1 Pancreatoduodenectomy: Total Mesopancreas Excision Approach

Xu-An Wang and Ying-bin Liu

1.1 Introduction

In 2012, Adham et al. [1] firstly described the application of Total Mesopancreas Excision (TMpE) Approach (Figs. 1.1 and 1.2), for the carcinoma of head of pancreas, which was based on the concept of total mesorectal excision [2]. They defined the contents in the region for the excision to be formed by the superior mesenteric vein, portal vein, superior mesenteric artery, and celiac trunk of the aorta, and they called this region as the "mesopancreas triangle." Totally 52 patients using the posterior approach of total mesopancreas excision (TMpE) for pancreatic head cancer were reported by them with a very high R0 resection rate of 80.7%, and the 5-year survival rate was significantly improved [1].

However, in the following years, only few reports have demonstrated the role of TMpE for pancreatic head carcinoma. In our center, the relevant clinical study was initiated in 2010, and the findings from 75 cases were quite encouraging [3, 4]. We further divided the concepts of TMpE into the anterior and posterior mesopancreas parts (Fig. 1.3), which were included in the en bloc resection of pancreatic head carcinoma.

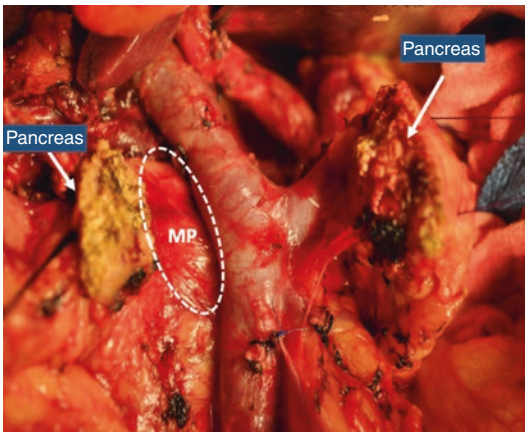

Fig. 1.1 The mesopancreas (*MP* mesopancreas)

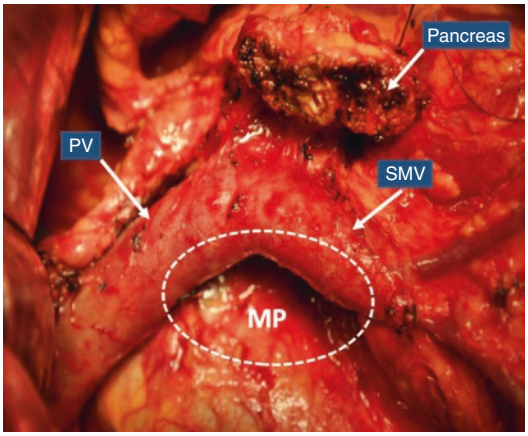

Fig. 1.2 The mesopancreas (*MP* mesopancreas, *PV* portal vein, *SMV* superior mesenteric vein)

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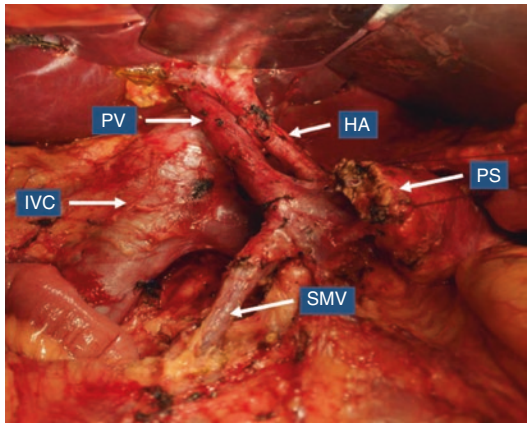

Fig. 1.3 Overview of the anterior and posterior mesopancreas parts (*HA* hepatic artery, *IVC* inferior vena cava, *PS* pancreatic stump)

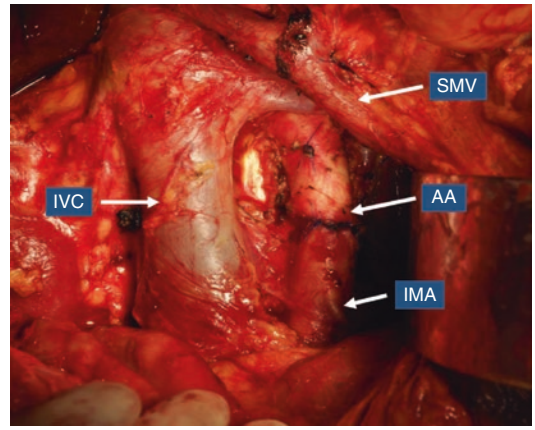

Fig. 1.4 The inferior boundary of the posterior mesopancreas (*AA* abdominal aorta, *SMA* superior mesenteric artery)

The anterior mesopancreas [3, 4] primarily consists of (1) the anterior leaf of the transverse mesocolon on the right side of the middle colic vein, (2) the greater omentum on the right side of the gastroepiploic artery, (3) the lesser omentum and portal vein to the right of the left gastric vein, (4) the region around the proper hepatic artery, (5) the lymphatic and adipose tissues around the hepatic artery, as well as (6) the antrum, duodenum, common bile duct, and their adjacent tissues. Excision of the anterior mesopancreas focuses on dissection and removal of lymphatic tissues.

The inferior mesenteric artery is used as the inferior boundary of the posterior mesopancreas [3, 4] to dissect all connective tissues around the inferior mesenteric artery (Fig. 1.4). On dissection of the abdominal aorta superiorly, a point of 2 cm above the celiac trunk forms the upper boundary of the posterior mesopancreas dissection (Fig. 1.5). All the connective tissues around the celiac trunk should be removed. Care should be taken to clear all the connective tissues between the upper and lower boundaries and between the inferior vena cava and the abdominal aorta (Fig. 1.6). The left gonadal vein is used as the left posterior boundary for excision of the mesopancreas, and the left anterior boundary is formed by the inferior mesenteric vein (Fig. 1.7). There are numerous nerve plexuses in the connective tissues behind the superior mesenteric artery and

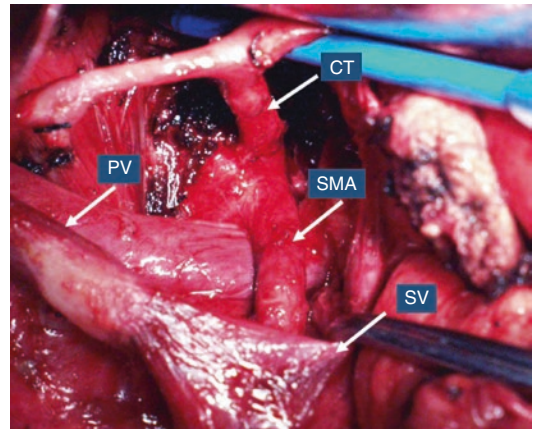

Fig. 1.5 The upper border of the posterior mesopancreas (*CT* celiac trunk, *SV* splenic vein)

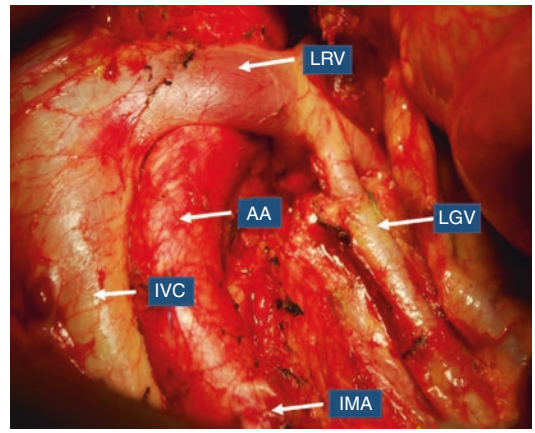

Fig. 1.6 Posterior border of posterior mesopancreas (*LGV* left gonadal vein, *LRV* left renal vein)

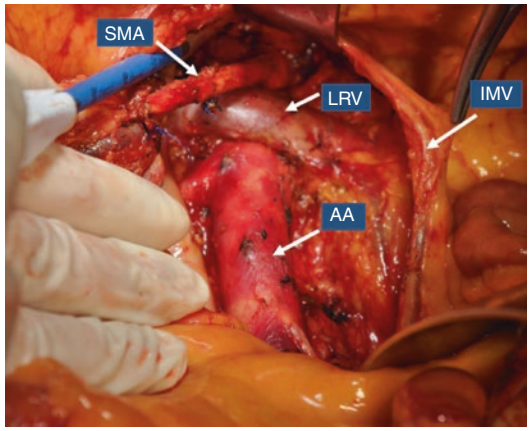

Fig. 1.7 The left anterior boundary of posterior mesopancreas (*IMV* inferior mesenteric vein)

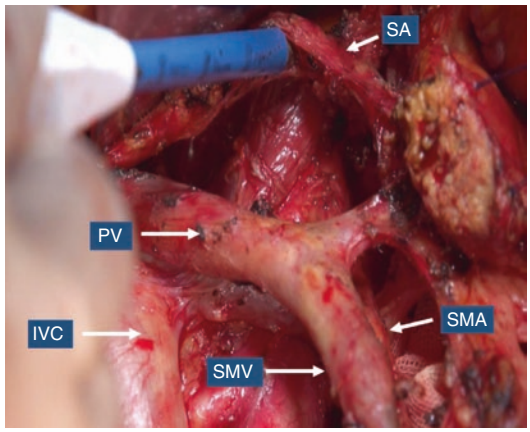

Fig. 1.8 The clearance of anterior and posterior of mesopancreas (*SA* splenic artery)

in front of the abdominal aorta and inferior vena cava [1–4]. Thus, the posterior mesopancreas excision is primarily dissection and removal of nerve plexuses.

The excision of the anterior and posterior mesopancreas targets the two primary sites of lymphatic metastasis and posterior nerve plexus invasion by pancreatic head cancer. A successful dissection of all these regions accomplishes the goal of en bloc excision of the anterior and posterior mesopancreas with clearance of all these tissues included (Figs. 1.8 and 1.9): (1) posterior to the pancreatic head, (2) posterior to the superior mesenteric vein-portal vein, (3) around the superior mesenteric artery, and (4) around the celiac trunk and the abdominal aorta.

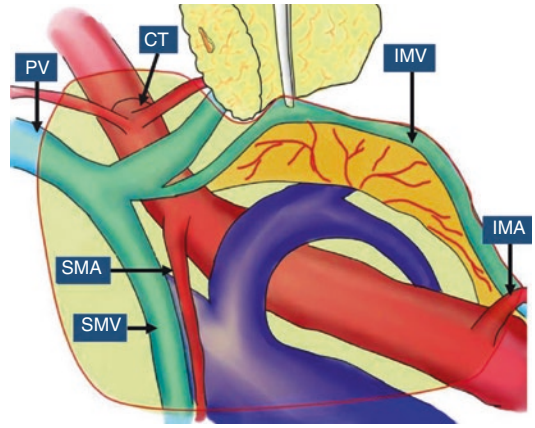

Fig. 1.9 The clearance of anterior and posterior of mesopancreas

1.2 Case

The patient was a 51-year-old man admitted to our hospital because of skin and sclera yellow stained for more than 1 month. Laboratory examinations showed an elevation of liver function tests: total bilirubin (TB) 112.7 μmol/L, direct bilirubin (DB) 88.1 μmol/L, aspartate aminotransferase (AST) 437 U/L, alanine aminotransferase (ALT) 1022 U/L, alkaline phosphatase (ALP) 254 U/L, and r-glutamyl transpeptidase (r-GTP) 1934 U/L. The tumor marker CA19-9 was increased to 183.1 kU/L, and others were normal.

The abdominal ultrasonography (US) and abdominal computed tomography (CT) showed a mass in the head of the pancreas, and a dilation of common bile duct and pancreatic duct. Pancreatic head adenocarcinoma was considered (Fig. 1.10). Same image was revealed by the abdominal magnetic resonance image. The digital reconstruction of 3D images was performed to observe the correlation of this mass and the portal vein, SMA, and SMV (Fig. 1.11).

From these findings, a diagnosis of pancreatic duct adenocarcinoma located in the head was made, and TMpE approach for pancreatoduodenectomy was performed.

Informed consent was obtained from all participating patients, and the ethics committee of Xinhua Hospital, Shanghai Jiaotong University School of Medicine approved this study.

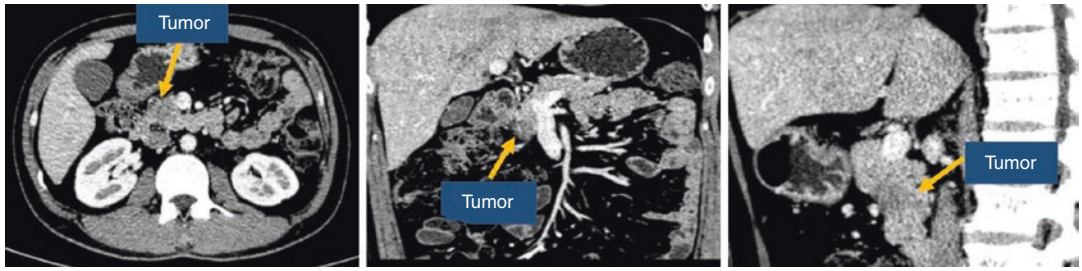

Fig. 1.10 CT image showed a mass in the head of the pancreas

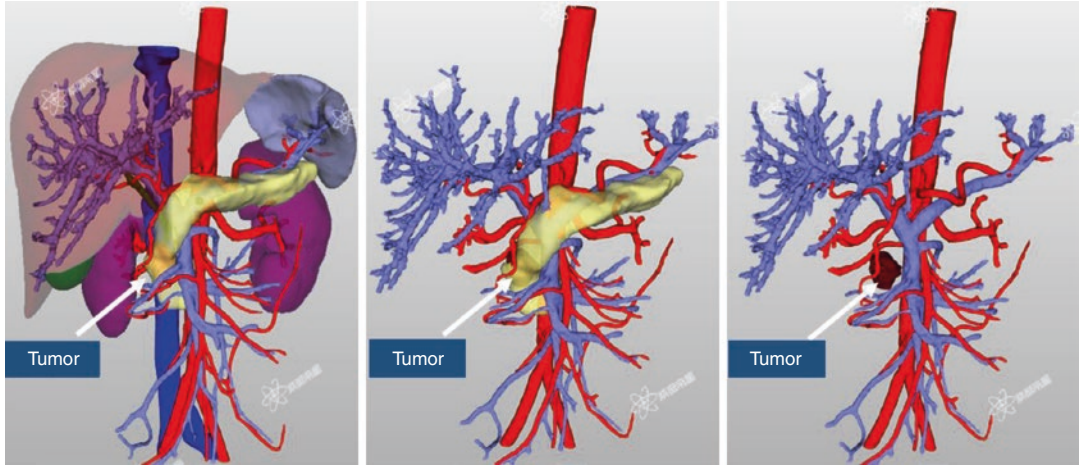

Fig. 1.11 3D reconstruction images revealed the correlation of the mass and the portal vein, SMA, and SMV

1.3 Details of Procedure

1.3.1 The Procedure Was the Same as Described in Our Previous Article [3–5]

1.3.1.1 Isolation of the Posterior Edge of the Mesopancreas Using the Kocher's Maneuver

Cut open the right anterior renal fascia along the external edge of the descendant duodenum. After the head of the pancreas and the duodenum were lifted to the left upper side by the assistant, the duodenal capsule was released and the hepatic flexure of the colon was protected (Fig. 1.12).

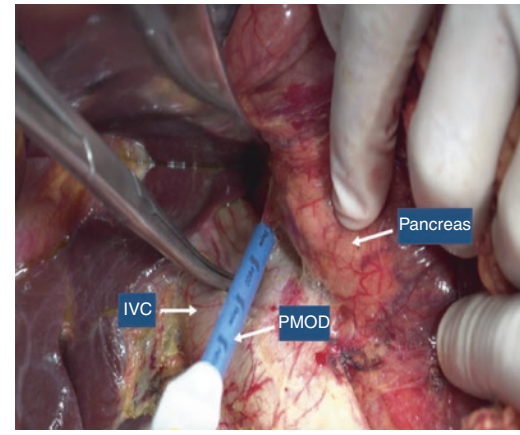

Fig. 1.12 Isolation of the posterior edge of the mesopancreas using the Kocher's maneuver (*PMOD* peng's multiple operation dissector)

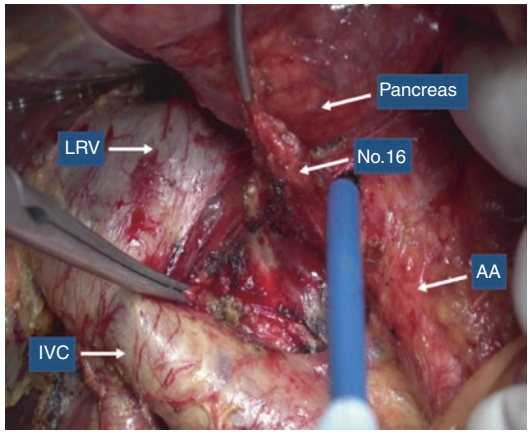

Fig. 1.13 Clearance of No.16 LN by using the Kocher's maneuver

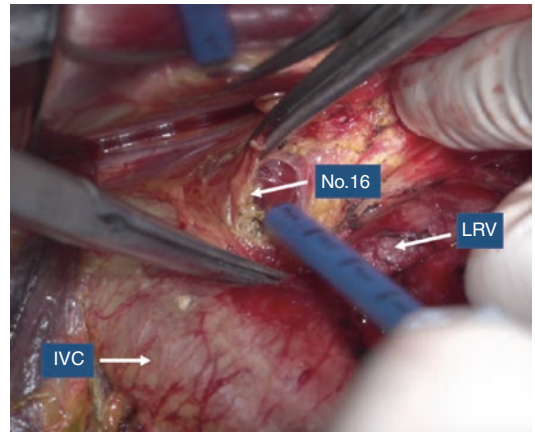

Fig. 1.14 Clearance of No.16 LN by using the Kocher's maneuver

Using the Kocher method, expose right renal vein, right genital vein, and inferior vena cava, and then leftwards expose and inspect the spaces behind the pancreatic head and portal vein (Fig. 1.13). After the exposure of the distal end of left renal vein and the abdominal aorta leftwards, expose the root of superior mesenteric artery that is located above the cephalic aorta at the distal end of left renal vein and inspect whether the superior mesenteric artery (Figs. 1.14 and 1.15) has been involved. Furthermore, expose the inferior vena cava and abdominal aorta towards the caudal (Fig. 1.16).

1.3.1.2 Resection of the Anterior Portion of the Mesopancreas

From the hepatic flexure of colon to the middle colic vein, expose and ligate the right gastroepiploic vein, dissect the greater omentum and the anterior lobe of the transverse mesocolon till the lower edge of the pancreas, expose the superior mesenteric vein beneath the pancreatic neck, dissect the adjacent adipose and lymphoid tissues, and then partially expose the space behind pancreatic neck and in front of the portal vein and superior mesenteric vein at the lower edge of the pancreatic neck (Fig. 1.17).

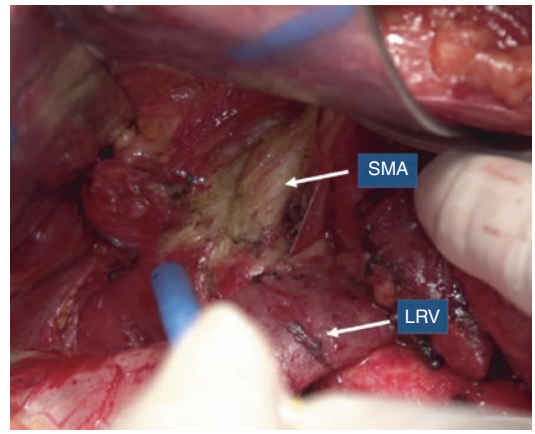

Fig. 1.15 Explore of the SMA

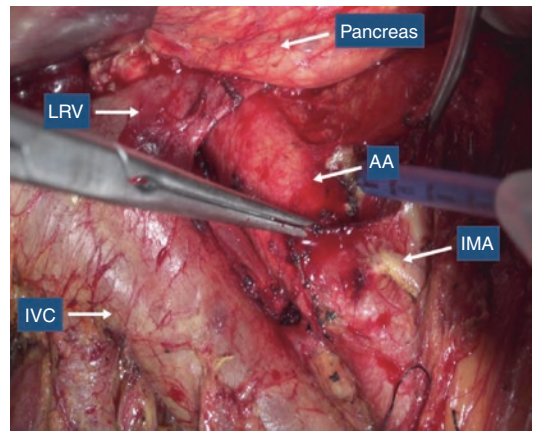

Fig. 1.16 Further expose the inferior vena cava and abdominal aorta

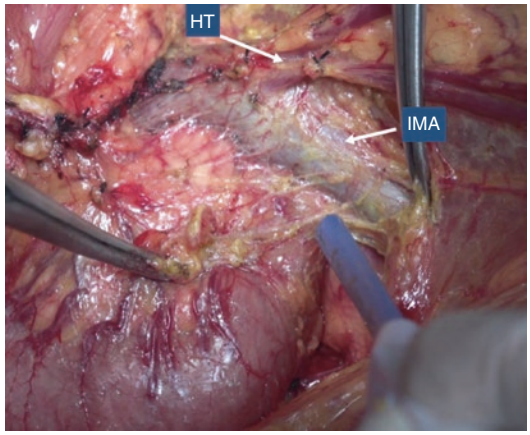

Fig. 1.17 Resection of the anterior portion of the mesopancreas (*HT* Helens trunk)

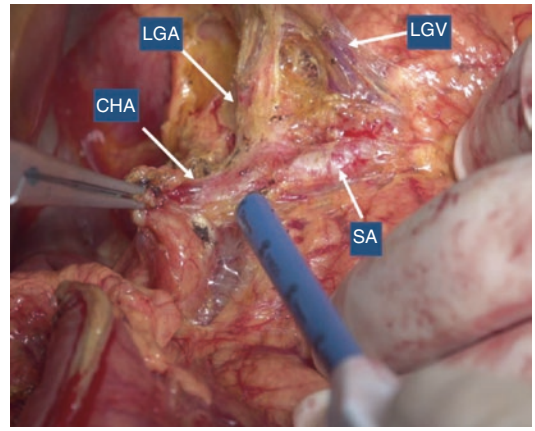

Fig. 1.19 Clearance of No.8a (*LGA* left gastric artery, *LGV* left gastric vein, *CHA* common hepatic artery)

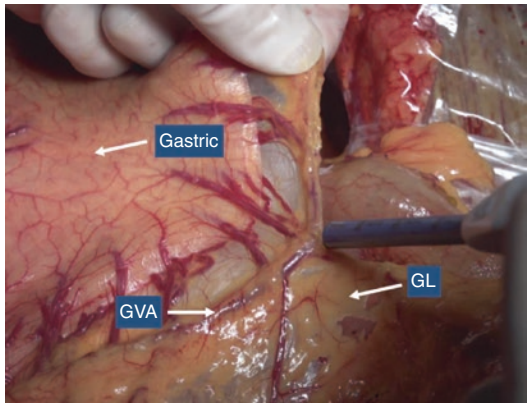

Fig. 1.18 Divide the greater omentum along the GVA (*GVA* gastroepiploic venous arch, *GL* gastric colon ligament)

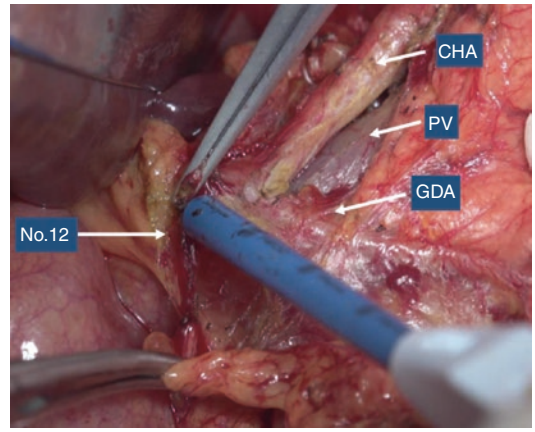

Fig. 1.20 Skeletonize the hepatoduodenal ligament (*GDA* gastric duodenum artery)

Divide the greater omentum from the middle to the right side along the external side of the gastroepiploic arterial arch till the gastric antrum (Fig. 1.18), during which the gastroepiploic arterial arch must be carefully protected. After the removal of the gallbladder, transect the common hepatic duct over the cystic duct, expose the hepatic artery and portal vein, skeletonize the hepatoduodenal ligament, and then expose and ligate the right gastric artery at the proximal end along the proper hepatic artery. Divide and ligate the gastroduodenal artery, followed by the exposure of the root of common hepatic artery and the abdominal aorta (Figs. 1.19, 1.20, 1.21).

Open the hepatogastric ligament along the lower edge of the left hepatic lobe till the distal

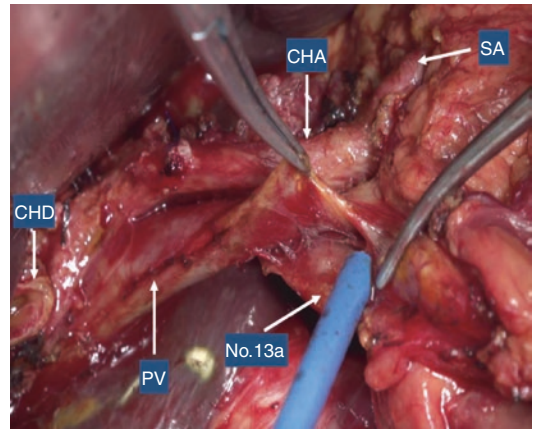

Fig. 1.21 Skeletonize the hepatoduodenal ligament and transect the common hepatic duct over the cystic duct (*CHD* common hepatic duct)

end of the left gastric vein. Remove the lesser omentum from the distal end of the left gastric vein to the gastric antrum along the external side of the vascular arch of the gastric lesser curvature (Fig. 1.22), during which the vascular arch must be carefully protected. Divide the gastric antrum using a stapler & cutter.

After the portal vein and superior mesenteric vein were exposed at the upper and lower edge of the pancreatic neck, respectively, the space behind the pancreatic neck in front of the portal vein- superior mesenteric vein was further exposed, and then the pancreas was divided. Specimen from the pancreatic stump was sent for routine frozen pathology (Fig. 1.23).

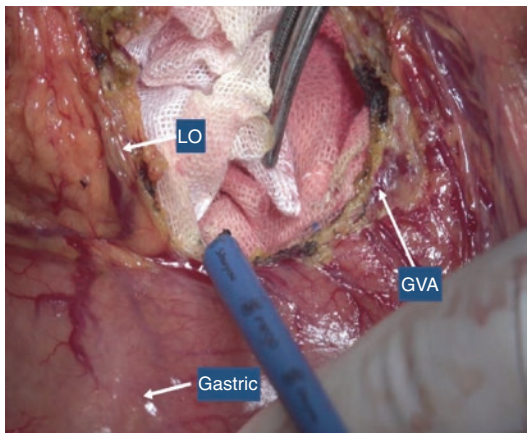

Fig. 1.22 Remove the lesser omentum along the GVA (*LO* lesser omentum)

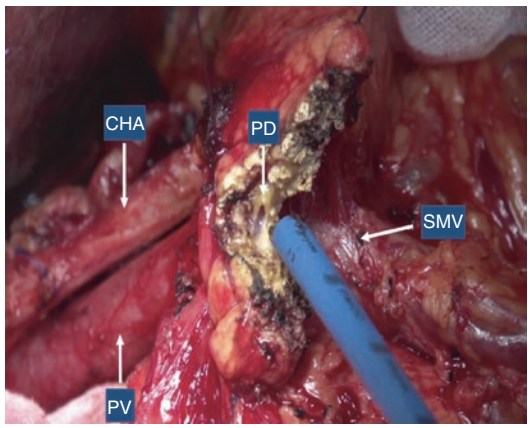

Fig. 1.23 The pancreas was divided and specimen from the pancreatic stump was sent for routine frozen pathology (*PD* pancreatic duct)

Thus, the anterior portion of the mesopancreas was completely divided, and the head of the pancreas and pancreas uncinate process were still connected with the posterior portion of the mesopancreas.

1.3.1.3 Resection of the Posterior Portion of the Mesopancreas

Lift the transverse colon upwards to expose the inferior mesenteric vein. Open the retroperitoneum along the left edge of the inferior mesenteric vein. Thus, the posterior portion of the mesopancreas became visible (Fig. 1.24).

The level of inferior mesenteric artery was defined as the lower border of the resection of the posterior portion of the mesopancreas. After the dissection of the connective tissues around the superior mesenteric artery (Fig. 1.25), the dissec-

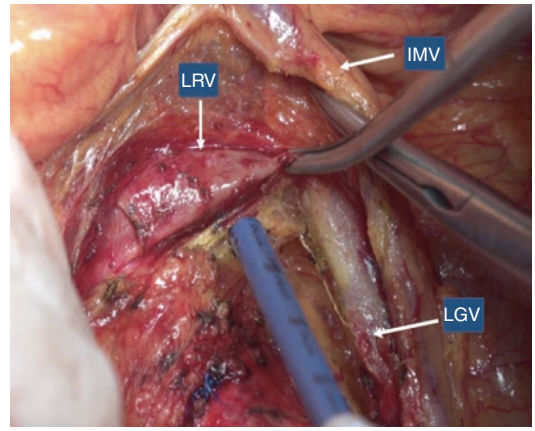

Fig. 1.24 The posterior portion of the mesopancreas

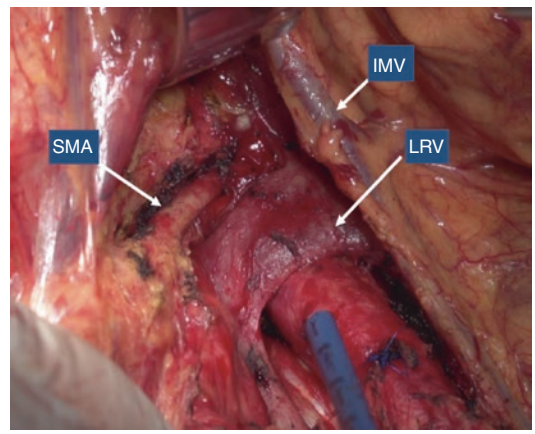

Fig. 1.25 Dissection of the connective tissues around the superior mesenteric artery

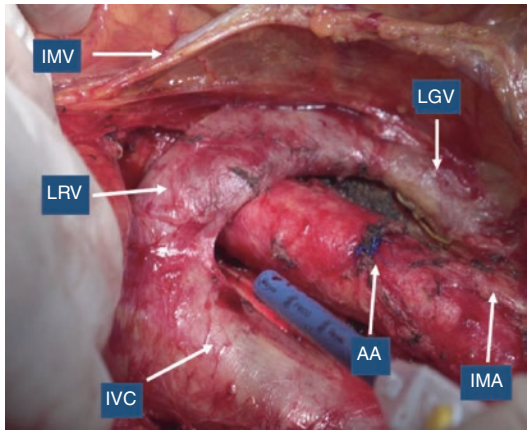

Fig. 1.26 Connective tissue between the inferior vena cava and the abdominal aorta was dissected

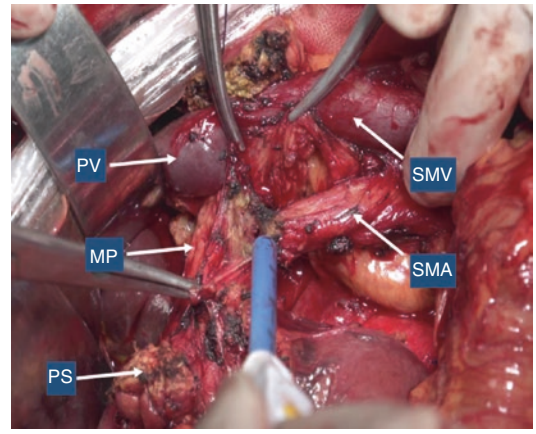

Fig. 1.27 The anterior and posterior sections of the mesopancreas had been completely divided

tion continued upwards along the anterior side of the abdominal aorta till 2 cm above the root of celiac trunk, which was defined as the upper border of resection of the posterior portion of the mesopancreas. Then, the connective tissues around the celiac trunk were dissected. The connective tissue between the inferior vena cava and the abdominal aorta should be carefully dissected (Fig. 1.26).

Furthermore, the left genital vein was set as the left posterior border for the resection of mesopancreas and the inferior mesenteric vein as the left anterior border. After the jejunum was transected 15 cm away from the ligament of Treitz, the anterior and posterior sections of the mesopancreas had been completely divided; only the junction between the anterior and posterior sections (the head of the pancreas and the uncinate process of the pancreas) was connected with the superior mesenteric artery and vein (Fig. 1.27).

Divide and ligate the vessels in the uncinate process of the pancreas and then dissociate the uncinate process. Pull away the uncinate process to expose the superior mesenteric artery at the left side of the superior mesenteric vein. Turn over the superior mesenteric artery in the first branch of jejunum to expose the right side of the superior mesenteric vein. Then, the lymphatic

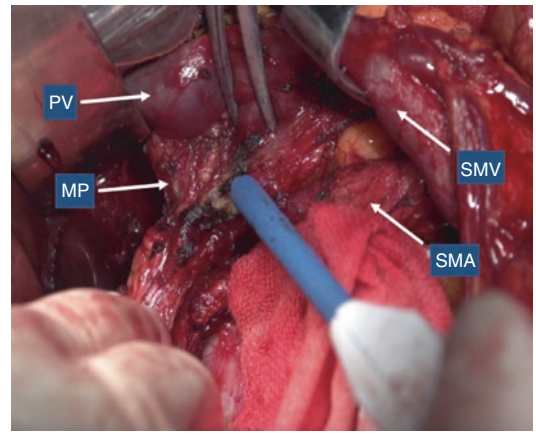

Fig. 1.28 Separate and ligate the small blood vessels in the uncinate process to complete the en bloc resection of the head of the pancreas

and nerve tissues around the superior mesenteric artery were dissected till its root (Fig. 1.28). Separate and ligate the small blood vessels in the uncinate process to complete the en bloc resection of the head of the pancreas, duodenum, and the anterior and posterior sections of the mesopancreas; if necessary, resection and reconstruction of the vessels were also performed (Figs. 1.29, 1.30, 1.31). After three-dimensional marking of the cutting edges, the surgical specimens were sent for pathology.

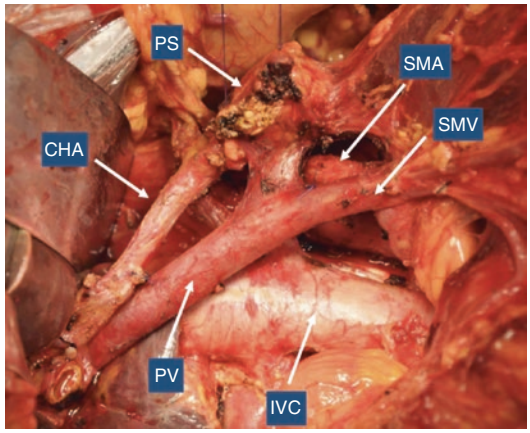

Fig. 1.29 The view after removing the specimen

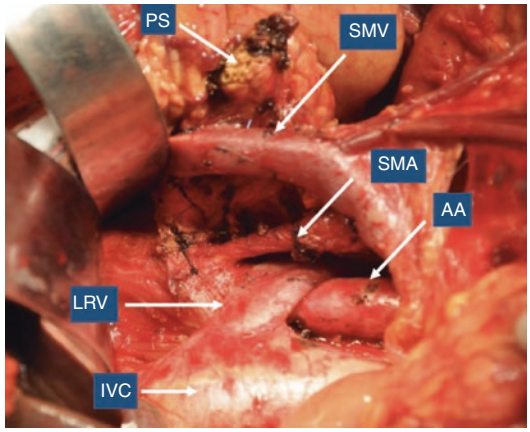

Fig. 1.30 The view after removing the specimen

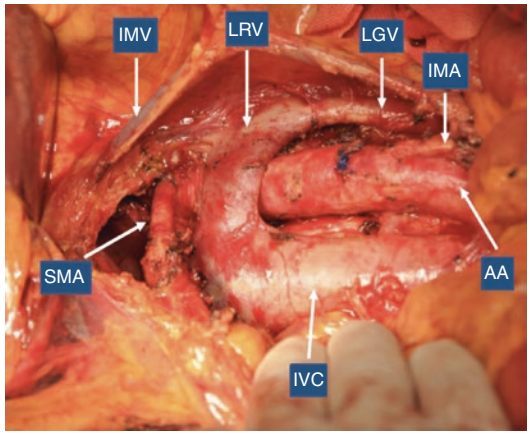

Fig. 1.31 The view after removing the specimen

Fig. 1.32 The resected specimen

1.4 Pathology and Prognosis

The resected specimen was showed as Fig. 1.32. Pathology diagnosis was poor to moderately differentiated pancreatic duct adenocarcinoma (grade II), invading the plexus, but no portal or venous infiltration was detected. The tumor also did not involve the duodenum and duodenal papilla. The cutting margin of common bile duct, pancreatic margin, stomach, and duodenal were negative; 19 lymph nodes including peri-pancreatic lymph nodes (n=5), the superior mesenteric artery/vein lymph nodes (n=5), No.16 lymph node (n=3), No.12 lymph nodes (n=4), No.8 lymph nodes (n=2) were harvasted totally, and none of them was positive.

The patient recovered uneventfully and was discharged 12 days after the operation. 6 months after surgery, follow-up CT and tumor marker revealed no recurrence.

1.5 Comment

Pancreatic duct adenocarcinoma is associated with worse prognosis, and radical resection with negative margin remains the only promising treatment. Retropancreatic margin or the medial margin is the most common site of positive resection margin [5]. Unfortunately, the R0 resection

rate of traditional PD is less than 50%, and most patients cannot be cured even with PD [6]. The two main sites of residual microscopical tumor after PD are at the medial and the posterior resection margins [7, 8].

Mesopancreas concepts, which lies posterior to the pancreas and contains pancreaticoduodenal vessels, lymphatics, nerve plexus, and loose areolar tissue, were proposed to increase the rate of R0 resection [1, 2]. We had modified this concept and summarized the clinicopathological data of 120 patients with pancreatic head cancer, which demonstrated that TMpE was safe and feasible when compared with conventional PD. And the R0 resection rate, especially on the mesopancreatic margin was improved, the postoperative local recurrence rate was decreased and overall survival rate was increased in the TMpE group of patients [3–5]. As these were retrospective studies, the true role of PD with TMpE stills requires further properly conducted large-scale, multicenter, randomized comparative studies to define.

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