Surgery for Pancreatic and Periampullary Carcinoma

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Received: 24 September 2015 / Accepted: 30 September 2015 / Published online: 10 October 2015
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Abstract Surgical resection for pancreatic and periampullary cancer has evolved over several decades. The postoperative mortality for these resections has declined to less than 5 %. However, morbidity associated with these resections is still considerable. Various technical modifications like pylorus preservation, reconstruction techniques and methods to perform pancreaticoenteric anastomosis have been suggested to improve postoperative outcomes after pancreaticoduodenectomy. Surgical modifications to improve oncological clearance and decrease fistula rates after distal pancreatic resections have also been suggested. Dilemma still exists whether interventions like pancreatic duct stents, octreotide and drains help to improve postoperative outcomes. The role of extended lymph node dissection and extended resections for pancreatic and periampullary cancer is still controversial, as is the management of borderline resectable pancreatic cancer. In this review, we discuss the literature pertaining to various surgical aspects of pancreatic and periampullary carcinoma.

Keywords Periampullary · Pancreatic · Carcinoma · Surgery

Introduction

Surgery for pancreatic and periampullary carcinoma is associated with a mortality of <5 % but is still associated with a morbidity of up to 40 % at high volume centres [1, 2]. Postoperative pancreatic fistula (POPF) is the most dreaded complica-

tion after pancreatic resections and ranges from 10 to 17 % even at high-volume centres [3, 4]. Various perioperative and surgical interventions have been proposed to lower the rate of POPF. These include the use of pancreatic duct stents and prophylactic octreotide. There is an ongoing debate as to which reconstruction method, pancreaticogastrostomy (PG) or pancreaticojejunostomy (PJ), is better at preventing POPF. Also, there are various techniques to choose from when performing a PJ or PG. Surgery for distal pancreatic cancers is associated with issues such as of high incidence of POPF and margin-positive resections. There is an ongoing debate with regard to the best method for the closure of pancreatic stump. Radical antegrade modular pancreaticosplenectomy (RAMPS) has been proposed to offer a better oncological clearance. Both lymphadenectomy and en bloc resection of involved organs are important for oncological clearance of pancreatic and periampullary cancer. The optimal extent of lymph node dissection has only been recently defined. Similarly effort has been made to determine what constitutes an extended pancreatic resection. The boundaries for resection of pancreatic cancer have expanded by defining “borderline resectable” group of pancreatic cancers. Surgery for these tumours can be done either upfront or after neoadjuvant therapy, although there is still no consensus on the best way to approach these tumours.

Pancreaticoduodenectomy for Pancreatic and Periampullary Cancer

Conventional Versus Pylorus-Preserving Pancreaticoduodenectomy

The conventional preserving pancreaticoduodenectomy (CPD) and pylorus-preserving pancreaticoduodenectomy (PPPD) were popularized by Whipple et al. in 1935 and

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Traverso and Longmire in 1980, respectively [5, 6]. The difference between the two procedures is the point of proximal luminal transection. In a CPD, distal stomach is transected along with the pylorus, whereas in PPPD, the pylorus along with 2-cm segment of duodenum is preserved. PPPD is associated with a better gastrointestinal quality of life (nausea, diarrhoea and postoperative weight gain) and lower reflux [7, 8]. On the other hand, pylorus preservation has been shown to contribute to delayed gastric emptying (DGE) [9]. A number of randomized controlled trials (RCTs) comparing the short- and long-term outcomes of these procedures have been conducted over almost two decades. A recent Cochrane review compared PPPD and CPD for pancreatic head and periampullary carcinoma [10]. Six RCTs and 465 patients were included. The various outcome measures included morbidity, mortality, blood loss, transfusion requirement, duration of surgery, length of stay, quality of life and survival [10]. There was no difference in the incidence of POPF, DGE and biliary leak between the two groups, although both POPF and DGE were not uniformly defined in any of the included studies [10]. The overall postoperative morbidity and mortality were also similar between the two groups [10]. PPPD was associated with a significantly lower blood loss and operative time, whereas the transfusion requirement was similar [10]. The length of stay, quality of life and survival were similar in the two groups [10]. The authors were of the opinion that the two procedures are comparable although PPPD is associated with a reduced blood loss and shorter operative time. However, larger and better designed RCTs with clearly defined endpoints and outcome measures are required to compare the two procedures [10]. Most surgeons prefer PPPD for pancreatic head and periampullary tumours and restrict CPD to a situation where disease is involving the first part of duodenum.

Pylorus-Resecting Pancreaticoduodenectomy Versus Pylorus-Preserving Pancreaticoduodenectomy

The preservation of pyloric ring in PPPD contributes to DGE. Pylorus-resecting pancreaticoduodenectomy (PRPD) involves resection of the pyloric ring with preservation of 95 % of stomach [11]. PRPD has been compared to PPPD in a RCT and found to be associated with a significant decrease in the incidence of DGE [12]. In a prospective study, DGE has been associated with poorer long-term outcomes like weight loss and poor nutritional status [11]. A recent meta-analysis has compared PRPD and PPPD and found that the former is associated with a longer operative duration, increased blood loss and transfusion requirement but decreased incidence of DGE [13]. However, due to the limited available data, the authors recommended performance of high-quality RCTs in the future [13].

Reconstruction After Pancreaticoduodenectomy

Techniques of Pancreaticojejunostomy

Duct to Mucosa Pancreaticojejunostomy

The technique of PJ performed at our centre has been described in detail by Shrikhande et al. [14]. The duct to mucosa PJ involves suturing the pancreatic duct to the jejunal mucosa using fine sutures. The jejunal limb is brought next to the pancreatic stump in a retrocolic fashion. Initially, ductal sutures, usually six in number, three anterior and three posterior, are placed, ensuring generous bites of pancreatic parenchyma. This is followed by creating an outer posterior layer, incorporating the posterior pancreatic parenchyma and seromuscular layer of jejunum. Thereafter, an enterotomy is created in the jejunal limb and the inner posterior and inner anterior layers between the pancreatic duct and jejunal mucosa are completed. The outer anterior layer is the replica of the outer posterior layer.

Invagination Pancreaticojejunostomy

The aim of this technique of PJ is to invaginate the pancreatic stump into the jejunal lumen. The outer posterior layer is the same as mentioned in the duct to mucosa PJ. After creating an enterotomy in the jejunum, the second and third layers are completed in a continuous or interrupted manner ensuring generous bites of pancreatic parenchyma and full-thickness jejunum taking care to not to incorporate the ductal mucosa in these bites. This is followed by an outer anterior layer which, along with the outer posterior layer, ensures that the stump is “dunked” into the jejunal lumen.

Beger et al. compared these two techniques in a randomized trial wherein 197 patients were stratified according to the texture of pancreatic parenchyma [15]. The overall POPF rate was 17.8 %. POPF developed in 24 % in the duct to mucosa vs. 12 % in the invagination group ($p < 0.05$). The only risk factor for POPF was soft texture of pancreas (POPF rate 8 % with hard versus 27 % with soft gland). The authors recommended additional studies to choose between the two techniques [15].

Binding Pancreaticojejunostomy

Peng et al. described a new technique of PJ whereby the distal 3 cm of the jejunal limb is everted and the mucosa is ablated [16]. The pancreatic stump is thereafter invaginated into a jejunal limb so as to bring the pancreatic surface in contact with the denuded mucosa, and the approximation is mainly achieved by tying a catgut suture approximately 1 cm proximal to the cut end of jejunum [16]. Peng et al. have reported a 0 % POPF rate using this technique and have also compared

their technique with the conventional PJ in a RCT [16, 17]. Their technique was associated with significantly better outcomes in terms of POPF (0 vs. 7.2 %) and morbidity (24.5 vs. 36.9 %) [17]. However, the same has not been shown in studies done at European centres [18, 19]. The comparison of the two techniques in one case-controlled and another prospective study has shown no difference in POPF rate; rather, binding PJ resulted in delayed healing and an increase in post-pancreatectomy haemorrhage in case of a POPF [18, 19]. Duct to mucosa and invagination PJ have been found to comparable with respect to POPF, reexploration and mortality in a recent meta-analysis [20]. The same study has also found comparable results for binding and conventional PJ [20].

The surgical tenets of proper haemostasis, tissue viability, lack of tension, meticulous tissue handling, proper tissue apposition and use of fine suture material ensure healing of the pancreatic anastomosis than the technique itself [21]. A surgeon should continue to practice and master one technique rather than trying out different techniques and ending up mastering none. Standardization of anastomotic technique helps reduce POPF, and in a study from our centre, the POPF reduced from 16 to 3.2 % [22].

Techniques of Pancreaticogastrostomy

Pancreaticogastrostomy (PG) was first performed by Waugh et al. in 1944 [23]. Since then, various modifications of PG have been described. PG can be performed by dunking or telescoping the pancreatic stump into the gastric lumen, performing a duct to mucosa anastomosis or binding the gastric wall over pancreatic stump. PG has been performed using mattress sutures between gastric wall and pancreas in a 'U'-shaped fashion that allows invagination of pancreatic stump into gastric lumen [24]. The pancreatic stump can be also be anastomosed to stomach in a duct to mucosa fashion with or without the use of pancreatic transfixation sutures [25, 26]. Peng et al. have suggested binding PG and have described four types [27]. An anterior gastrostomy is performed in types I and II and avoided in types III and IV [27]. However, binding PG is a difficult technique. Barsch et al. described a technique using a combination of trans-pancreatic mattress sutures and a binding purse string [28]. A prospective study describes a simpler technique for soft pancreas. Anastomosis is performed with the aid of two hemistitches on the gastric wall without any trans-pancreatic sutures, thus avoiding the possibility of a pancreatic laceration. The use of this technique resulted in POPF rate of 2.2 % [29]. A new technique for PG with gastric partition was described by Fernandez-Cruz et al. [30]. A 10–12-cm gastric tube is created by firing a stapler approximately 3 cm from the greater curve, and this is used for PG [30]. This technique was associated with a significant reduction of POPF and morbidity as compared to PJ in a RCT [30].

However, none of the techniques of PG has been compared in RCTs, and thus, it is difficult to choose one over the other.

Pancreaticojejunostomy Versus Pancreaticogastrostomy

The proposed advantages of PG include a better blood supply of stomach, inactivation of pancreatic enzymes by the acidic gastric contents and lesser tension than PJ in case that the pancreatic transaction is to the left, all of which allow for a better anastomotic healing. An initial RCT by Bassi et al. revealed a significant decrease in the postoperative fluid collection, DGE and biliary leak with PG [31]. However, Bassi et al. and another RCT by Duffas et al. revealed similar POPF rates [31, 32]. A multi-centric RCT in which the patients were stratified based on duct size revealed a significantly lower clinically significant POPF in PG group [33]. The earliest meta-analysis, in which the senior author participated, compared PJ and PG and found both procedures to be equivalent [34]. The authors also highlighted the importance of conducting well-designed RCTs [34]. The latest meta-analysis by Menahem et al. included seven RCTs and showed significantly lower rates of POPF and biliary fistula in PG group [35]. Another meta-analysis has shown a decrease in the risk of fistula developing by 10 % in high-risk group using PG [36]. The result of these meta-analyses proves PG to be superior to PJ for prevention of POPF and could thus be considered as the preferred reconstruction technique especially in high-risk cases. However, the final word is not spoken as yet. This is because all the meta-analyses suffer from heterogeneity and PG may not be considered superior to PJ since the overall morbidity, reoperation rate, hospital stay and mortality have not been different despite lower rates of POPF following PG.

Isolated Versus Dual (Roux)-Loop Reconstruction

The conventional technique of reconstructing the alimentary tract, also called the isolated or single-loop reconstruction, after pancreaticoduodenectomy (PD) involves the performance of PJ or PG followed by hepatico-jejunostomy and gastrojejunostomy. The dual or Roux loop reconstruction that isolates the pancreatic anastomosis from the biliary and gastric anastomosis was first described in 1976 by Macado et al. [37]. The separation of pancreatic and biliary secretions avoids the activation of pancreatic secretions. This ensures better healing of pancreatic anastomosis and prevents the further aggravation of a pancreatic fistula and its sequel in the event of a leak. Retrospective series have shown a reduction in morbidity and mortality with the use of the dual-loop reconstruction [38, 39]. A recent meta-analysis that included three RCTs and four clinical controlled trials has shown that the two methods are similar with respect to POPF rates, morbidity and mortality

[40]. The dual-loop reconstruction is associated with a longer operative duration and an additional anastomosis [40]. The choice of reconstruction should therefore be based on the experience of the surgeon and the results of that particular centre.

Measures to Prevent Postoperative Pancreatic Fistula

Role of Pancreatic Duct Stenting

Pancreatic anastomosis is the Achilles heel of PD, and POPF is the main determinant for postoperative outcomes after PD. A pancreatic stent that is usually aimed at diverting the pancreatic juice internally or externally, away from the anastomosis, has been employed as one of the preventive strategies. A recently published Cochrane systematic review included 502 patients and three RCTs comparing stents versus no stents [41]. The POPF rate in all the individual studies was lower with the use of a pancreatic stent. However, overall, no significant difference was noticed in the risk of pancreatic fistula, in-hospital mortality, reoperation and wound infection rates between the two groups, but external stents resulted in a shorter hospital stay [41]. One of these three RCTs, with 234 patients, which compared the use of internal versus no stent, found no significant difference in the pancreatic fistula, in-hospital mortality, reoperation and wound infection rates between the two groups [42]. The other two RCTs, including a total of 278 patients, compared external versus no stent [43, 44]. In one of these two trials, only patients with soft pancreas and duct size <3 mm were included [43]. The use of external stents did not affect the in-hospital mortality and reoperation rates but significantly reduced POPF rate, morbidity and hospital stay [43, 44]. Another recent RCT, not included in this meta-analysis, compared external versus no stent in 93 patients [45]. There was a significant decrease in clinically significant POPF in the stented group and also in stented patients with a non-dilated duct [45].

Two RCTs included in this meta-analysis have compared internal and external stents; however, the results with their use were not statistically different [41]. However, a recent RCT compared external and internal stents and found a significant reduction in the POPF, overall morbidity and individual morbidities with the use of external stents [46]. The existing evidence suggests that the use of external stents might reduce the POPF rate, morbidity and hospital stay after PD whereas there is insufficient evidence to support the use of internal stents. However, not all studies analyzed the results based on consistency of pancreas and duct size, the main risk factors for development of POPF.

Role of Prophylactic Octreotide

The question regarding prophylactic administration of octreotide after pancreatic surgery remains unanswered. Four European multi-centre placebo-controlled RCTs demonstrated that prophylactic administration decreased the postoperative complications and POPF rate [47–50]. However, these trials included all pancreatic resections and had a high POPF rate in the placebo group and the mortality in the two groups was similar [47–50]. Yeo et al. studied the role of octreotide in patients undergoing PD in a RCT [51]. There was no difference in the morbidity, mortality, POPF or length of hospital stay between the two groups [51]. Moreover, the use of octreotide incurred an additional cost of \$75/day [51]. Two other placebo-controlled RCTs assessed pancreatic juice output and DGE as primary endpoints along with other secondary endpoints [52, 53]. One of these trials reported a significant reduction in the length of stay and complications with octreotide administration, while there was no benefit in the other trial [52, 53]. The recent Cochrane review on the role of octreotide has included 19 RCTs and 2245 patients [54]. This trial demonstrates a decrease in postoperative complications and pancreatic fistula with the use of somatostatin or its analogues [54]. However, there was no difference in the reoperation rate, the length of stay or clinically significant POPF [54]. However, 17 of the 19 RCTs had a high-risk bias and subgroup analysis for the type of pancreatic surgery was not possible. The authors thus concluded in favour of prophylactic octreotide administration for pancreatic surgeries but called for high-quality RCTs to further confirm its role [54]. The role of prophylactic octreotide administration needs to be further studied in high-quality RCTs with clearly defined endpoints and outcome measures and also stratified as per the type of pancreatic resections, pancreatic texture and size of the pancreatic duct.

Role of Drains

The prophylactic drainage after pancreatic surgery is a debatable issue. The proposed advantages of drainage after pancreatic resections include an early detection of leaks, collections or haemorrhage [55]. They also help in drainage of postoperative collections, thus avoiding the need for an intervention. However, prophylactic drainage can lead of an increase in infective complications [56]. There have been several observational studies and two RCTs evaluating the role of prophylactic drainage. The prospective RCT conducted by Conlon et al showed that although the placement of drain was not associated with an increase in major complications, intervention, reoperation and length of stay but it did increase the infectious complications. [56]. However, a recent multi-centric RCT by Van Buren et al. revealed an increase in frequency and severity of infective complications without drainage after

PD [57]. A recent meta-analysis comparing prophylactic drainage vs. none included two RCTs, one case control and six observational studies [58]. Prophylactic drainage was not associated with a decrease in POPF, intervention, reoperation and length of hospital stay overall [58]. However, a lack of prophylactic drainage was associated with non-significant increase in mortality after all pancreatic resections, a significant increase in mortality after PD and a decrease in POPF rates [58]. However, the drainage group was associated with a higher morbidity overall and also after PD [58]. The higher rate of POPF in the drainage group could be due to the tissue damage caused by the negative suction [58]. Some authors have proposed a selective no drainage approach in patients at a low risk of POPF while others have proposed an early removal of drain [59, 60]. An encouraging trend towards lesser use of drains is also possible due to the high success rate of image-guided interventions [61]. In one of our studies, we showed that drains help in identifying 62 % of complications after major upper gastrointestinal surgery [62]. The use of two drains did not provide any advantage, rather increased hospital stay, and hence, a single drain was sufficient [62]. However, the role of prophylactic drainage is still not clear due to the conflicting results of the two RCTs. There is no evidence as of now to suggest that drains cause harm or impair quality of life. Though better evidence is awaited, the use of drains as of now should be individualized and based on the audit of a centre's data [63].

Distal Pancreatic Resections

Radical Antegrade Modular Pancreaticosplenectomy

The conventional distal pancreaticosplenectomy which involves dissection from left to right is associated with shortcomings like inability to obtain R0 resection especially along the posterior plane, inadequate lymphadenectomy, late control of the vasculature and improper visualization of the posterior plane during dissection [64]. A modified technique for distal pancreatic tumours especially medially placed body tumours was proposed by Strasberg et al. in 2003 [65]. Strasberg et al. proposed that this can be achieved by modulating the posterior dissection plane, either anterior (anterior RAMPS) or posterior (posterior RAMPS) to the left adrenal gland and Gerota's fascia [65]. Based on the work of O'Morchoe, the lymphadenectomy for a distal pancreatic tumour includes removal of nodes along the superior and inferior border of pancreas, gastroduodenal, inferior pancreatic, splenic, gastrosplenic, celiac and those anterior and to the left of superior mesenteric artery [65]. A good-quality computed tomography (CT) scan helps in planning the plane of dissection preoperatively. The choice of anterior versus posterior RAMPS is based on whether the tumour breaches the posterior pancreatic capsule or not. A posterior RAMPS is

chosen for the former and anterior RAMPS for the latter. The dissection starts medially and involves an early division of the neck of pancreas and ligation of the splenic vessels [65]. The plane of dissection then continues posteriorly to the celiac and superior mesentery artery along the aorta and thereafter laterally and modulated as per the tumour extent [65] (Fig. 1). All the non-peritonealized margins, for example, the posterior, superior and inferior, should be inked for a standardized pathology reporting as stressed by Strasberg et al. [64]. Strasberg et al. have earlier reported a negative tangential margin rate of 91 % and a median nodal yield of 15 using RAMPS in 23 patients [64]. They have recently reported an excellent 5-year overall survival of 35 % using RAMPS in 73 patients [66]. These are superior to the 5-year survival reported with standard distal pancreatic resections ranging from 10 to 19 % [67, 68]. The eastern series, which have employed RAMPS, have reported survival rates similar to those reported by Strasberg et al. [69, 70]. The ideal way of comparing the conventional approach and RAMPS is by a RCT, requiring 228 patients per group to test the proposed difference in survival as suggested by Strasberg et al. [66]. Based on these results, RAMPS seems to be a better oncological approach for distal pancreatic tumours, although more evidence supporting this procedure is warranted.

Techniques for Closure of Pancreatic Stump After Distal Pancreatic Resections

Distal pancreatic resections are associated with a high risk of pancreatic fistula. Two main techniques of stump closure

Fig. 1 Intraoperative photograph after RAMPS: red arrow—SMA, small red arrow—celiac axis, red arrowhead—common hepatic artery, green arrowhead—ligated splenic artery, blue arrow—portal vein end-to-end anastomosis and yellow arrowhead—pancreatic stump

include stapled and suture closure with or without individual pancreatic duct ligation. Two large western series have found that POPF rate remains the same irrespective of the technique used and ranges between 24 and 33 % [71, 72]. The DISPACT, a multi-institutional RCT, did not reveal any difference in the rate of POPF and mortality between the stapled and suture closure groups [73]. A recent meta-analysis of 37 studies has shown that stapled closure significantly reduces POPF when compared to suture closure. It also showed that anastomotic closure and a combination of stapled and suture closure were better than suture closure alone [74]. A RCT comparing distal pancreatectomy with or without prophylactic stenting has found no difference in the POPF rate [75]. Mesh reinforcement of the stapled stump has been shown to reduce the POPF rate significantly in a recent RCT (1.9 vs. 20 %) [76]. However, more robust evidence is needed to be sure if this new method actually helps to reduce POPF significantly.

Extent of Lymphadenectomy

The extent of lymphadenectomy for pancreatic cancer is a controversial topic. Till date, four RCTs have compared standard and extended lymphadenectomy though the extent of lymph node dissection has varied amongst studies. Pedrazzoli et al. reported the first multi-centric RCT, which showed that extended lymphadenectomy can be performed without any added morbidity and mortality [77]. The overall survival was similar between the two groups; however, there was a trend towards an improved survival with extended procedures in node-positive patients [77]. In another RCT from John Hopkins, extended lymphadenectomy was associated with an increased morbidity and operative time without an improvement in 5-year overall survival [78]. The third trial from Mayo clinic reported a drop in quality of life without any improvement in survival with the addition of extended nodal dissection [79]. The latest multi-centric Japanese trial again failed to show any survival benefit [80]. A recent International Study Group for Pancreatic Surgery (ISGPS) consensus statement has defined what constitutes a standard lymph node dissection for pancreatic head and periampullary carcinoma as per the nodal stations described by the Japanese Pancreatic Society [81]. A standard lymphadenectomy for a pancreatic head tumour includes stations 5, 6, 8a, 12b, 12c, 13a, 13b, 14a, b (along the right side of superior mesenteric artery (SMA)), 17a and 17b [81]. The stations 7, 9, 10 and 11 are not a part of standard lymphadenectomy [81]. The inclusion of para-aortic lymphadenectomy is still controversial. Positive para-aortic node has been associated with a poor survival in some studies, whereas it does not impact the survival according to others [82–84]. The decision regarding proceeding with resection or bypass on encountering a positive para-aortic node should be based on comorbidity, age, tumour growth into the vessels and CA 19-9 level [81]. Similarly,

lymphadenectomy for distal pancreatic cancers includes stations 10, 11 and 18 with inclusion of station 9 in case of body tumours [81]. This definition of standard lymphadenectomy can be helpful in proper conduct and reporting of trials in the future.

Extended Pancreatic Resections

An extended pancreatic resection refers to an additional en bloc resection of an adjacent organ or vasculature. Various studies have compared the outcomes of extended resections to standard ones. The extended resections are associated with a higher morbidity, increased operative time, blood loss and transfusion requirement, a longer ICU and hospital stay although the mortality has been similar in most studies [85, 86]. The role of these resections is difficult to define due to small numbers, heterogenous patient population and retrospective nature of the studies. Long-term outcome with these resections has been found to be similar to standard resections, and this is certainly better than palliative surgery [85, 87]. Thus, an extended resection is justified if it ensures a R0 resection and if it can be performed at an acceptable morbidity and low mortality since it is associated with long-term survival. Till now, there was no definition of what qualifies as an “extended pancreatic resection”. A recent ISGPS consensus statement has provided definition of extended pancreatic resections with the aim of use in future trials [88].

Surgery for Borderline Resectable Pancreatic Cancer and Superior Mesenteric Artery First Approach

Borderline pancreatic tumours comprise of a group of tumours with venous and limited arterial involvement and thus amenable to resection. However, surgery for this group is associated with an increase in margin positivity and need for vein resection [89]. It has been shown in a prospective study from our centre that the radiological findings including extent of circumferential contact and venous deformity can predict vein resection [90]. The proposed treatment strategies include upfront surgery or surgery after neoadjuvant treatment. In a systematic review, vein resections have been associated with a poor 5-year survival [91]. However, as per a recent meta-analysis, long-term survival for vein resections is similar to standard resections, and therefore, upfront resection for borderline tumours is justified, and this view is also supported in a recent ISGPS consensus statement [92, 93]. The neoadjuvant approach allows early initiation of systemic treatment, helps in assessing in vivo response, causes tumour downstaging to allow R0 resection and selects out the patients with progressive disease. The neoadjuvant treatment does not increase the morbidity or mortality of the pancreatic resection. However, the true impact of neoadjuvant treatment is not known for this

group of patients and there is no level I evidence that neoadjuvant treatment is superior to upfront resection [93].

Though the vein can be resected and reconstructed, arterial resections are not routinely recommended in case of pancreatic carcinoma [94]. Therefore, it is important that arterial involvement be ruled out at an early stage in surgery before proceeding with the irreversible steps. This can be done using one of the “artery first” approaches [95]. Six approaches have been described. Each of these allows the exposure of SMA and is based on the tumour location. These include posterior, medial or uncinate-first, inferior infracolic or mesenteric, left posterior, inferior supracolic and superior approaches [95]. In a prospective comparative study from Tata Memorial Hospital, the uncinate process first approach was found to be comparable to combined uncinate process and SMA first approach [96].

Compliance with Ethical Standards

Conflict of Interests The authors declared that they have no conflict of interest.

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