Pancreatic anastomosis after pancreaticoduodenectomy: how we do it

Shailesh V. Shrikhande · Jörg Kleeff · Markus W. Büchler · Helmut Friess

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Abstract While mortality following pancreaticoduodenectomy has progressively decreased over the last decade, its morbidity, especially the development of pancreatic fistula, has remained constant over the years. However, high volume centers and individual surgeons report a major decrease in the rate of post-operative pancreatic fistulas. Technical refinements are crucial to reduce, and if possible prevent, the development of pancreatic fistula. No uniformity of opinion exists as to the method of pancreatic anastomosis after resection and few reports provide a detailed description of the actual technique employed. This article illustrates step-by-step the technique of pancreaticojejunostomy as practiced by the authors. Apart from presenting our previously published experience, results from other centres around the world are also provided in this review article.

Keywords Pancreaticojejunostomy · Pancreatic reconstruction · Pancreaticoduodenectomy · Pancreatic head resection · Pancreatic fistula

Introduction

Pancreaticoduodenectomy remains the procedure of choice for treatment of periampullary and pancreatic head cancer. It represents a formidable challenge to the best of surgeons and mortality and morbidity following this surgery has historically been high. However, high volume experienced centers now report mortality rates of less than 1% [1, 2]. Despite improved results of pancreaticoduodenectomy, the morbidity figures still hover around 20–30% [3, 4]. The single most feared cause of morbidity is a leak from the pancreatic anastomosis with development of a pancreatic fistula and its associated complications [5].

Several methods of anastomosis of the pancreatic remnant have been described and no universal opinion exists in the world literature. However, it is perhaps the technique of anastomosis that is more important over other known factors that influence the formation of a pancreatic fistula after pancreatic head resection. Therefore, an illustrated step-by-step guide to performing a pancreaticojejunostomy is described in practical details and results of this technique are reviewed.

Technique

Division of the pancreatic neck

The pancreas is transected at the neck anterior to the superior mesenteric / portal vein. We always divide the parenchyma with a sharp knife after the pancreas has been stabilized with 4 stay sutures (Fig. 1). Every effort must be made to have a neat vertical transection and not an oblique one at different levels of the pancreatic parenchyma (Fig. 1). This can be avoided by steady successive strokes of the knife in the same plane that is created by the first stroke.

S. V. Shrikhande^{1,2} · J. Kleeff³ · M. W. Büchler² · H. Friess³ (✉)

¹Department of Gastrointestinal Surgical Oncology,
Tata Memorial Hospital,
Mumbai, India

²Department of General Surgery,
University of Heidelberg, Germany

³Department of Surgery,
Technische Universität München,
Munich, Germany

Tel: + 49 89 4140 2120

Fax: + 49 89 4140 4870

E-mail: helmut.friess@chir.med.tu-muenchen.de

With this technique of transection, the pancreas starts to bleed from 5–10 intra-parenchymal vessels with the first stroke of the knife itself and it is crucial for the second assistant to keep the operative field devoid of any blood by continuous suction so that the surgeon is transecting the pancreatic neck with complete control. The other major advantage of continuous suction is that the superior mesenteric and portal vein, that lie immediately posterior to the transection plane, are under constant vision of the operating surgeon.

Management of cut surface of the pancreatic remnant

It is our policy to control the inevitable haemorrhage from the pancreatic cut surface with sutures of 5–0 Novafil (B. Braun; Germany) with an atraumatic fine needle. Monopolar or bipolar coagulation are avoided on the pancreas.

Preparation of the pancreatic remnant for anastomosis

The pancreatic remnant is mobilized for 2 cm from the retroperitoneum. This is achieved by careful dissection posterior to the pancreas. For ease of this dissection, the two stay sutures (superior and inferior border of the pancreas) on the pancreatic remnant are gently lifted up by the first assistant (Fig. 1). Additionally, placement of a fine probe (or an infant feeding tube) into the pancreatic duct also helps in lifting up the remnant to aid posterior dissection.

The mobilization of the pancreatic remnant is necessary for placement of the posterior outer layer of sutures of the future pancreaticojejunostomy.

Compromised vascularity of the pancreatic remnant is not observed after this mobilization which is carried out in a completely avascular plane.

Pancreaticojejunal anastomosis

Step 1: Anterior ductal sutures

The first step involves placement of at least three sutures (number is variable depending on main pancreatic duct size) on the anterior wall of the duct. A point to note is that the sutures (5-0 PDS, Ethicon; Johnson and Johnson with atraumatic JRB – 1 (5/8) needle) must traverse the full thickness of the pancreatic parenchyma from the anterior pancreatic surface until the needle comes out from the anterior duct wall (outside in ductal stitches) (Fig. 2).

Step 2: Posterior ductal sutures

The second step involves a similar placement of sutures on the posterior wall of the duct. Here again one must ensure

that the sutures traverse the full thickness of the pancreatic parenchyma from the posterior wall of the duct until the needle comes out from the posterior pancreatic surface (inside out ductal stitches) (Fig. 3).

All sutures of step 1 and 2 are held long with needles intact for future use on the jejunal loop. To avoid confusion at a later stage, the anterior and posterior ductal sutures are kept in different layers separated by a sheet of operation towel or gauze.

Step 3: Posterior outer layer

The third step involves the placement of interrupted sutures (5-0 PDS, Ethicon; Johnson and Johnson with atraumatic JRB – 1 (5/8) needle) beginning on the posterior aspect of the mobilized pancreatic parenchyma and coming onto the seromuscular side wall of the jejunal loop (Fig. 4) that is brought up from the infracolic compartment to the supracolic compartment through an opening made in the transverse mesocolon. A point to note is that the posterior pancreatic cut margin is free of any sutures at this stage. These interrupted sutures are all tied at the end rather than at the beginning of this layer. This ensures that there is sufficient vision and space to place all the sutures precisely in a straight line on the posterior aspect of the pancreas. The sutures are tied very gently to ensure adaptation of the jejunum to the posterior pancreatic capsule some distance away from the posterior pancreatic cut margin without the stitches tearing through the capsule.

Step 4: Posterior inner layer

Step number four involves the placement of interrupted sutures to anastomose the posterior cut margin of the pancreas with the posterior wall (full thickness) of the now opened jejunum. The jejunum is opened with care to ensure that the jejunal opening is a little smaller in length than the superoinferior extent of the pancreatic remnant. We usually begin with sutures along the postero-inferior margin of the parenchyma and go upwards. However, this can also be done the other way around depending on the local situation. As one progresses upwards, the preplaced posterior ductal sutures (Step 2) are also used to ensure that the posterior wall of the pancreatic duct is now anastomosed to the jejunal mucosa posteriorly (Fig. 5).

Step 5: Anterior inner layer

This step involves the placement of interrupted sutures to anastomose the anterior cut margin of the pancreatic remnant with the anterior wall (full thickness) of the opened jejunum. Similar to the posterior duct sutures used in step 4, the preplaced anterior ductal sutures (Step 1) are also used to ensure that the anterior wall of the pancreatic duct is now anastomosed to the jejunal mucosa anteriorly (Fig. 6).

Fig. 1 Division of the pancreas with a sharp knife after stabilization of the pancreas with 4 stay sutures. Note that an oblique or jagged transection has been avoided.

Fig. 2 Anterior ductal sutures.

Fig. 3 Posterior ductal sutures.

Step 6: Anterior outer layer

This concluding step involves the placement of interrupted sutures beginning on the anterior aspect of the mobilized pancreatic parenchyma and coming onto the seromuscular side wall of the jejunal loop. As with the posterior outer layer that covers the posterior inner layer, the jejunal seromuscular layer covers the anterior inner layer and is approximated to the pancreatic parenchyma some distance away from the anterior border of the pancreatic cut margin (Fig. 7).

Thus, the completed anastomosis is an end to side duct to mucosa anastomosis with an outer seromuscular and inner full thickness layer.

Discussion

The principal aim of describing the technique of pancreaticojejunostomy in great detail is to highlight the importance of a meticulous technique. It may be the most important means to reduce the risk of, or even prevent the development of a pancreatic leak and fistula. The technique described ensures ideal conditions for healing of the

anastomosis – an excellent blood supply, an anatomical position with tension free approximation and unobstructed flow of pancreatic juice from the pancreas into the jejunal loop.

Blood Supply

Recently it was reported that extending the resection margin to the left of the medial margin of the superior mesenteric and portal veins ensures excellent vascularity of the pancreatic remnant [6]. After the pancreas has been divided anterior to the superior mesenteric and portal veins, we have never found vascularity of the pancreatic remnant to be a problem. The point to stress here is that irrespective of the underlying pancreatic pathology, it appears that vascularity is uncommonly compromised in the pancreatic remnant after pancreaticoduodenectomy. Another aspect that merits emphasis is the use of electrocautery. It is known to cause heat coagulation of tissues and therefore its use on the pancreas possibly affects tissue perfusion. Consequently, sutures through such a pancreas are unlikely to hold well. As mentioned before, we have avoided use of electrocautery on the pancreas at all times. However, whether to use

Fig. 4 Posterior outer layer.

Fig. 5 Posterior inner layer.

Fig. 6 Anterior inner layer.

Fig. 7 Completed anastomosis with anterior outer layer.

electrocautery or otherwise remains an individual decision all over the world.

Anatomical position

We have adapted to an end to side pancreaticojejunostomy. The method ensures that the jejunum and the pancreas, are lying in an anatomical position. This is crucial since an anastomosis of the pancreas, in particular the anastomosis of the digestive tract to a soft pancreatic parenchyma, is likely to be inherently unstable and even slight tension can have negative effects on its integrity. A number of studies

have reported excellent results with pancreaticogastrostomy [7, 8] and some trials comparing pancreaticojejunostomy and pancreaticogastrostomy have failed to demonstrate benefit of one method over the other [9, 10, 11, 12, 13]. Thus while no universal consensus exists [14], we prefer the two layer suture technique where an end to side pancreaticojejunostomy is more anatomical in the sense that it can be better tailored according to the form and texture of the pancreatic remnant. In our opinion, a secure anastomosis that comprises two layers of sutures is easier to perform with the thin walled jejunum lying in the same plane than a thick walled stomach lying anterior to the pancreas. Fur-

thermore, a pancreaticojejunostomy possibly requires less mobilization of the pancreatic remnant than that required in a pancreaticogastrostomy.

Tension free anastomosis

It has been suggested that the number of sutures may have an impact on the safety of the pancreatic anastomosis. We use very fine sutures but employ as many as required without hesitation. The usual distance between two sutures is 4–6 mm. The 5–0 PDS sutures with their fine needles ensure that the pancreatic capsule, pancreatic parenchyma, and the pancreatic duct are traumatized in the least while maintaining the integrity of the pancreatojejunal anastomosis. This is especially important when the pancreatic texture is soft and friable and the duct is small in caliber. Furthermore, these fine sutures are less likely to result in obstruction of the main pancreatic duct and hence pancreatic juice can flow freely into the jejunum. We still perform the pancreatic anastomosis without optical magnification, and even the smallest diameter pancreatic ducts can be anastomosed by the experienced surgeon. The use of operating ocular loupes may facilitate the reconstruction in some cases [6]. However, since the opening of the jejunum is rather large with the technique described, the preplaced ductal sutures can be easily intergrated in their corresponding jejunal layer. We do not stent the pancreatic anastomosis. Now there are some studies which show no benefit of stenting when a duct to mucosa anastomosis is performed [15]. However, one randomized controlled trial demonstrated that internal pancreatic duct stenting does not decrease the frequency or the severity of postoperative pancreatic fistulas [16], whereas another randomized controlled trial showed that external drainage of pancreatic duct with a stent reduces the leakage rate of the pancreatic anastomosis after pancreaticoduodenectomy [17]. Thus, like the use of electrocautery

on the pancreas, pancreatic duct stenting largely remains an individual surgeon's preference.

Outcomes of pancreaticojejunostomy – major series

There are a number of studies that have reported their results of pancreaticojejunostomy. The literature suggests that a meticulous duct to mucosa technique is more reliable in preventing a pancreatic leak and fistula as compared to other techniques such as dunking of the pancreatic stump into the jejunum [6]. Several techniques of pancreaticojejunostomy have been used with a low fistula rate. However, the majority of these institutions use a duct to mucosa anastomosis as the technical cornerstone. Our published experience indicates that technical details are crucial for the successful outcome of a pancreatic anastomosis [18, 19]. In our series of 331 pancreatic head resections, we had observed a 2% pancreatic fistula rate and the mortality rate was 0% [18]. While a large number have been observational studies, few have been randomized controlled trials. Table 1 [6, 11–13, 18–25] lists some of the major series of pancreaticojejunostomy after pancreaticoduodenectomy. More recently, the first author has published the experience from the Tata Memorial Hospital [25] with this identical technique (January 2003–April 2007). This series of 123 pancreaticoduodenectomies documented a 3.2% pancreatic fistula rate and an overall mortality of 3.2% but fistula related mortality was only 0.8% [25].

Conclusion

Pancreatic fistula remains a potentially serious complication following major pancreatic resections. The management of pancreatic fistula often requires further evaluation by CT scans and possibly CT guided drainage of pancreatic

Table 1 Major series of pancreaticojejunostomy (PJ).

Author	Ref.	Year	PJ (n)	Pancreatic fistula (%)	Mortality (%)
Marcus et al	20	1995	114	17	0.8
*Yeo et al	11	1995	72	11.1	0
Arnaud et al	21	1999	91	13	12
Büchler et al**	18	2000	331	2	0
Ohwada et al	22	2001	100	4	2
Strasberg et al	6	2002	123	1.6	0.8
Peng et al	23	2002	150	0	0
Schlitt et al	24	2002	191	12.6	5.2
*Bassi et al	12	2005	82	16	N.A.
*Duffas et al	13	2005	68	20	N.A.
Shrikhande et al**	25	2007	123	3.2	0.8%

*Randomized controlled trials comparing pancreaticojejunostomy with pancreaticogastrostomy.

** Authors published experience with the described technique

fluid collections. Apart from the risks to the patient and the eventual need for some sort of re-intervention, the hospitalization is prolonged and costs significantly increased. However, specialized centers now report a major reduction in fistula rates due to ongoing efforts to refine surgical techniques and improve perioperative management strategies. In conclusion, with a technique that is nearly standardized and yet easily adaptable to the individual pancreas, pancreatic anastomosis can only be expected to become increasingly safer in experienced hands.

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