adenomatosis in familial adenomatous polyposis. Gut. 2004;53:381–6.
16. Vasen HF, Bulow S, Myrhoj T, Mathus-Vliegen L, Griffioen G, Buskens E, et al. Decision analysis in the management of duodenal adenomatosis in familial adenomatous polyposis. Gut. 1997;40:716–9.
17. Alarcon FJ, Burke CA, Church JM, van Stolk RU. Familial adenomatous polyposis: efficacy of endoscopic and surgical treatment for advanced duodenal adenomas. Dis Colon Rectum. 1999;42:1533–6.
18. Penna C, Phillips RK, Tiret E, Spigelman AD. Surgical polypectomy of duodenal adenomas in familial adenomatous polyposis: experience of two European centres. Br J Surg. 1993;80:1027–9.
19. Penna C, Bataille N, Balladur P, Tiret E, Parc R. Surgical treatment of severe duodenal polyposis in familial adenomatous polyposis. Br J Surg. 1998;85:665–8.
20. Kimura Y, Mukaiya M, Honma T, Okuya K, Akizuki E, Kihara C, et al. Pancreas-sparing duodenectomy for a recurrent retroperitoneal liposarcoma: report of a case. Surg Today. 2005;35:91–3.
21. Takagi H, Miyairi J, Hata M, Tuboi J, Kamijou T, Nakajima K, et al. Multiple somatostatin- and gastrin-containing carcinoids of the duodenum: report of a case treated by pancreas-sparing duodenectomy. Hepatogastroenterology. 2003;50:711–3.
22. Wig JD, Kudari A, Yadav TD, Doley RP, Bharathy KG, Kalra N. Pancreas preserving total duodenectomy for complex duodenal injury. JOP. 2009;10:425–8.
23. Paluszkiewicz P, Dudek W, Lowery K, Hart CA. Pancreas sparing duodenectomy as an emergency procedure. World J Emerg Surg. 2009;4:19.
24. Konishi M, Kinoshita T, Nakagohri T, Takahashi S, Gotohda N, Ryu M. Pancreas-sparing duodenectomy for duodenal neoplasms including malignancies. Hepatogastroenterology. 2007;54:753–7.
25. Eisenberger CF, Knoefel WT, Peiper M, Yekebas EF, Hosch SB, Busch C, et al. Pancreas-sparing duodenectomy in duodenal pathology: indications and results. Hepatogastroenterology. 2004;51:727–31.
26. Gallagher MC, Shankar A, Groves CJ, Russell RC, Phillips RK. Pylorus-preserving pancreaticoduodenectomy for advanced duodenal disease in familial adenomatous polyposis. Br J Surg. 2004;91:1157–64.
27. Kimura W, Nagai H. Study of surgical anatomy for duodenum-preserving resection of the head of the pancreas. Ann Surg. 1995;221:359–63.
28. Tsiotos GG, Sarr MG. Pancreas-preserving total duodenectomy. Dig Surg. 1998;15:398–403.
29. Nagai H, Hyodo M, Kurihara K, Ohki J, Yasuda T, Kasahara K, et al. Pancreas-sparing duodenectomy: classification, indication and procedures. Hepatogastroenterology. 1999;46:1953–8.
30. Imamura M, Komoto I, Doi R, Onodera H, Kobayashi H, Kawai Y. New pancreas-preserving total duodenectomy technique. World J Surg. 2005;29:203–7.
31. Koshariya M, Jagad RB, Kawamoto J, Papastratis P, Kefalourous H, Porfiris T, et al. Pancreas-preserving total duodenectomy without pancreato-enteric anastomosis. Hepatogastroenterology. 2007;54:2123–8.