

Inframesocolic Superior Mesenteric Artery First Approach as an Introductory Procedure of Radical Antegrade Modular Pancreatosplenectomy for Carcinoma of the Pancreatic Body and Tail

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Abstract Superior mesenteric artery (SMA)-first approaches are operative tactics used to determine tumor resectability early during pancreatoduodenectomy. With locally advanced carcinoma of the pancreatic body and tail, early determination of SMA involvement also helps establish whether curative resection is feasible. During either radical antegrade modular pancreatosplenectomy (RAMPS) or classic left-to-right distal pancreatectomy, dissection of the SMA is performed after transection of the pancreas or wide detachment of the distal pancreas and spleen. Herein, we describe an inframesocolic SMA-first approach as an introductory procedure when treating carcinoma of the pancreatic body and tail. This first approach procedure provides a reliable and safe introduction to RAMPS.

Keywords Superior mesenteric artery · Distal pancreatectomy · Pancreatic cancer

Introduction

Radical antegrade modular pancreatosplenectomy (RAMPS) is a surgical procedure used to treat carcinoma of the pancreatic body and tail, which enables surgeons to achieve negative posterior margins more frequently than the traditional left-to-right surgical approach.¹ RAMPS has been reported to achieve satisfactory surgical outcomes as demonstrated by a negative tangential margin and the number of harvested lymph nodes.² We have preferentially adopted this approach

for the last 10 years and have reported favorable post-resection outcomes for carcinoma of the pancreatic body and tail.³

More recently, neoadjuvant treatment has been proposed as a way to decrease tumor burden and downstage tumors in patients with locally advanced pancreatic adenocarcinoma prior to surgery.^{4,5} Meta-analyses have indicated that neoadjuvant treatment also has some efficacy in patients with borderline/unresectable carcinoma.^{6,7} In pretreated patients with locally advanced disease, the evaluation of cancer involvement by multidetector row computed tomography (MDCT) or magnetic resonance imaging (MRI) is sometimes difficult. Therefore, intraoperative early determination of blood vessel involvement is of vital importance in establishing the potential curability of the disease.⁸ Superior mesenteric artery (SMA)-first approaches are operative tactics performed to aid the early determination of whether or not this crucial vessel is involved prior to committing to an irreversible operative step during surgery. These techniques have occasionally been reported for pancreatoduodenectomy.^{8,9}

With locally advanced carcinoma of the pancreatic body and tail, celiac axis (CA) involvement is relatively common compared to SMA involvement. Although CA-limited invasion has been effectively treated using distal pancreatectomy with celiac axis resection (DP-CAR),^{10–12} SMA involvement is a definitive marker of unresectable disease. During RAMPS or classic left-to-right distal pancreatectomy, dissection of the

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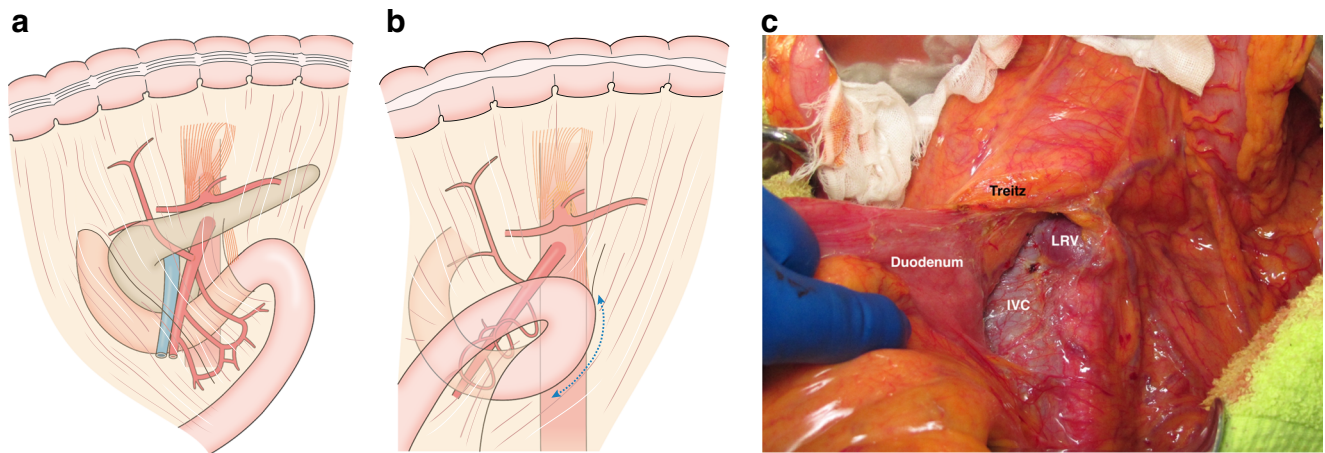


Fig. 1 **a** The omentum and transverse colon are superiorly retracted. **b** The small intestine is retracted to the right. The peritoneum is incised at the duodenal recess (*broken line*). **c** Intraoperative image. The aorta,

inferior vena cava, and left renal vein are exposed. *Treitz* the ligament of Treitz, *LRV* left renal vein, *IVC* inferior vena cava

SMA can occur after transection of the pancreas or wide detachment of the distal pancreas and spleen.¹ This paper presents an introductory procedure useful for estimating resectability and preparing an appropriate modulated dissection plane prior to committing to RAMPS.

Surgical Techniques

After the abdominal cavity has been explored to exclude liver and peritoneal metastases from pancreatic cancer, the omentum and transverse colon are superiorly retracted (Fig. 1a) and the small intestine is retracted to the right (Fig. 1b). The peritoneum is incised at the duodenal recess and the aorta, inferior vena cava, and left renal vein are exposed by mobilizing and rotating the fourth portion of the duodenum and the uncinate process of the pancreas (Fig. 1c). These procedures will expose the left aortic wall and left adrenal gland. The mesentery base is then incised, the ligament of Treitz is opened on the left and anterior side of the mesenteric root, and the

duodenojejunal flexure is pulled down. The SMA is then identified, and a vessel loop is passed around the SMA. Dissection of the SMA proceeds to the origin of the SMA (Fig. 2).

Next, the transverse colon is pulled downward, and the gastrocolic ligament is incised, opening the omental bursa. The stomach is then lifted anteriorly. After dissecting the inferior border of the pancreas to the right, the superior mesenteric vein (SMV) is exposed and the mesocolon is opened on the left side of the SMA (Fig. 3a). The middle colic veins are severed if the tumor has invaded these vessels.

The gastroduodenal lymph nodes are then dissected, and the common hepatic artery and portal vein are exposed along the superior border of the pancreas (Fig. 3b). After division of the splenic artery at its origin, the neck of the pancreas is tunneled and divided with a linear stapler comprising bioabsorbable felt (Fig. 4) and tilted to the left in order to facilitate lymph node dissection around the CA. Subsequently, the splenic vein was ligated at its origin. The anterior surface of the SMA, which is already exposed, is located and proximally dissected until reaching the SMA origin (Fig. 5).

Fig. 2 **a** The ligament of Treitz is opened, divided on the left and anterior side of the mesenteric root, and a vessel loop is passed around the superior mesenteric artery (SMA). The dissection proceeds up to the origin of the SMA. **b** Intraoperative image. *LAV* left adrenal vein, *LRV* left renal vein

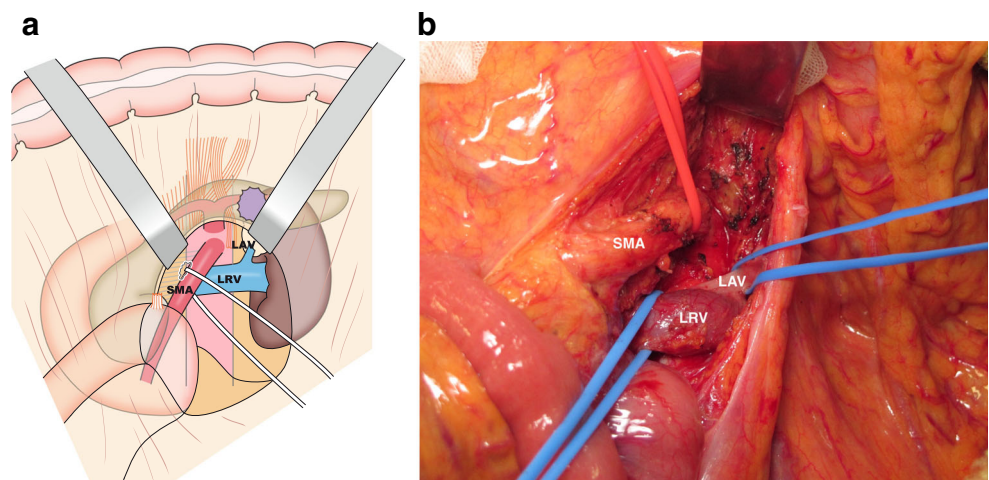
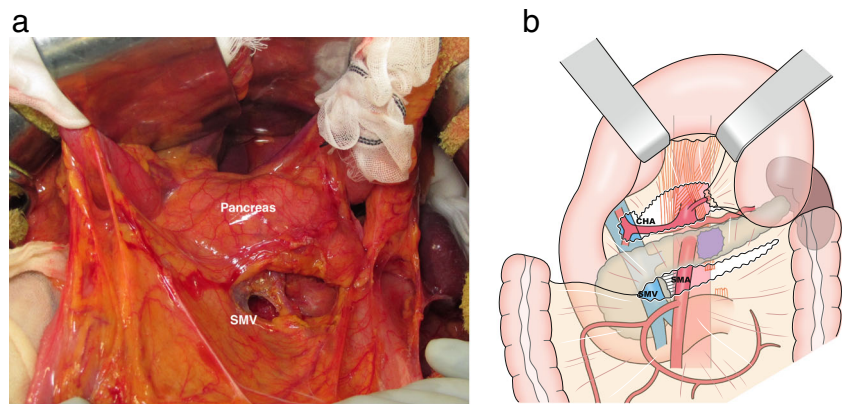


Fig. 3 **a** Intraoperative image. After dissecting the inferior border of the pancreas to the right, the superior mesenteric vein (SMV) is exposed and the mesocolon is opened on the left side of the superior mesenteric artery (SMA). **b** The gastroduodenal lymph nodes are dissected, and the common hepatic artery (CHA) and portal vein are exposed along the superior border of the pancreas



After these introductory procedures are completed, the RAMPS procedures are performed. The retroperitoneal dissection has already been partially performed; thus, a surgeon should be able to easily locate the right plane and complete the dissection from the aorta, adrenal gland, kidney and the diaphragm and the retroperitoneal muscles to finish RAMPS.

Discussion

Pancreatic cancer has an extremely poor prognosis and prolonged survival is achieved only by resection with macroscopic tumor clearance. With current advances in surgical techniques, the oncological optimal margin for pancreatic cancer resection includes the SMA rather than the portal-superior mesenteric vein.¹³ In practice, the estimation of resectability by computed tomography is not always accurate, particularly in the neoadjuvant setting.¹⁴

SMA-first approach, as devised by Pessaux et al.,⁸ aligns exactly with the need for early determination of cancer resectability during pancreatoduodenectomy. This procedure also

effectively prevents damage to an aberrant hepatic artery which arises near the SMA origin in 15–20 % of cases. The aforementioned article⁸ has inspired many authors to publish various approaches to use in securing a curative margin around the SMA for pancreatic head carcinomas.^{15–19} Sanjay et al.⁹ systematically reviewed and classified various techniques for SMA-first approaches that are exclusively performed for pancreatoduodenectomy.

Carcinoma of the pancreatic body and tail often presents at an advanced stage, and the resectability rate is lower than that for lesions in the pancreatic head.^{20–22} One of the reasons for this difference is its propensity to invade pivotal blood vessels such as the CA and SMA. Although pancreatic body carcinoma limitedly invading the CA has been effectively treated with DP-CAR,^{10–12} SMA encroachment generally indicates that a carcinoma is inoperable.²³ Strasberg et al.¹ reported on RAMPS a novel approach for resecting a carcinoma of the pancreatic body and tail. With RAMPS, the posterior plane of dissection is defined by an anatomical component, such as the SMA, aorta, left adrenal gland, Gerota's fascia, or dorsal muscle. The authors reported a significantly improved rate in

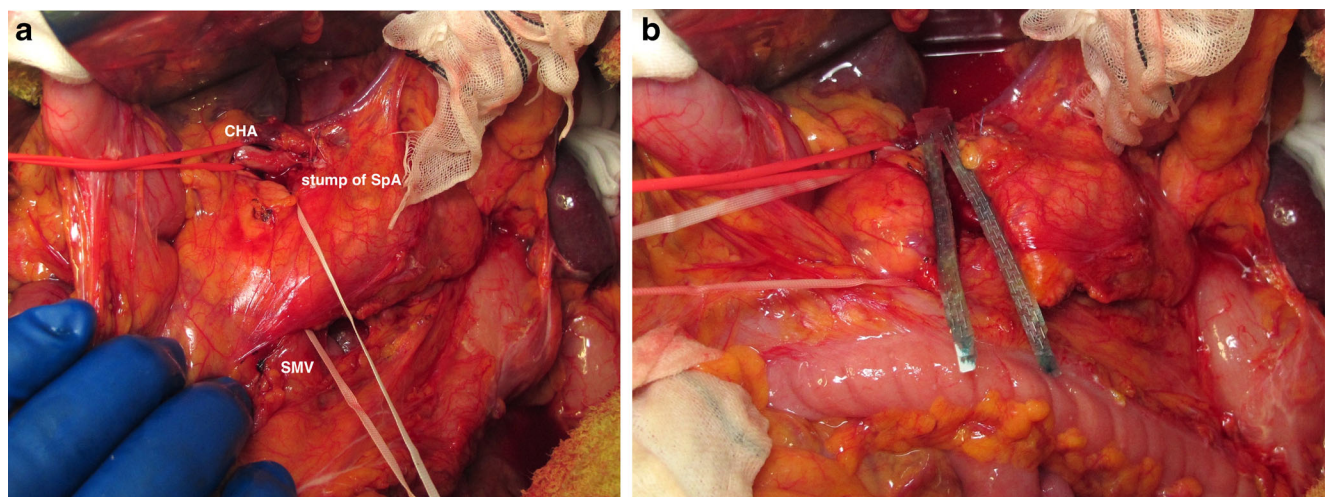


Fig. 4 Intraoperative images. **a** The neck of the pancreas is tunneled. **b** The pancreas is divided with a linear stapler comprising bio-absorbable felt. *CHA* common hepatic artery, *SMV* superior mesenteric vein, *SpA* splenic artery

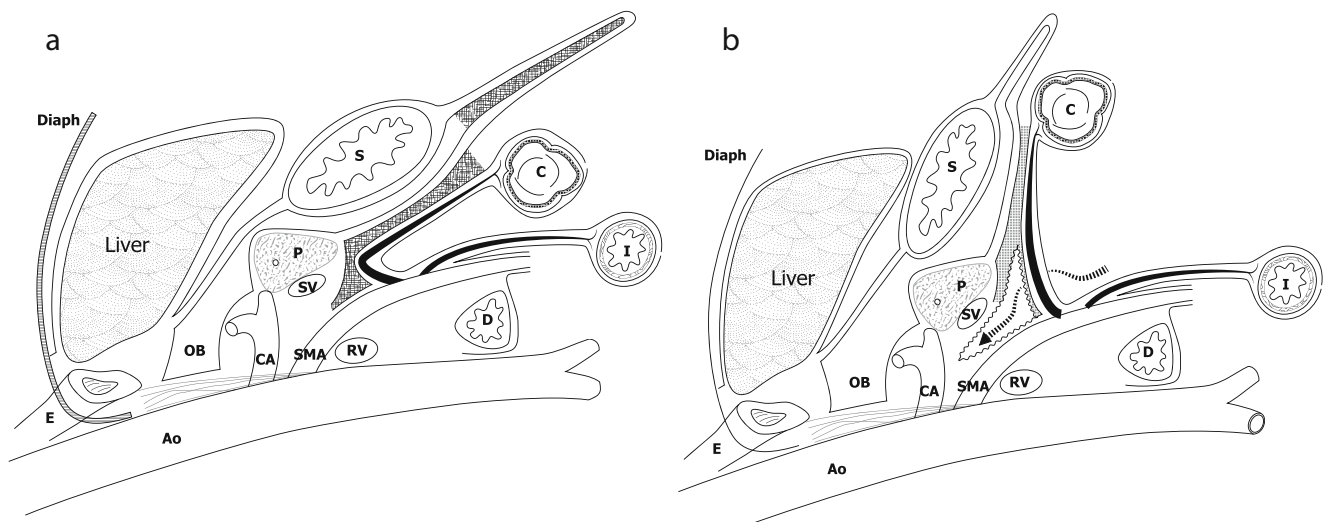


Fig. 5 **a** Schema of a sagittal view of the procedure. **b** The arrow indicates the dissection line proceeding to the origin of the superior mesenteric artery (SMA). *E* esophagus, *OB* omentum bursa, *Diaph*

diaphragm, *Ao* aorta, *CA* celiac axis, *RV* renal vein, *SV* splenic vein, *P* pancreas, *S* stomach, *D* duodenum, *C* colon, *I* ileum

achieving a negative dissection margin on the dorsal plane of carcinoma of the pancreatic body and tail using the RAMPS procedure, Kitagawa et al.²⁴ also reported the satisfactory survival rate with modified RAMPS for approaching the anterior renal fascia from the left side. During RAMPS, the dissection commences and advances from-right-to-left, with early division of the neck of the pancreas and splenic vessels. The SMA is then dissected from right-to-left to its origin on the aorta after tilting the pancreatic stump to the right. This positioning allows the surgeon to visualize the vascular structures around the SMA, thereby enabling the identification of SMA margin clearance. Therefore, determination of SMA involvement is impossible without first committing these irreversible operative steps.

According to Bonnichon et al.,²⁵ an inframesocolic approach can be employed to expose the proximal section of the SMA to evaluate atherosclerotic disease. We have resumed utilizing this approach for trial dissection of the SMA on patients with carcinoma of the pancreatic body and tail. After freeing the ligament of Treitz and pulling down the duodenum, this approach allows the exposure and taping of the SMA between its retropancreatic and interpancreaticoduodenal sections.²⁵ Although this procedure is not always sufficient to allow access to the most proximal portion of the SMA, especially in obese patients, it provides an opening for critical dissection in order to determine resectability. Dissection further up along the aorta to expose the left renal vein and the left adrenal gland can help prepare the RAMPS right dissection plane in advance. When the renal vein has been reached, the surgeon can accurately assess the extent of tumor penetration to help decide whether anterior or posterior RAMPS are optimal.

Between April 2008 and September 2015, 32 patients underwent RAMPS and nine patients underwent DP-CAR for carcinoma of the pancreatic body and tail. Among these patients, the procedure described here was performed in five patients and all patients underwent R0 resection. This procedure is both feasible and useful for laparoscopic distal pancreatectomy.²⁶ We believe that the inframesocolic SMA-first approach provides a reliable and safe introduction to RAMPS.

Compliance with Ethical Standards

Conflict of Interest Authors declare that they have no conflict of interest.

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