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# The Posterior Approach in Pancreaticoduodenectomy: Preliminary Results

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**ABSTRACT**

**Background/Aims:** We present our technical version of pancreaticoduodenectomy by posterior approach that enables a complete dissection of the right side of the mesenteric superior artery and of the portal vein, as well as a complete excision of the retroportal pancreatic process (or lamina), and report the preliminary outcomes of the first 10 selected patients.

**Methodology:** Between 1 December 2005 and 1 March 2006 10 patients (7 males and 3 females) with a mean age of 60.6 years (range 45-81 years) were operated on using this technique. The patients were diagnosed with carcinoma of the pancreatic head (8 cases), ampullary carcinoma (1 case), and carcinoma of the distal part of the common bile duct (1 case). Invasion of the portal vein occurred in 2 of the 8 cases of carcinoma of the pancreatic head.

**Results:** No significant intraoperative incident was recorded. The mean operative time was 225 minutes (ranging between 180 and 240 minutes) and the mean blood loss was 372,25cc (range 150-800cc). Two cases of carcinoma of the pancreatic head that had a segmental resection of the portal vein needed vascular reconstruction which was performed by Goretex graft interpositing. The pylorus-preserving procedure was used in 2 cases (ampullary carcinoma, and carcinoma of the distal part of the common bile duct, respectively). Postoperative complications consisted of intraabdominal hemorrhage from an arterial source of the pancreatic capsule (on the day of the operation necessitating reoperation for hemostasis) in one case, and pancreatic fistula (that required conservative treatment) in another case. No postoperative diarrhea, delayed gastric emptying episodes or postoperative deaths were recorded. There were no postoperative deaths. The mean length of hospitalization was 12.2 days (range 10-24 days).

**Conclusions:** The posterior approach in pancreaticoduodenectomy offers an early selection of patients during the operation (in terms of resectability). As compared to the standard procedure, it enables an adequate lymphadenectomy that can be safely performed (by early dissection and isolation of the superior mesenteric artery), and avoids possible intraoperative accidents secondary to anatomical arterial abnormalities. This approach is particularly recommended in cases with portal vein invasion because it allows a "no-touch" resection.

**KEY WORDS:** Pancreaticoduodenectomy; Retroportal process; Posterior approach

**ABBREVIATIONS:** Pancreaticoduodenectomy (PD); Superior Mesenteric Artery (SMA); Portal Vein (PV)

## INTRODUCTION

Pancreaticoduodenectomy (PD) is particularly recommended in malignant tumors (adenocarcinoma of the pancreatic head, periampullary and ampullary malignancies, duodenal cancers) and more rarely in the management of benign lesions (chronic pancreatitis, pancreatic trauma) (1-3).

In the case of malignant tumors, in accordance with operative indication, it may associate a regional (or extended) lymph node dissection - a lymphadenectomy of the hepatic pedicle, celiac axis and proximal superior mesenteric artery - and/or the complete retroperitoneal lymph node dissection (2-4).

Based on Richelme and Pissas' research in the lymphatic drainage of the pancreas, Pessaux *et al.* described, in 2003, a type of PD in which an adequate lymphadenectomy was performed by the complete resection of the retroportal process (or lamina) subsequently to the identification and dissection of the proximal segment of the superior mesenteric artery (SMA) (5-7).

Given the French authors' recommendations, we decided not to limit the dissection of the SMA to the few first centimeters but to continue it until complete separation of the artery from the pancreas and duodenum, that is, until the artery penetrates the mesentery. A complete resection of the retroportal process or tissue as well as an adequate lymph node dissection and a complete dissection of the portal vein (PV) were thus obtained, while pancreas division (and removal of the specimen) represented the final step of the procedure.

We present our technical version of PD by the posterior approach, focusing on specific and technical issues of the operation, and analyze the preliminary results of the surgical treatment for the first 10 selected patients.

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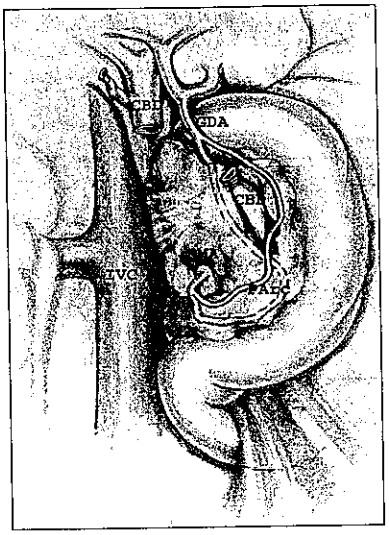


**FIGURE 1**
Mobilization of the second portion of the duodenum (Kocher maneuver). CBD: common bile duct; IVC: inferior vena cava; GDA: gastroduodenal artery; PArc.: vascular arcades of the head of the pancreas; SMA: superior mesenteric artery

## METHODOLOGY

### Patients/Subjects

In the Center of General Surgery and Liver Transplantation of Fundeni Clinical Institute in last 5 years we performed 112 resections for cancer of the pancreatic head (an average of 22.4 PD per year). The posterior approach in PD was introduced in December 2005.

Between 1 December 2005 and 1 March 2006, the procedure was used for 10 patients (7 males and 3 females) with the mean age of 60.6 years (range 45-81 years).

The posterior approach was indicated in:

- malignant tumors of the pancreatic head and uncinate process,
- malignant tumors of the ampullary region,
- malignant tumors of the distal common bile duct,
- tumors that were limited to the pancreas or extended beyond it, but not involving the celiac axis or the SMA,
- malignancies with no lymph node metastases that fall outside the scope of our operation (metastases to paraaortic and celiac lymph nodes),
- malignancies with no hepatic metastases, peritoneal metastases, and extraabdominal metastases (pulmonary metastases).

All cases had normal cardiovascular, pulmonary, hepatic and renal functions. The age alone did not represent a contraindication to PD.

The preoperative diagnosis was carcinoma of the pancreatic head (8 cases), ampullary carcinoma (1 case), and carcinoma of the distal part of the common bile duct (1 case). In one case, pancreatic cancer was associated with chronic pancreatitis.

All the patients had obstructive jaundice with significant hyperbilirubinemia (the mean of direct bilirubinemia was 16.2mg/dL) and weight loss as major symptomatology.

Two of the 8 cases of pancreatic head carcinoma had an invasion of the PV shown by dynamic contrast-enhanced computed tomography (CT) and confirmed by intraoperative exploration.

### Technical Considerations

1) Either a bilateral subcostal (or transversal) or a long midline incision provides adequate exposure for the procedure. We performed a midline incision in 5 patients, and bilateral subcostal incision in 5 cases. A bilateral costal margin retractor was used to increase the exposure and the other retractor to separate the wound edges.

2) Following the incision, the abdomen was thoroughly explored to assess the disease extent and resectability. The liver, the celiac axis, the parietal and visceral peritoneal surfaces, the omentum, the Treitz ligament and the entire small and intraabdominal large intestine were also accurately examined.

3) An extensive Kocher maneuver began with the mobilization of the descending portion (second portion) of the duodenum by division of lateral peritoneal attachments followed by blunt dissection posteriorly. The duodenum and the pancreatic head were forced out of the retroperitoneum in a sagittal plane by temperate traction. At this step, the main goal is a clear visualization of the inferior vena cava and left renal vein and within the angle between these two veins, the SMA (**Figure 1**). The lymphoareolar tissue and the lymphatic nodes could be cleared from the inferior vena cava to the lateral border of the aorta, to sharply expose the inferior vena cava and left renal vein. The Kocher maneuver was continued by the mobilization of the horizontal portion of the duodenum (third, preaortic or transverse portion) to the proximity of the duodenojejunal flexure, beneath the superior mesenteric vessels and the mesentery, by mobilizing the right colon, the right colic flexure and the right portion of the transverse mesocolon. The third portion of the duodenum is connected to the retroperitoneal tissue by a soft and avascular band that is subsequently divided.

4) After complete mobilization of the pancreatic head, dissection of the inferior border of the pancreas allows visualization of the terminal portion of the superior mesenteric vein, which is running towards the third portion of the duodenum and receives tributaries from pancreas, stomach and colon. These tributaries underwent a step-by-step division procedure to further enable the cephalad dissection (alternating by blunt and sharp dissection) and the demarcation of the plane between the portal vein and the pancreatic neck.

5) Dissection of the hepatic pedicle and PV started with cholecystectomy (if the patient had not had a previous cholecystectomy). After the transversal incision of the peritoneum of hepatic pedicle we identified the common hepatic duct (with the cystic duct entry site) that was circumferentially dissected, the PV in the posterior plane, and the proper hepatic artery with the origin of the gastroduodenal artery. Following the division of the common hepatic duct, the anterior surface of the PV was easily detected by caudal traction of the distal part of the common bile duct. The lymph

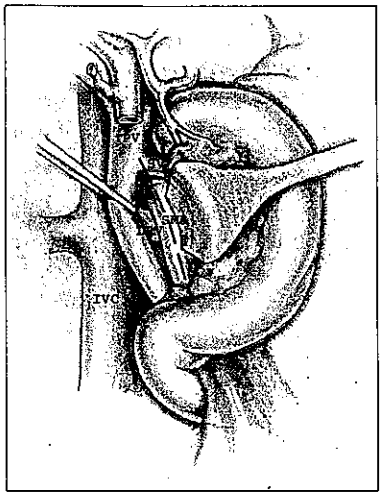


**FIGURE 2**
Dissection of the superior mesenteric artery.
SMA: superior mesenteric artery; IVC: inferior vena cava; LRV: left renal vein; PV: portal vein; SV: splenic vein; the dotted line represents the arterial plane of dissection (a right side of the mesenteric superior artery)

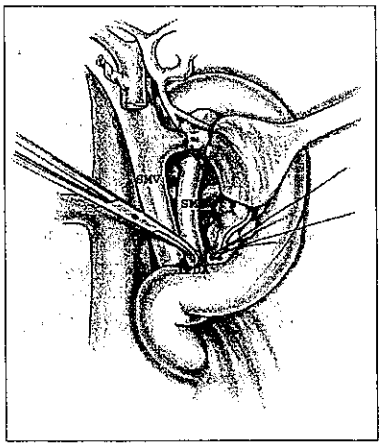


**FIGURE 3**
Transection and ligation of the inferior and posterior pancreaticoduodenal artery. SMA: superior mesenteric artery; SMV: superior mesenteric vein; IPDA: inferior pancreaticoduodenal artery.

nodes and the tissue between the hepatic duct and the PV should be dissected off the structures to be included in the surgical specimen. The PV was therefore completely released from the retroportal process facilitating its complete dissection from the undersurface of the pancreas and the end of the early plane developed in the previous step (a Penrose drain was used for the elevation of the pancreatic neck). An invasion of the PV or the superior mesenteric portal vein confluence (rarely in the anterior wall and frequently of the lateral and posterior aspect) could be identified. If this is the case, a "no-touch" policy is applied, and any attempt to dissect an invaded portal vein transforms a potentially curative resection into a palliative one. The portal vein will be left in place and the invaded part will be removed en-bloc with the operative specimen at the end of the operation.

6) Dissection of the SMA. Returning to the posterior region of the head of the pancreas in the angle between the left border of the inferior vena cava and the superior border of the left renal vein, we found the origin of the SMA - the right border of the artery. The whole lymphatic tissue originating at this level - representing the left portion of the retroportal process - was divided by a step-by-step procedure **(Figure 2)**. By the use of a vascular tape around the artery, we subsequently separated the artery from the pancreatic tissue and PV (which was laterally displaced by the assistant) and divided the inferior and posterior pancreaticoduodenal arteries (which arise separately or by common trunk) as well as the other minor arterial branches **(Figure 3)**. The lymph nodes and the lymphatic tissue between the portal vein and the superior mesenteric artery were dissected. Whenever a replaced right hepatic artery originating in the SMA is found, the artery should be dissected and carefully protected **(Figure 4)**.

7) Mobilization of the duodenojejunal flexure was performed following the division of the Treitz ligament and the peritoneal reflection of the third portion of the duodenum. Duodenum and jejunum were reflected beneath the mesenteric vessels; this maneuver allowed the identification of the jejunal arteries that had been firstly divided. This surgical step was followed by a complete separation of the SMA from the right retroportal process; the artery was therefore set free until its entry into the mesentery.

8) The right gastric artery or a few supraduodenal branches were divided at the superior border of the pancreas (these arterial branches could be spare in the case of pylorus-preserving procedure). The gastro-duodenal artery was identified, dissected and ligated. A gastric transection (or duodenal transection at 2 to 3cm distal to the pylorus) and a jejunal transection (approximately 15cm distal to the Treitz ligament) were done.

9) The last step of the operation involved division of the pancreatic neck by the use of a scalpel to avoid any thermal injury to the duct and assess blood supply at the cut surface of the pancreas. In contrast to the standard procedure, the pancreas is at last free from the right posterior retroportal process. In the case of venous invasion after pancreatic transection, the PV or the superior mesenteric portal vein confluence might be resected in accordance with invasion extent: tumors that involve less than 1/3 of the total circumference may be resected tangentially and those with

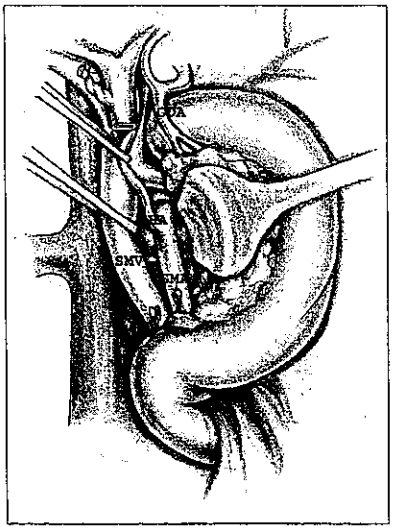


**FIGURE 4**
Dissection of the right hepatic artery originating in the superior mesenteric artery.
SMA: superior mesenteric artery; PV: portal vein; GDA: gastro-duodenal artery; RHA: right hepatic artery.

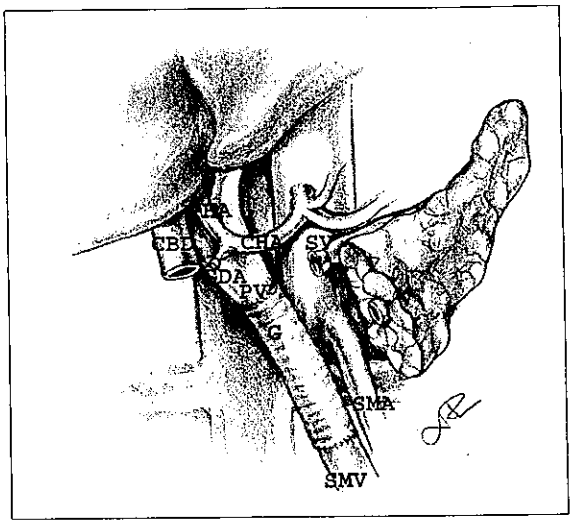


**FIGURE 5**
Vascular reconstruction with interpositing grafting.
CHA: common hepatic artery; PHA: proper hepatic artery; GDA: gastroduodenal artery; CBD: common bile duct; G: graft; SMV: superior mesenteric vein; PV: portal vein; SV: splenic vein ligated.

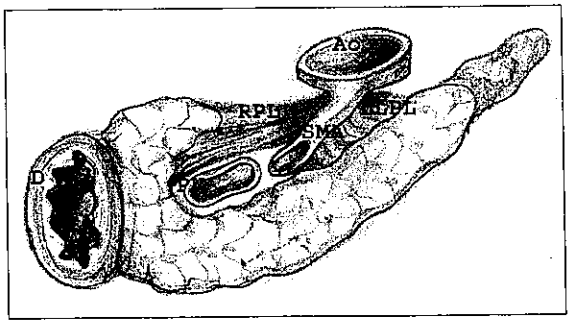


**FIGURE 6** Transverse section through the pancreas showing the relations of the retroportal process (lamina). RPL: retroportal lamina; Ao: aorta; SMA: superior mesenteric artery; PV: portal vein, D: duodenum; LLPL: left lateroportal lamina.

more extensive involvement may be segmentally resected with vascular reconstruction (with primary anastomosis or interpositing grafting) **(Figure 5)**.

10) Gastrointestinal continuity, abdominal drainage and postoperative care were managed similarly to the standard procedure. In the case of the pancreaticojejunal anastomosis, we performed the end-to-side technique with the stent in the pancreatic duct in 9 cases, and the end-to-side pancreaticojejunostomy with duct anastomosis in 1 case.

## RESULTS

We did not record any significant intraoperative incident.

The mean operative time was 225 minutes (range 180-240 minutes).

The mean blood loss was 372.25cc (range 150-800cc) and only one of the studied cases required intraoperative blood transfusions (1 unit of blood).

The segmental resection of the PV was recorded in 2 cases of pancreatic head carcinoma and the vascular reconstruction was performed by Goretex graft interpositing.

Two cases (one with ampullary carcinoma and the other one with carcinoma of the distal part of the common bile duct) were managed by the pylorus-preservation procedure.

Specimen analysis in patients with pancreatic cancer revealed the presence of ductal adenocarcinoma in all the 8 cases. We identified the following postoperative stages: IA (T1NOM0) (4 cases), IB (T2N0M0) (2 cases) and IIB (T3N1M0) (2 cases). Histological analysis of carcinoma of the distal part of the common bile duct revealed a ductal adenocarcinoma with IIB (T3N1M0) postoperative stage.

The mean length of hospitalization was 12.2 days (range 10-24 days).

There were no postoperative deaths.

Postoperative complications consisted of an intraabdominal hemorrhage from arterial source of the pancreatic capsule (on the day of the operation) (1 case), which was treated by reoperation and local hemostasis, and a pancreatic fistula (that received conservative treatment) (1 case).

Moderate glucose levels that were found in 3 cases were monitored by adequate diet and oral antidiabetics.

No postoperative episodes of diarrhea or delayed gastric emptying occurred.

## DISCUSSION

The standard PD was performed for the first time by Alan O. Whipple. It was used for a carcinoma of the Vater ampulla and a description of the procedure was published in 1935 (8). A similar operation had been earlier performed by the German surgeon Kausch, who reported his results in 1912 (9). During the almost seven decades since the first report of Whipple's cases, over 68 technical changes of the original operation have been recorded and his one-stage PD, performed in 1945, is still the most widely used surgical approach for the neoplastic disease of pancreatic head and periampullary region (10,11). Historically, the operation was associated with a significant mortality rate (20% to 25%) and its long-term outcome has been very poor (more than 50% of patients develop locoregional recurrence after curative PD) (12-14).

Several attempts (correlated with anatomical and clinical studies) have been made to improve results by extending the operation by either more extensive lymph node dissections or resection of the vascular structures (e.g. superior mesenteric vein) but there is no clear evidence of their effectiveness in improving overall survival (14,15).

In the posterior region of the pancreatic head, the lymphatic drainage has an anatomical support which Richelme has defined as right retroportal process or right retropancreatic process or lamina (in French, "la lame rétro-portale"); it corresponds to the mesentery of the ventral pancreatic bud that is actually a cluster of soft tissue situated approximately in a frontal plane, between the pancreas and the superior mesenteric artery **(Figure 6)** (5-7). This structure includes the PV, nerve fibers, lymph nodes and the lymphatics of the pancreaticoduodenal and posterior arcade. An adequate lymphadenectomy will therefore involve a com-

plete resection of the retroportal process.

It is a well known fact that cases of pancreatic head cancer usually show a nodal involvement in the anterior and posterior pancreaticoduodenal regions and the area situated along the superior mesenteric vessels; the most commonly involved lymph node group is represented by posterior pancreaticoduodenal lymph nodes, superior mesenteric nodes, anterior pancreaticoduodenal lymph nodes and paraaortic nodes (15-17). The cause of the locoregional recurrence was attributed to the extrapancreatic cancer extension - nodal involvement and microinvasion into lymphatic channels, vascular vessels, soft tissues, and perineural spaces - all these structures being situated in the retroportal tissue or lamina (17).

Based on these prerequisites, Pessaux *et al.* introduced the last modification of the standard resection which consists of the complete resection of the retroportal pancreatic lamina during PD (5). In this case, the resection begins with the dissection of the origin of the SMA, followed by a step-by-step section of the retroportal pancreatic lamina on the right side of the SMA; the pancreatic head is then retracted to the left and freed from the PV, and the neck of the pancreas is finally transected, allowing a full lymph node clearance and ensuring a safe dissection of the SMA. In addition, early dissection of the SMA origin enables the identification of a replaced right hepatic artery (which is a common anatomic type in this location in 15-20% of the total number of cases) and clearly establishes the occurrence of a possible invasion in the superior mesenteric artery which is unlikely to be overcome by resection (5).

In our Center an increasing preoccupation for pancreatic surgery, along with an improved surgical experience, resulted in a constant rise in the number of patients resected for pancreatic cancer, with a low morbidity and mortality rate (the overall morbidity was 31% and the mortality rate was 4.1% in the last 5-year experience in surgical resection for pancreatic cancer) similarly with the results of the others high-volume referral centers (that means more 16 pancreatectomy per year), where the mortality rate for PD was under 5% and morbidity rate approximately 30% (18-21). Based on our experience in pancreatic surgery, in carefully selected cases (suitable general status, young patients) we advocate the role of lymphadenectomy for tumors in the pancreatic head and uncinate process. To maximize the radial retroperitoneal margin during PD, dissection must occur in the immediate periadventitial plane of the SMA (21). As a consequence, the SMA dissection is the most oncologically significant step in PD (21).

We continued the dissection of the SMA until the artery penetrated the layers of the mesentery. The portal vein is also completely dissected if noninvaded and left in place to be ressected at the end of the operation if it is invaded. Operating time, intraoperative blood loss and transfusion requirements had not significantly higher levels in our procedure. Although a complete dissection of the SMA may produce a disabling diarrhea (mediated by the denervation of the small bowel associated with extended circumferential perivascular soft tissue), such a symptom was not recorded by us postoperatively, because dissection freed only the right side of the artery (3,19).

As compared to the standard procedure, the posterior approach allows an optimal exposure of arterial abnormalities (a right hepatic artery from the SMA) or venous invasion, facilitating vascular resection and reconstruction. Like other authors, we believe that, except for resection of the PV or the superior mesenteric vein (restricted to tumors that have arisen close to the veins and involved them while still small), extended resections (with other arterial or venous resections) are no longer recommended (16,19).

The posterior approach in PD offers an early selection of patients during the operation (in terms of resectability). As compared to the standard procedure, it enables an adequate lymphadenectomy that can be safely performed (by early dissection and isolation of the superior mesenteric artery), and avoids possible intraoperative accidents secondary to anatomical arterial abnormalities. The posterior approach is particularly useful in cases with portal vein invasion, where it allows a "no-touch" resection, avoiding intraportal tumor dissemination.

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