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ORIGINAL ARTICLE

Pancreatoduodenectomy - Preventing Complications

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Abstract Increased awareness of periampullary & pancreatic head cancers, and the accompanying improved outcomes following pancreatoduodenectomy (PD), has possibly led to an increase in patients seeking treatment for the same. While there has definitely been a reduction in morbidity rates following PD in the last few decades, this decline has not mirrored the drastic fall in mortality. Amongst the foremost in the factors responsible for this reduction in mortality is the standardization of surgical technique and development of dedicated teams to manage all aspects of this demanding procedure. This review intends to provide the reader with an overview of major complications following this major surgery and measures to prevent them based on the authors' experience.

Keywords Pancreatoduodenectomy · Complications · Classification · Haemorrhage · Pancreatic fistula · Prevention

Introduction

Resectional surgery for pancreatic cancer has advanced considerably in the last decade. The high mortality of nearly 25 % following pancreatoduodenectomy (PD) has now been reduced to less than 5 % [1–5] and even zero in some centres of excellence [6, 7]. However, the morbidity statistics after PD remain worrisome with a reported range of 25–50 % [6, 8–10]. The most common complications encountered are post pancreatectomy haemorrhage (PPH), post operative pancreatic fistula (POPF), delayed gastric emptying (DGE) and biliary anastomotic leakage and their attendant problems. This review discusses these complications and suggests measures to prevent them while providing relevant data from the authors' centre against a global backdrop.

Post Pancreatectomy Haemorrhage (PPH)

Post surgical bleeding complications are reported in 5–16 % [8, 11–15] of patients following PD and are associated with high morbidity and mortality. A number of different definitions have been used by different authors. PPH following PD is best divided into early haemorrhage, i.e. bleeding within 24 h after surgery, and late haemorrhage when the bleeding occurs in the 2nd to 3rd post-operative week. In 2007, the International Study Group of Pancreatic Fistula (ISGPF) graded post-operative haemorrhage into three grades (A,B & C) based on the onset (early or late), site of bleeding (intraluminal or extraluminal), severity, and clinical impact [16].

Early Haemorrhage

One of the most common causes for early haemorrhage is technical failure which can happen after any major surgery. This haemorrhage can be either intraluminal or extraluminal which can be fatal in certain situations. The various sites are shown in Table 1, with pancreatic anastomosis bleeding and bleeding from gastroduodenal artery being the most common and dangerous forms of intraluminal and extraluminal bleeding respectively.

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Table 1 Potential sites of early Haemorrhage following PD

Intraluminal Bleeding	Extraluminal bleeding
Pancreatic anastomosis	Gastroduodenal artery (GDA)
Pancreaticojejunostomy (PJ)	Hepatic artery
Pancreaticogastrostomy (PG)	Splenic artery
Gastrojejunostomy (GJ)/ Duodenojejunostomy (DJ)	Inferior pancreaticoduodenal artery
Gastric erosion/Stress ulcer	Margin of uncinate process of pancreas
Choledochojejunostomy/ Hepaticojejunostomy	Superior mesenteric vein/portal vein/colic veins

The underlying reasons are ligature slippage, improper transfixation sutures, wider distance between sutures, and unnamed small blood vessels which may undergo vasospasm preventing their initial intra-operative detection and which bleed spontaneously later in the post-operative period.

Delayed Haemorrhage

Delayed haemorrhage invariably occurs in association with a pancreatic anastomotic leak with an associated pancreatic fistula or a biliary leak [17] and rarely, stress-induced gastric erosion. Intra-abdominal infection and sepsis result in delayed haemorrhage by erosion of ligated blood vessels in the region around the pancreatic anastomosis viz., gastroduodenal artery, pancreatic branches of the proximal splenic artery, superior mesenteric vein, portal vein and superior mesenteric artery and its branches [18, 19]. At this juncture, the concept of a sentinel bleed assumes significance [19]. Here, patients who develop a mild bleed, particularly in association with a complicated post-operative course (e.g. pancreatic leak with fistula, fever etc.), are very likely to develop a massive haemorrhage shortly after this initial episode of apparently harmless & mild bleeding. Forty five percent of the patients who present with sentinel bleed manifest with massive delayed haemorrhage [20]. Patients with a sentinel bleed should ideally be investigated to ascertain the cause, site and extent of bleeding so that a decision on a therapeutic intervention can be taken without delay in the event of a massive bleed that may follow.

Diagnosis of PPH

Continuous evaluation of the patient in a high dependency unit is essential for a successful outcome in the event of early haemorrhage after PD [21]. Clinical signs of progressive hypovolemia continue to remain reliable during significant haemorrhage and should put the surgical and intensive care team on alert for impending emergency intervention. Additionally, persistently fresh blood (not blood tinged aspirate as can commonly occur after any gastric anastomosis due to old accumulated blood) from a nasogastric tube is a definite sign of intraluminal bleeding and the volume of aspirate should be monitored since its primary detection. Furthermore, an assessment of the abdominal drain output, both in terms of quantity and quality, is critical to reach a clinical, bedside decision whether the haemorrhage is only intra luminal, extra luminal or both intra luminal and extra luminal as can occasionally happen when pancreatic anastomotic suture line bleeding results in anastomotic disruption with resultant extravasation of blood into the peritoneal cavity.

In addition to progressive hypotension, signs of abdominal distension with peritonism (due to irritation of the peritoneum by extravasated blood) in combination with blood in the abdominal drains are an indication for immediate re-laparotomy to identify and control the bleeding source. A good practice is to re-operate on a “more stable” patient rather than an unstable patient. Radiologic imaging investigations, with the exception of a bedside portable ultrasonography to evaluate free intra abdominal fluid [22], have a limited role to play in the approach to management of early haemorrhage after PD. An endoscopy, to visualize the stomach & assess the afferent and efferent limbs of the digestive anastomosis, can be diagnostic and therapeutic for intraluminal-only PPH with the cause being the stomach lining.

Patients with a difficult and stormy post-operative course and those who develop a sentinel bleed should undergo a contrast enhanced triphasic CT scan of the abdomen. A CT scan at this stage can reveal fluid collections and abscess formation, common sequelae of pancreatic anastomotic leak and fistula. Furthermore, pseudo aneurysms can also be revealed (Fig. 1). In case the patient has a sentinel bleed, the intravenous contrast CT may detect the source of bleeding. However, a selective angiography is a more appropriate procedure to detect the bleeding source and a definite therapeutic intervention in the form of embolization (endocoil, gel foam pellets, stents etc.) can be added to the diagnostic procedure at the same time.

Prevention of PPH

The best way to prevent early haemorrhage after a PD is a well done primary operation with perfect haemostasis. Vasospasm of unknown vessels on the pancreatic cut surface that tends to get relieved during the post-operative phase with resultant bleeding, a distance of more than 3 mm between sutures, and a failure to include sub mucosal layers of the jejunum or stomach are some of the factors that may cause early haemorrhage from pancreatic anastomosis suture lines.

As discussed earlier (Table 1), there are a few common recognized sources of extra-luminal haemorrhage following

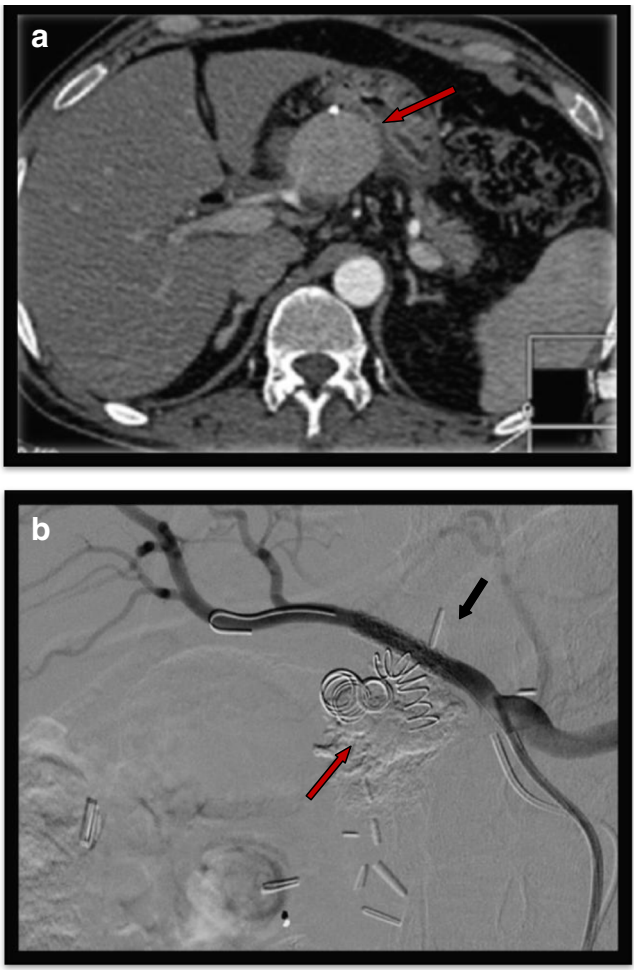

Fig. 1 **a** CECT showing pseudoaneurysm of the common hepatic artery (*arrow in red*), referred to the hospital a year after PD—An unusual presentation. **b** Celiac angiogram with post coil & glue embolization (*arrow in red*) of pseudoaneurysm followed by stent graft placement (*arrow in black*) shows exclusion of pseudoaneurysm with flow maintained in the hepatic artery

PD. Meticulous attention to a few simple surgical steps can go a long way in preventing PPH. These are discussed below

a. Major arterial pedicles—Gastroduodenal and inferior pancreaticoduodenal arteries are the most common sources of extra-luminal bleeding and should be securely transfixed with fine polypropylene sutures (4-0, 5-0) during the primary operation to avoid ligature slippage and psuedoaneurysm.
b. Duodenojejunal (DJ) flexure mobilization site—The area under the mesenteric vessels, the region from where the DJ flexure is mobilized and ultimately resected, should be carefully examined for any potential bleeding source from vessels directly communicating between the superior mesenteric vessels and the proximal jejunal mesentery. This is because the jejunal loop used for pancreatic anastomosis, once it is brought to the supracolic compartment and the pancreatic anastomosis performed, tends to prevent a proper examination of these two areas.
c. Pancreatic cut surface—The pancreatic cut surface can cause significant bleeding in the post-operative period. The vessels should be precisely identified and hemostasis achieved by under running them with fine 4-0/5-0 polypropylene sutures, taking necessary care to not include the pancreatic duct inadvertently.
d. Uncinate process -. It is a good practice to examine the area around the superior mesenteric vessels and the portal vein from where the uncinate process of the pancreas has been dissected off after completion of resection just prior to embarking on the pancreaticojejunal anastomosis. It is also advisable to avoid electrical energy sources in this area, as the lateral thermal spread causes inadvertent injury to the vessel.

Delayed haemorrhage is invariably associated with a pancreatic anastomotic leakage [13–17] and therefore prevention of delayed haemorrhage is almost always dependent on a well done and secure pancreatic anastomosis. The various aspects on pancreatic anastomosis would be discussed in the section dealing with the preventive aspects of pancreatic anastomotic leak and fistula.

Post-Operative Pancreatic Fistula (POPF)

The incidence of POPF after PD is around 5–10 % even in high-volume centres although rates of less than 4 % have been reported [23–25]. Most importantly, pancreatic leakage is still responsible for 33–88 % of post-operative deaths after pancreatic resection [26–30]. After a pancreatic anastomotic leak, activated pancreatic enzymes escape into the operative field in the peripancreatic region and cause inflammation and liquefaction necrosis. This result in local and systemic sepsis especially if the collection remains undrained and the fistula then becomes an uncontrolled one since drainage remains inadequate or incomplete. These conditions favour erosion of vessels leading to pseudo aneurysms and subsequent massive delayed haemorrhage often with lethal outcomes.

Diagnosis of POPF

The definition of pancreatic anastomotic dehiscence and fistula has evolved only recently after years of diverse definitions. The diagnosis of POPF may be suspected based on many clinical and biochemical findings. A broad definition encompasses the following criteria: drain output of any measurable volume on or after post-operative day 3, with amylase content more than 3 times the upper limit of normal serum value. The definition proposed by the ISGPF [31] is widely

followed to facilitate reporting of complications. By this definition, POPF is graded A, B & C depending on the severity of POPF and this grading guides management and prognostication. However, the definition of ISGPF has been questioned by some others. Strasberg et al. defined pancreatic fistula as 'pancreatic anastomotic failure' (PAF), as any intra-abdominal collection requiring drainage (irrespective of the drain fluid amylase levels), haemorrhage or peritionitis, into seven categories and five grades. High drain amylase in an asymptomatic patient without any change in the clinical management should not be considered as anastamotic failure as defined by ISGPF [32].

Usually pancreatic fistula manifests sometime between the 3rd and 7th post-operative days and colour of the drain changes from a normal post-operative "clear serous" nature to one that is cloudy and sometimes thick and even dark coloured. Furthermore, patients may develop abdominal distension, altered bowel function, ileus and tenderness and in the presence of septic complications, manifest fever.

Pancreatic fistula is essentially a clinical bedside diagnosis and definite investigations such as, a baseline X-ray of the chest and limited upper abdominal CT scan may be helpful to rule out basal congestion, pleural effusions, and abdominal fluid collections and thus aid in appropriate management of this leak.

Risk Factors and Prevention of POPF

Risk Factors

It is important to study the risk factors leading to POPF so that specific preventive measures can be taken to avoid such complications thus reducing the overall morbidity and mortality. The risk factors can be grouped into three broad categories –

1. Patient factors
2. Organ and disease-related factors
3. Peri-operative factors

1. Patient factors

   A single prospective study showed age > 70 year was associated with an increased risk of fistula formation [33]. A recent meta-analysis showed an increase in post-operative mortality and pneumonia, but no difference in the rates of POPF or DGE among elderly patients ≥ 75 years [34]. Male sex was found to be a risk factor in another study [35].

   Poor nutritional status and increased body mass index (BMI) are known risk factors for POPF. The post-operative morbidity can be up to four-fold higher in patients who are poorly nourished [36]. Preoperative albumin levels and prognostic nutrition index (PNI) have been shown to be independent factors to predict POPF. Serum albumin level of < 4.0 g/dl and a PNI of < 45 is associated with significantly higher incidence of fistula (37.5 % versus 18.7 % and 40 % versus 22 % respectively) [37]. Patients with higher BMI (>25 kg/m^2) are associated with an increased risk of POPF [38, 39].

2. Organ & Disease related factors

   Texture of the organ, duct size and the pathology of the disease have an impact on POPF. Amongst all, texture of the gland remains the most important predictive factor. The soft and fatty texture of the pancreas [38–46] with a non dilated duct (duct size < 3 mm) [45, 46] has a higher incidence of fistula when compared to fibrotic/atrophic pancreas with a dilated duct. Increased secretion of pancreatic juice is seen in patients with soft or normal pancreatic remnant and is associated with increased rates of POPF [41]. In a meta-analysis, Bartoli et al. observed that incidence of POPF was influenced by the pathology of the disease and the location of the tumor. The study showed lower incidence of fistula in chronic pancreatitis (5 %) compared to malignancy and distal bile duct cancer (33 %) had a higher risk [40].

3. Peri-operative factors

   Intra operative blood loss, degree of pancreatic mobilization & vascularity of the remnant, nature of anastomosis (Pancreaticojejunostomy versus Pancreaticogastrostomy, duct to mucosa versus invagination), pancreatic stents and administration of octreotide have all shown an impact on the development of POPF.

Prevention of POPF

Meticulous tissue handling and minimizing intra-operative blood loss is the key to reduce morbidity following any surgical procedure. Reduced blood loss has been shown to reduce the incidence of fistula [47].

Extent of Mobilization and Vascularity

Adequate mobilization of the gland for a tension-free anastomosis without compromising the vascularity of the pancreatic remnant reduces the rates of pancreatic fistula. While generally the pancreas is extremely vascular, ensuring adequate blood supply to the neck of the pancreas (vascular watershed area) has been highlighted by Strasberg et al. as a way to reduce incidence of POPF [48].

Pancreaticoenteric Anastomosis

Pancreaticoenteric anastomosis is necessary to avoid severe exocrine and endocrine deficiencies [49–51]. Tran et al.

observed increased incidence of diabetes mellitus with pancreatic duct occlusion [50]. The rates of fistula are higher following duct occlusion compared to pancreaticoenteric anastomosis [40, 50]. A number of pancreatic anastomotic techniques have evolved over the years with markedly improved results. The diverse options that continue to be employed for management of the pancreatic remnant after PD are an indication of a lack of universal agreement over a particular anastomotic technique.

Duct to Mucosa Versus Invagination

A duct to mucosa anastomosis avoids the direct contact of pancreatic juice with the cut surface of the gland reducing the rates of fistula. The rates of fistula are significantly lower in patients undergoing duct to mucosa anastomosis when compared to invagination [44, 52–55]. Bassi et al. in a prospective study showed no difference in the technique used [56]. Duct to mucosa anastomosis was considered in patients with dilated pancreatic duct and invagination in high risk patients with soft and friable pancreas with non-dilated duct [35]. However the current standard is a duct to mucosa technique irrespective of the texture and the size of the duct.

Pancreaticogastrostomy (PG) Versus Pancreaticojejunostomy (PJ)

There has been a debate regarding PG versus PJ, but the current evidence does not suggest superiority of one technique over the other [57–60]. It is possible to achieve fistula rates of less than 5–10 % irrespective of the technique used. Thus any anastomosis performed with fine sutures (for e.g. 4/0, 5/0 or 6/0 PDS) and minimal handling is most likely to yield a favorable outcome even in those situations where a fistula does ultimately occur. Standardization of the anastomotic technique and adherence to a single method can reduce the rates of fistula [54, 61]. It thus appears that the surgeon is one of the most, if not the most, important factor in prevention of a pancreatic anastomotic leak [62, 63].

Role of Magnification

The use of surgical loupes and operating microscopes by the surgeon has been utilized for the reconstruction of pancreatic remnant as duct to mucosa approximation is crucial for a favorable outcome. Traverso et al. highlighted the role of operating microscope and noted reduced incidence of fistula when compared with loupes (21 % versus 11 %) in high risk patients (duct size ≤ 3 mm) [64, 65].

Role of Stents

Placement of trans-anastomotic stents (either internal or external) has been associated with reduced rates of POPF. Stenting facilitates precise placement of sutures, diverts the pancreatic juice and avoids inadvertent duct occlusion thereby decreasing chances of severity of varying grades of POPF.

Internal stents have documented reduced rates of POPF in some prospective non randomized studies [66, 67] but on the other hand, stents have not been beneficial in some well designed studies [68, 69]. A recent meta-analysis by Zhou et al. (comparing internal pancreatic stents versus no stents) showed that stents did not reduce the risk of fistula but may even increase the risk of fistula in a soft pancreas [70].

External stents are placed across the anastomosis and brought out through the skin. Some prospective randomized [71–73], non-randomized studies and a meta-analysis showed external stents reduced the rates of pancreatic fistula when compared to no stents or internal stents [74–77]. In a recent meta-analysis by Hong et al. (external stents versus no stents) showed no difference in clinical outcome, but reduced the rates of POPF and related morbidity and hospital stay [77].

The use of transanastomotic stents should be left to the discretion of the operating surgeon as the evidence is conflicting. At our institution, the authors prefer a free internal stent (size smaller than the duct size) when the duct size is (< 3 mm) small and posteriorly located in a soft pancreas.

Role of Octreotide

Current evidence for the role of Octreotide in reducing pancreatic fistula is controversial. A meta-analysis by Zeng et al. does not recommend the use of Octreotide in pancreatic surgery [78]. A Cochrane review, however, recommends the use of somatostatin analogues in patients undergoing pancreatic surgery [79]. Despite conflicting evidence Octreotide is being widely used by many surgeons. The authors use it selectively in patients with high risk features like soft pancreas with a small duct. Octreotide is administered about an hour before the transection of the pancreatic neck and is continued in the post-operative period for 3 days. If the drain fluid amylase levels are higher on Day 3, octreotide is further continued till day 7.

Role of Fibrin Glue

Fibrin glue sealant has been used for haemostasis and as a tissue sealant. Initial studies have shown fibrin glue to reduce the incidence of POPF; however two prospective randomized studies showed application of tissue sealant on the surface of the pancreaticoenteric anastomosis showed no difference in the rates of POPF [80, 81].

Role of Omentum and Falciform Ligament

Use of omentum or the falciform ligament to wrap surrounding vulnerable structures to prevent direct contact with the

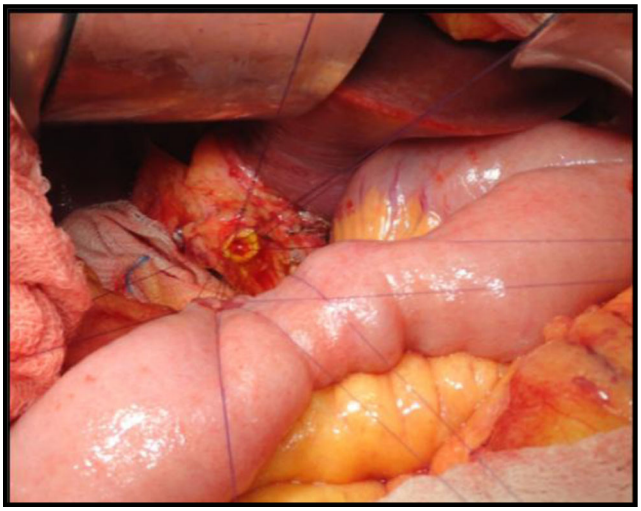

Fig. 2 Hepaticojejunostomy—anterior and posterior wall parachuting sutures ensuring duct to mucosa approximation

pancreatic juice is a simple and safe technique which has been widely followed. Occasionally this results in inflammation of the fat due to activation of pancreatic enzymes and can cause intra-abdominal collections. It has been shown to prevent post-operative hemorrhagic complications in various studies following pancreatic leak [82–84]. A retrospective study by Tani et al. revealed higher incidence of POPF in omental wrapping group compared to nonwrapping (42.8 % versus 37.3 %) [85]. However, some studies have shown a benefit in reducing the rate of perianastomotic collections [86, 87], but their role in reducing the incidence of POPF is questionable and need further studies.

DGE

DGE is one of the most common complications following a PD. It can be a troublesome complication adding to prolonged hospital stay and additional costs. DGE warrants the need for a radiological imaging to diagnose intra-abdominal collections. The incidence of DGE among different studies is 20–45 % [88–92]. The aetiopathogenesis of DGE has not been well understood and is multifactorial. Numerous studies have analyzed the clinical factors associated with DGE. The possible causes of DGE are pancreatic cancer itself as a disease [93], post-surgical complications resulting in inflammation [29], the type of gastric reconstruction performed after resection of the pancreatic head for pancreatic head cancer [94], and the extent of lymph node dissection [95, 96].

Diagnosis of DGE

DGE after PD has two aspects namely early gastric stasis and subsequent postprandial delayed emptying. A number of definitions have been employed to define immediate post-operative DGE. More than a specific cut off time limit, it appears that DGE is best defined as the unusually prolonged need for nasogastric suction after performance of a PD. Furthermore postprandial DGE has been defined as the inability of oral intake of more than a half of usual soft meals at 1 month post-operatively. The ISGPF defined and graded DGE into three groups A,B & C [97] depending on the need for an NGT > 3 days or reinsertion for persistent vomiting after POD 3 and inability to tolerate solid diet by day 7. The current definition has been validated by many authors across the globe and is being widely followed [91, 92].

Prevention of DGE

Definitive strategies for prevention of DGE are not clear, and decisions need to be individualized. Long duration of surgery, diabetic patients and an obstructed stomach are some of the clinical situations where it may be worthwhile to retain a nasogastric tube for durations longer than normal. Maintenance of electrolyte balance is another aspect that needs attention in the immediate post-operative period and these measures might prevent the development of DGE after a PD.

The initial studies showed a higher incidence of DGE in patients with pylorus preserving PD (PPPD) compared to classical PD [98, 99]. However, a Cochrane review by Diener et al. showed no difference between the two groups [100]. The route of reconstruction, antecolic or retrocolic also has an impact on the incidence of DGE. The performance of an antecolic duodenojejunostomy has been associated with a reduction in the incidence of DGE which has been shown in randomized and nonrandomized studies [94, 101–104]. Antecolic reconstruction when compared to retrocolic, DGE occurred in 10 % versus 22 % [105]. Role of prophylactic injectable erythromycin in reducing the incidence has been studied. Ohwada s et al. showed shorter duration of nasogastric drainage, an earlier resumption of oral intake and reduction in the incidence of DGE by 75 % following prophylactic low dose erythromycin [89]. A recent systematic review and meta-analysis by Qu et al. showed diabetes, POPF and post-operative complications increased the incidence while antecolic reconstruction and preoperative biliary drainage reduced the incidence of DGE [105]. POPF being an important risk factor for DGE, preventing pancreatic fistula leads to decreased incidence of DGE.

Hepaticojejunostomy (HJ) Leak

The incidence of biliary leaks after a PD varies between 2.2 % and 8 % [106–108]. Not many studies have particularly looked at failure of a HJ which can be a troublesome complication. A number of factors (advanced age, low serum total cholesterol, low serum albumin, impaired glucose tolerance, preoperative biliary drainage, size of the common hepatic duct

Table 2 Tata memorial hospital experience

Period	A 1992–2001	B Jan 2003–July 2009	C Aug 2009–Dec 2011	D Jan 2012–July 2013	Total
PPPD		205	141	126	472(75 %)
Classical	144	1	9		154(25 %)
Morbidity	41.7 %(60)	30 %(61)	29 %(44)	27 %(34)	31.7 %(199)
Mortality	6.3 %(9)	4.8 %(10)	5.3 %(8)	0 %(0)	4.3 %(27)
POPF	16 %(23)	8 %(16)	10.7 %(16)	18.2 %(23)	12.4 %(78)
DGE	6.9 %(10)	2.4 %(3)	2 %(3)	1.6 %(2)	2.8 %(18)
PPH	11.1 %(16)	5 %(10)	2 %(3)	0.8 %(1)	4.8 %(30)
Bile leaks	6.3 %(9)	3.4 %(7)	0.7 %(1)	0 %(0)	17(2.7 %)

and undone anastomotic leak test as intra-operative factors) were analyzed to evaluate the risk factors for the development of a bile leak from a dehiscence of hepaticojejunostomy. Except for an undone anastomotic leak test, none of the factors reached statistical significance [106]. The International study group of liver surgery (ISGLS) defined bile leaks in patients who underwent hepatobiliary and pancreatic surgery and graded them as A, B & C depending on the severity of bile leak and its impact on clinical management. Bile leak is defined as drain fluid bilirubin concentration thrice the serum levels or presence of any biliary collections or peritonitis requiring either radiological or surgical intervention [109]. The standardized technique of a single layer, end-to-side hepaticojejunostomy with fine absorbable sutures has resulted in minimizing this complication after PD. In patients with a non dilated hepatic duct, the preferred technique of anastomosis is parachuting the sutures ensuring precise duct to mucosa approximation (Fig. 2).

The Tata Memorial Hospital Experience

The Tata Memorial Hospital experience on PD over the past two decades is shown in Table 2 [5]. The overall post-operative morbidity and mortality following PD has been 31.7 % and 4.3 % respectively. However, with consecutive accumulating experience, there was been no peri-operative mortality over 2 years (126 PD's). The most common complication observed was POPF which was seen in 12.4 % patients. The ISGPF grades A, B & C of POPF since 2009 was 4.4 %, 6.8 % and 1.2 % respectively. Majority of these patients are managed conservatively, with help from dedicated interventional radiology. The incidence of DGE, PPH and biliary leaks was 2.8 %, 4.8 % and 2.7 %, respectively.

Summary

PD has evolved into a safe procedure more than ever before and yet a high morbidity persists. Pancreatic anastomotic leak carries a high morbidity and even mortality and hence its prevention is more crucial rather than its treatment which can still carry a high morbidity and mortality. Post-PD complications may be encountered even in centers with a high-volume. However, an enhanced ability to suspect, recognize early and treat complications in a systematic and prompt fashion may go a long way in making the difference between a major post-operative complication and death.

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