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Overview of pancreatic resections: indications and procedures

Pancreatic resections are currently performed at specialist units in the UK. They involve complex decision making, dissection and reconstruction, and are associated with significant peri- and postoperative complications. It is important for trainees to be well informed about the nomenclature of pancreatic resection and reconstruction, associated complications and the postoperative management.

Surgical resection of the pancreas dates back to the 19th century, when the first 'en-bloc' resection of the head of the pancreas and duodenum was performed for a periampullary cancer. William Halsted at the Johns Hopkins Hospital performed the first successful local resection of a periampullary carcinoma in 1898 (Halsted, 1899), a feat that Walther Carl Eduard Kausch repeated in 1909 (Kausch, 1912). Dr Allen Oldfather Whipple, the person synonymous with pancreatic head resection, performed a two-stage pancreatoduodenectomy in 1935 (Whipple et al, 1935) and 6 years later described and popularized the classical one-stage pancreatoduodenectomy (Whipple, 1946).

Ever since these first pioneering operations, numerous other pancreatic resections have been described; the boundaries of what is surgically achievable continue to be pushed with associated major venous and/or arterial resection performed with varying outcomes (Weitz et al, 2007; Mollberg et al, 2011). The retroperitoneal position of the pancreas, its production of potentially harmful proteolytic enzymes in close proximity to anastomoses, and its relationship to major vasculature, in particular to the superior mesenteric vein, artery and portal vein, demands specialist surgical skills and training (Are et al, 2011).

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Over the past few decades, mortality associated with pancreatic head resection has decreased significantly with centralization of services to large volume centres, from around 20% to approximately less than 3% (Gooiker et al, 2011). However, morbidity rates remain high at up to 30% for head of pancreas resections and up to 15% following distal pancreas resections (Rosales-Velderrain et al, 2012).

Part one of this two-part article gives an overview of the types of common pancreatic surgery. Part two focuses upon postoperative management, complications and how to manage them.

Indications for pancreatic resection

Pancreatic resections are performed for periampullary tumours (lesions of the pancreatic head and uncinate process, distal bile duct and ampulla of Vater), duodenal tumours, chronic pancreatitis, mucinous lesions with malignant potential (such as intraductal papillary mucinous neoplasms and mucinous cystic neoplasms), and neuroendocrine tumours.

The overall pancreatic resection rate for the UK is approximately 35–40 per million population (Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland, 2011). Resection rates have doubled in the UK in the last 10 years and are expected to rise further (Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland, 2011) as a result of increased early diagnosis of incidental lesions on cross-sectional imaging, improved perioperative care allowing sur-

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geons to perform major resectional surgery in the elderly, and the use of neo-adjuvant chemotherapy in borderline resectable tumours (Strobel et al, 2012).

Irrespective of the type of procedure performed, the principal aim is to resect the tumour with clear margins, perform adequate local lymphadenectomy, and to restore intestinal continuity in the case of resections where the duodenum is excised.

Types of pancreatic surgical resections

The type of resection performed depends upon the anatomical location and nature of the disease, patient factors and institutional preferences.

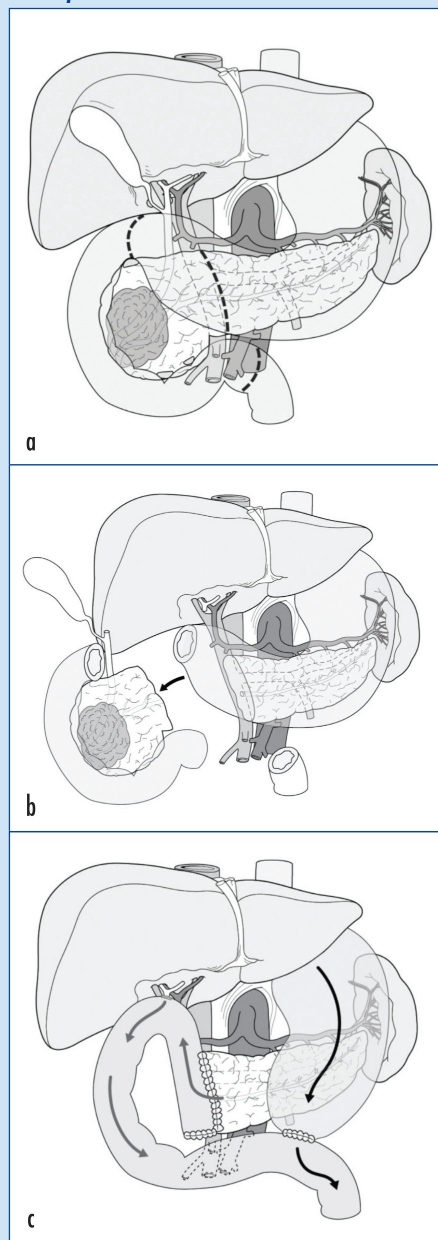
Whipple's procedure

The classic procedure for a periampullary lesion consists of an en-bloc removal of the pancreatic head, the duodenum, the common bile duct, the gall bladder and the distal stomach together with lymphadenectomy of the common and true hepatic arteries to the level of the splenic artery origin (Lavu and Yeo, 2013) (http://pie.med.utoronto.ca/TVASurg/TVASurg_content/surg/PP_whipple.html). There are many variations of these anastomoses and one such method is illustrated in *Figures 1a–c*. The procedure is briefly described below.

A midline or subcostal incision can be used. The duodenum and head of the pancreas are mobilized off the vena cava (Kocherisation) by releasing the lateral peritoneal attachment of duodenum; this is facilitated by mobilizing the hepatic flexure of the colon. The superior mesenteric vein is exposed at the inferior border of the neck of the pancreas adjacent to the uncinate process. The porta hepatis is dissected where the common hepatic duct is divided after cholecystectomy. Dissection is continued anterior to the portal vein and posterior to the neck of the pancreas to create a tunnel that confirms that tumour has not infiltrated the portal vein. The antrum of the stomach is divided with or without preservation of the pylorus. The jejunum is divided and mobilized off the small bowel mesentery and delivered into the supracolic compartment (*Figures 1a* and *b*). The pancreas is then divided at the level of the portal vein and the pancreatic head is reflected laterally ligating the arterial branches between the superior mesenteric artery and uncinate process. Intestinal continuity is reconstructed by gastrojejunostomy and hepaticojejunostomy (*Figure 1c*).

Postoperative pancreatic fistula is associated with increased morbidity and mortality and the risk is higher with soft gland and narrow pancreatic duct (Roberts et al, 2014b). While patients with background chronic pancreatitis have a firm to hard gland, the pancreas is often soft in patients undergoing pancreatoduodenectomy. There is much debate as to the optimal means of constructing the pancreatico-enteric anastomosis – pancreaticojejunostomy or pancreaticogastrostomy, interrupted or continuous sutures, single or double layered anastomoses are some of the techniques currently debated. While there are various reconstructive options, what is clear is that no one technique is widely accepted as being superior; surgeons develop a technique they are happy with and tend to stick to that.

Figure 1. Whipple's procedure for tumour in head of the pancreas.



Pylorus preserving pancreatoduodenectomy

This is a variation of the classical pancreatoduodenectomy where the pylorus of the stomach and first 2 cm of the duodenum are preserved, and a duodenojejunal anastomosis is performed (Traverso and Longmire, 1978; Lavu and Yeo, 2013). Pylorus preservation has theoretical physiological benefits although various randomized controlled trials and meta-analyses comparing the two procedures have found no statistically significant differences in morbidity, in-hospital mortality or overall survival. However, the operating time and the intraoperative blood loss are significantly reduced with a pylorus-preserving pancreatoduodenectomy (Diener et al, 2011).

Distal pancreatectomy

Distal pancreatectomy involves resection of the body (lateral to the portal vein) and/or tail of the pancreas as shown in *Figure 2*. This is the standard surgical therapy for lesions of the body and tail of the pancreas. In cases where distal pancreatectomy is being performed for a benign or borderline disease process, the spleen can often be preserved either by dissecting it from the splenic vessels or by sacrificing the splenic artery and vein but leaving the short gastric vessels intact, the so-called Warshaw operation (Warshaw, 1988). No anastomoses are required during a distal pancreatectomy but leakage of pancreatic secretions from the cut surface of the pancreas is the Achilles heel of this procedure (Rosales-Velderrain et al, 2012). Various interventions have been subject to randomized controlled trials such as stapled *vs* hand-sewn closure, the addition of fibrin sealants and buttressing the closure with the falciform ligament but none reliably reduces rates of postoperative pancreatic fistula.

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Central pancreatectomy

Middle or central pancreatectomy is advocated in the management of small benign or borderline neoplasms. This procedure allows preservation of normal pancreatic tissue, thus reducing the risk of loss of exocrine and endocrine function (the majority of endocrine function is located in the pancreatic tail). The distal pancreatic margin is anastomosed to a Roux-en-Y loop of jejunum (pancreaticojejunostomy), and the remnant of the head region is left in place but oversewn in a manner similar to a standard distal pancreatectomy to try and prevent a postoperative pancreatic fistula, as shown in *Figure 3*.

Total pancreatectomy

Total pancreatectomy is performed to treat multicentric or extensive endocrine tumours and intraductal papillary mucinous neoplasms – either involving the whole of the main pancreatic duct or multifocal disease. Completion pancreatectomy is occasionally performed as a salvage procedure in patients with postoperative pancreatic fistula as a technique to control sepsis in desperate circumstances. The entire pancreas, in addition to the duodenum, gallbladder, common bile duct and spleen, is removed en-bloc. Reconstruction is performed by means of duodenojejunostomy and hepaticojejunostomy (*Figure 4*).

Total pancreatectomy leads to inherent endocrine and exocrine insufficiency with potential severe metabolic consequences, such as difficult glycaemic control, malabsorption-associated diarrhoea and weight loss, steatohepatitis and eventually liver failure. However, studies questioned the existence of 'brittle diabetes' with diabetes-related outcomes comparable to patients with type 1 diabetes (Barbier et al, 2013; Roberts et al, 2014a). Pancreatic enzyme replacement is offered and should be in conjunction with proton pump inhibitor therapy as this reduces destruction of the proteins by gastric acid.

Figure 2. Distal pancreatectomy for tumour in tail of the pancreas.

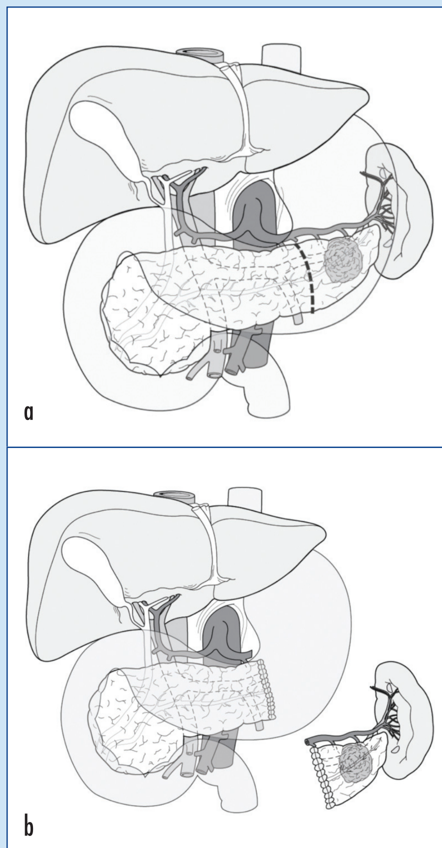


Figure 3. Reconstruction following central pancreatectomy.

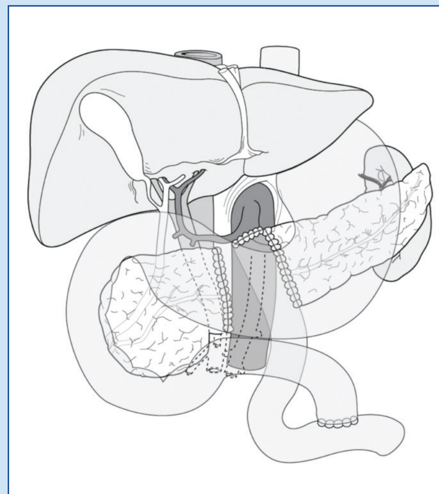
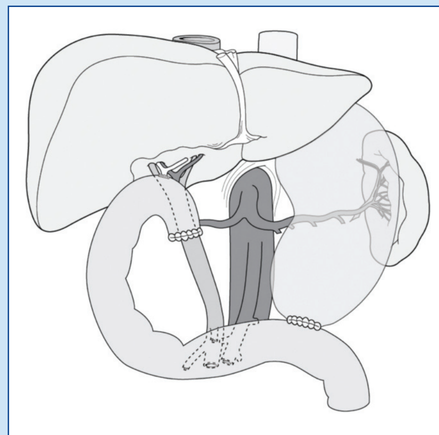


Figure 4. Reconstruction following total pancreatectomy.



Surgery for chronic pancreatitis

Total pancreatectomy or segmental resections (pylorus-preserving pancreatoduodenectomy or distal pancreatectomy) can be performed for patients with chronic pancreatitis although outcomes such as pain relief are unfortunately poor. Chronic pancreatitis can be associated with disease of the head where this can be resected but the duodenum preserved (Beger and Frey procedures). For patients with pancreatic duct dilation with or without ductal stones, drainage procedures, such as Partington–Rochelle pancreaticojejunostomy, can be performed. With largely disappointing results, surgery for chronic pancreatitis is used for a selected group of patients who had failed conservative, percutaneous and endoscopic options (van Loo et al, 2010).

In terms of operative technique, all the above operations may be performed using an open or a laparoscopic approach. Indeed, the laparoscopic approach to distal pancreatectomy is now regarded by many as the standard of care (Venkat et al, 2012) as it is associated with a shorter operative time and postoperative hospital stay, with no increase in morbidity or mortality. It also provides comparable oncological outcomes to open surgery (Kooby et al, 2010; Venkat et al, 2012). The evidence for pancreatoduodenectomy is less strong but is increasing with larger series of laparoscopic (Kim et al, 2013) and robotic procedures (Chalikonda et al, 2012) being reported in the literature.

Conclusions

This article has discussed the standard surgical procedures in pancreatic surgery. The second part will look at the incidence, diagnosis and management of postoperative complications. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Pancreatic resections are performed in specialist centres because of the complex nature of the disease and surgical treatment.
- Mortality and morbidity following pancreatoduodenectomy has decreased significantly with centralization of services to high-volume centres but remains significant. Postoperative pancreatic fistula remains a problem with no effective strategy to reduce its incidence.
- Although technically less demanding distal pancreatectomy is associated with a higher rate of postoperative fistula, largely because the glands are softer with non-dilated ducts.

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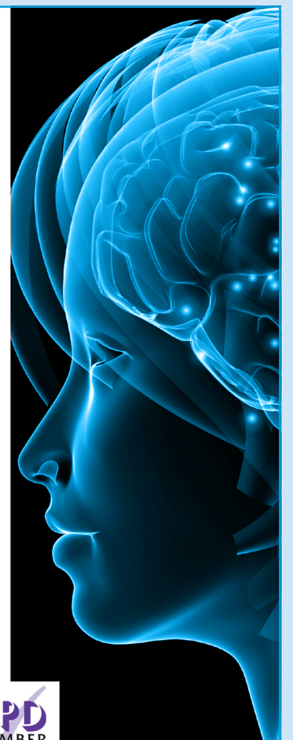

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