

# Laparoscopic duodenum and spleen-preserving total pancreatectomy: A novel surgical technique for pancreatic intraductal papillary mucinous neoplasms

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## Summary

Intraductal papillary mucinous neoplasm (IPMN) of the pancreas is no longer a rarely diagnosed disease, because of the development of medical imaging. With a high incidence of canceration, especially in the main duct type, surgery is strongly recommended. Pancreatoduodenectomy, distal pancreatectomy and central pancreatectomy are applied in those cases. For this potentially malignant disease, function-preserving surgery seems more appropriate. An old female was enrolled in our research, who was diagnosed with IPMN. Diameter of the main pancreatic duct (MPD) was > 5 mm and lesions distributed to the whole pancreas. laparoscopic duodenum and spleen-preserving total pancreatoduodenectomy was carried out, which has not reported previously. We successfully performed laparoscopic duodenum and spleen-preserving total pancreatectomy, without major complications such as severe pancreatic fistula, postoperative bleeding, and delayed ischemia of duodenum and spleen. We consider laparoscopic duodenum and spleen-preserving total pancreatectomy is technically feasible, but a large sample of randomized controlled trials is needed to evaluate its safety, effectiveness and long-term outcome.

**Keywords:** Laparoscopy, function-preserving, total pancreatectomy, IPMN, pancreatoduodenectomy

## 1. Introduction

Although some consensus defined the surgical indication for intraductal papillary mucinous neoplasm (IPMN) as diameter of main pancreatic duct more than 10 mm (1). However, it is still controversial, Hackert *et al.* reported main duct type IPMN of the pancreas is potentially malignant, especially when the diameter of the main pancreatic duct (MPD) is > 5 mm (2). To achieve radical resection in these cases, total pancreatectomy (TP) is indicated. Laparoscopic TP is a

complicated procedure that has been described recently with resection of the spleen and/or duodenum (3-6). However, function-preserving surgery, such as pylorus-preserving pancreatoduodenectomy, is widely used for benign, potentially malignant and even malignant tumors of the pancreas (7). Laparoscopic spleen-preserving distal pancreatectomy and laparoscopic duodenum-preserving pancreatic head resection (8,9) have been reported to treat benign or low-grade malignant tumors respectively.

Here, we present a patient with main duct IPMN treated with laparoscopic duodenum and spleen-preserving TP, which has not published previously.

## 2. Materials and Methods

### 2.1. Characteristic of patient

A 68-year-old female patient was admitted to our hospital because preoperative examination revealed

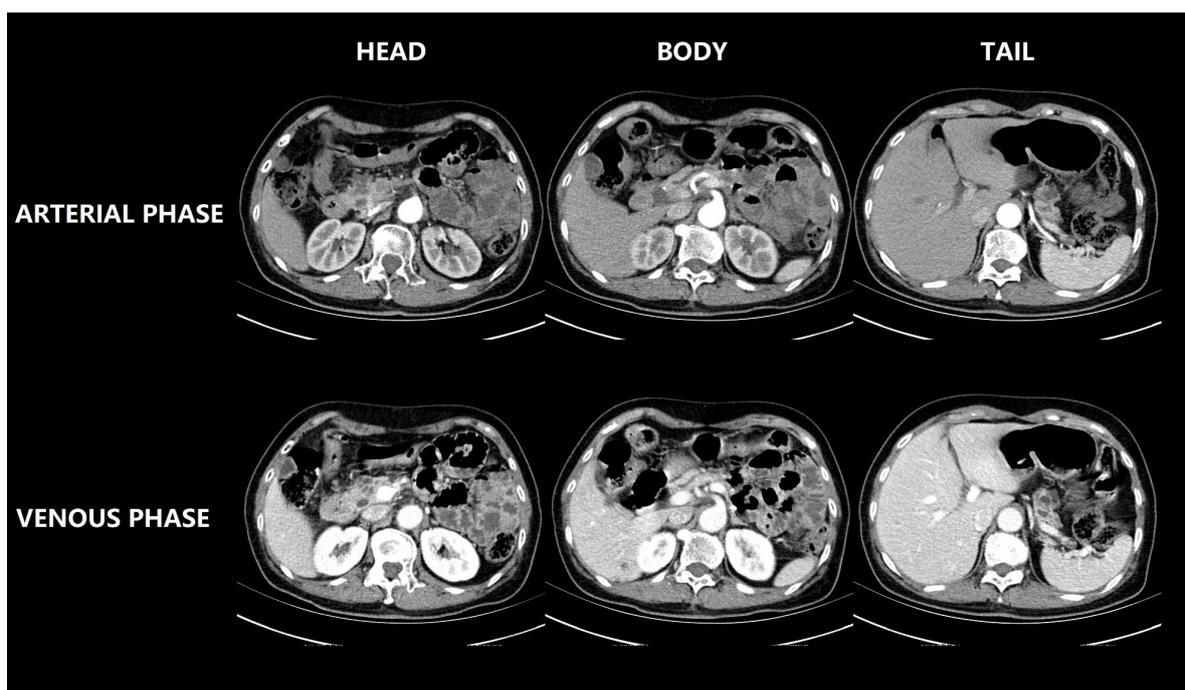
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**Figure 1.** Enhanced CT showed the lesions in different parts of pancreas in each phase.

pancreatic cystic lesions when she underwent endoscopic submucosal dissection (ESD) for early gastric cancer in another hospital 3 months previously. Physical examination and laboratory workup, including tumor markers, were all negative and she denied a history of alcohol abuse.

## 2.2. Imaging outcome

Enhanced computed tomography (CT) demonstrated (Figure 1) that there was a cystic solid lesion in the pancreatic head, which connected with the MPD, which was dilated. The lesion was not enhanced after injection of contrast agent, and the left renal anterior fascia was not thickened. The common bile duct (CBD) was not dilated and no significantly enlarged lymph nodes were found in the retroperitoneum. Endoscopic ultrasonography (EUS) revealed that the pancreatic duct at the tail of the pancreas was significantly dilated, with a maximum inner diameter of 6.5 mm. The pancreatic neck had a honeycomb-like non-echo structure, smooth cystic wall, no mural nodules, and the cystic solid lesion communicated with the MPD. The diameter of pancreatic head MPD expanded to 5.5 mm, and duodenal papilla were normal, and similar changes were found on magnetic resonance imaging.

According to enhanced CT and EUS, the patient was diagnosed with pancreatic IPMN of mixed type. The lesion spread throughout the whole pancreas and TP was indicated. However, for this borderline tumor, function-preserving surgery was more appropriate than TP. Based on our experience with laparoscopic pancreaticoduodenectomy and spleen-preserving distal

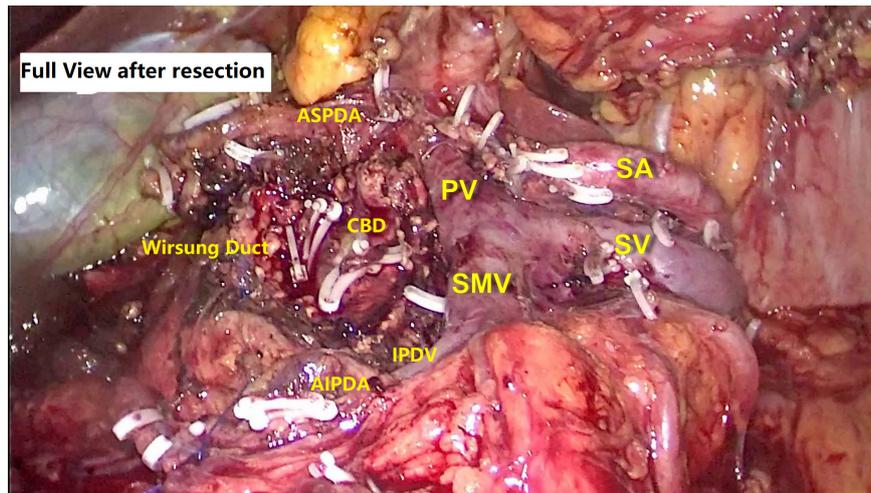
pancreatectomy, we decided to perform laparoscopic duodenum and spleen-preserving TP. It was approved by Ethics Committee of Zhejiang Provincial People's Hospital and had gotten written informed consent from the patient.

## 2.3. Surgical procedure

The patient was placed in the reverse Trendelenburg position with head raised to 30°. Pneumoperitoneum was established in the umbilical incision with setting pressure at 14 mmHg. The 5 trocars were placed in a V shape. The gastrocolic and hepatogastric ligaments were opened to visualize the pancreas. A catheter was used to hang up the stomach through the abdominal wall. Our procedure started with opening the retroperitoneum at the upper edge of the pancreatic neck, and dividing the initial part of the splenic artery and suspending it with a fine rubber tape. Then, we opened the retroperitoneum at the lower edge of the pancreas, near the superior mesenteric vein (SMV). After establishing a retropancreatic tunnel, the pancreatic neck was suspended by a tape and transected by an ultrasonic scalpel. After transection of the pancreatic neck, the operation was divided into two steps: spleen-preserving distal pancreatectomy and duodenum-preserving pancreatic head resection.

### 2.3.1. Spleen-preserving distal pancreatectomy

After hanging the pancreatic neck by the atraumatic grasper, we opened the pancreatic capsule along the lower edge from proximal to distal, visualized the



**Figure 2.** The structure after duodenum and spleen preserving total pancreatectomy.

splenic vein, and carefully dissected the branches of the vein toward the pancreas and ligated them with a hem-o-lok (Teleflex, USA.) clip. After disconnecting all the branches attached to the splenic vein, we pulled the pancreas to the tail side, which made it clearer to expose the upper edge of the pancreas. We opened the pancreatic capsule along the upper edge from proximal to distal and pulled the initial part of the splenic artery, which was suspended by a tape in the direction of the head side, which ensured proper tension between the distal pancreas and the splenic artery. As with the splenic vein, we disconnected the branches from the splenic artery to the pancreas. The distal pancreas was resected completely.

### 2.3.2. Duodenum-preserving pancreatic head resection

After finishing distal pancreatectomy, we started duodenum-preserving pancreatic head resection. We turned the pancreatic neck to the right side, and divided the space between the portal vein-SMV and pancreatic head, some collateral branches toward the uncinate process were dissected and sealed by hem-o-lok. We dissected the tissue between the superior mesenteric artery (SMA) and uncinate process, bipolar coagulation and hem-o-lok were used to ligate or seal the small branches from the SMA to the uncinate process. The anterior capsule of the pancreas was opened at the lower part of the pancreatic neck, and subcapsular dissection was carried out. After the anterior inferior pancreaticoduodenal artery (AIPDA) was dissected and ligated by hem-o-lok, the lower part of the pancreatic head and uncinate process were separated by preserving a small amount of pancreatic tissue to ensure the integrity of the posterior inferior pancreaticoduodenal arterial (PIPDA) arcade. When the upper part of the pancreatic head was separated, the lower CBD was exposed and the terminal CBD was embedded in the pancreas. The blood supply of the lower CBD came

from the posterior superior pancreaticoduodenal artery (PSPDA), which came from the gastroduodenal artery. Maintenance of the integrity of the PSPDA was the key to avoiding ischemia of the CBD and postoperative bile leakage.

We followed the principle that from left to right, from ventral to dorsal, preservation of some pancreatic tissue would avoid injury to the posterior arcade along the duodenum. When we reached the descending duodenum, the MPD to the ampulla of Vater was visualized, ligated and cut off. The pancreatic head including the uncinate process was resected completely (Figure 2), and the specimen was placed in a bag and retrieved by an enlarged trocar incision. Two drainage tubes were positioned on the wound surface of the pancreas and Winslow hole, respectively.

### 3. Results and Discussion

Spleen-preserving and duodenum-preserving laparoscopic TP was performed in 270 min, with 250 ml blood loss, without major complications including postoperative bleeding, duodenal or splenic necrosis, or delayed gastric emptying. On postoperative day (POD) 1, the nasogastric tube was discontinued, and diabetic fluid was started on POD 3. The drainage tube was withdrawn on POD 7, when there was no evidence of bile and pancreatic leakage. The patient's hospital course was uncomplicated and she was discharged home on POD 9. Pathological examination demonstrated mixed type of IPMN with mild to moderate dysplasia. For insulin regimen, we gave continuous insulin infusion during fasting and adjusted the dosage according to the level of fasting blood glucose. When oral feeding was resumed, we gave quick-acting insulin before three meals and long-acting insulin before bedtime, after obtaining the opinion of an endocrinology consultant. Compound digestive enzyme capsules were used in the substitution therapy of external secretion function.

We followed up the patient for 3 months, and routine blood, biochemical and other indicators, and glycosylated hemoglobin were in the normal range. Enhanced CT was repeated 1 month after surgery, which showed a small amount of normal pancreatic tissue left surrounding the CBD, and no duodenal or splenic ischemia.

MPD diameter 5-9.9 mm is the single best predictor of high-grade or invasive main duct type IPMN, and is a key indicator of surgical candidates (10). MPD diameter > 10 mm is identified as a high-risk stigmata for malignancy in the Fukuoka guidelines (1). According to the location of the lesion, pancreatoduodenectomy, central pancreatectomy, distal pancreatectomy and TP are available surgical procedures.

TP is a complicated and highly technically demanding procedure, especially when performed laparoscopically. Several studies have focused on laparoscopic TP and demonstrated that it is a safe procedure in selected patients. Chapman *et al.* reported laparoscopic TP with spleen preservation for main duct IPMN (3). Peng *et al.* reported 3 cases of TP for IPMN and pancreatic neuroendocrine tumor, they resected the whole pancreas and duodenum with preservation of the pylorus and spleen (6).

Function-preserving pancreatic surgery was launched recently, and provided patients with enhanced recovery and low rate of postoperative complications (7). Beger *et al.* reported duodenum-preserving pancreatic head resection for pancreatic benign or low-grade malignant lesions (11). Cao *et al.* reported 12 cases of laparoscopic duodenum-preserving total pancreatic head resection (8). They transected the pancreatic neck and performed subcapsular dissection to mobilize the pancreatic head, and paid close attention to preserving the anterior and/or posterior pancreatic duodenal arterial arcade. Furthermore, Yamashita *et al.* reported the case of resection of the second portion of the duodenum but preserving the pancreas for a recurrent duodenal adenocarcinoma patient (12).

However, in most of the published studies, TP was combined with duodenal and/or splenic resection, even in some patients with benign or potentially malignant lesions. There are no reports of laparoscopic TP with both spleen and duodenum preservation.

Our center has experience of laparoscopic spleen-preserving distal pancreatectomy and laparoscopic duodenum-preserving pancreatic head resection over 100 cases in the past 5 years. These procedures have been proved to be minimally invasive and patients have better survival and quality of life postoperatively.

In the present case, we performed duodenum and spleen-preserving TP. The duodenal papilla could be seen at the intersection of the biliary, pancreatic and alimentary tracts. Our procedure starts with transection of the pancreatic neck, followed by two steps of spleen-preserving distal pancreatectomy and duodenum-

preserving pancreatic head resection. The key feature of spleen-preserving distal pancreatectomy is accurately identifying the arterial branches of the splenic artery (*e.g.* great pancreatic artery, transverse pancreatic artery, or dorsal pancreatic artery) and venous branches toward the pancreas. The small branches usually tear easily if we hang the distal pancreas with too much tension, and this is the most common reason for conversion to or combination with splenectomy. We strongly recommend transection of the pancreatic neck first, which facilitates hanging the distal pancreas to visualize the space between the splenic vessels and distal pancreas, by excluding the limitation of the immobilized pancreatic head. But in potentially malignant cases, the principle of En bloc resection should be applied strictly.

Duodenum-preserving pancreatic head resection is the best choice for treatment of benign and low-grade malignant tumors, but it only can be carried out in large centers. The duodenum has a poor blood supply. Its feeding arteries are the anterior and posterior arcades, which are formed by branches of the superior pancreatoduodenal artery (SPDA) and IPDA. The anterior SPDA (ASPD) and AIPDA derive from the anterior arcade, and the PSPDA and PIPDA from the posterior arcade. Compared with the concomitant artery, preservation of venous arcade is tougher because of thin wall. The pancreatic head is covered by a capsule to the front and in the rear, and this capsule is continuous with the retroperitoneum, and surrounded by the C-shaped duodenum and left margin of the portal vein. In this space, we must preserve at least one arcade. The anterior arcade is usually detached for further deep dissection, and the posterior arcade must be preserved carefully. Takada (13) mentioned that the PSPDA is important to avoid ischemia, and the retropancreatic fascia (posterior capsule) and fibrotic tissue along the CBD were preserved to ensure the blood supply. The anterior capsule should be opened with ligation of the initial part of the ASPDA and AIPDA, the posterior capsule should be kept integrally for preserving PSPDA and PIPDA. In addition, the segment of the Wirsung duct (MPD) that converges into the ampulla should be identified and sealed.

Laparoscopic duodenum and spleen-preserving TP is a safe, feasible, function-preserving, novel surgical procedure, and surgeons should implement spleen-preserving distal pancreatectomy and duodenum-preserving pancreatoduodenectomy. Surgeons who want to implement this procedure should perform laparoscopic spleen-preserving distal pancreatectomy or laparoscopic duodenum-preserving pancreatic head resection, and then laparoscopic duodenum and spleen-preserving TP. The outcome from present single case or small numbers of cases can only be suggestive, and further prospective randomized studies are needed to obtain an objective assessment of laparoscopic duodenum and spleen-preserving TP.

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