EARLY RETROPANCREATIC DISSECTION DURING PANCREATICODUODENECTOMY - TECHNICAL NOTES

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EARLY RETROPANCREATIC DISSECTION DURING PANCREATICO-DUODENECTOMY - TECHNICAL NOTES (ABSTRACT): *Background:* Pancreaticoduodenectomy (PD) is the procedure of choice for malignant tumors of the pancreatic head and periampullary region. During PD, early pancreatic neck division may be inadequate, especially in cases of hepatic artery (HA) anatomic variants, when invasion of the superior mesenteric artery (SMA) is suspected, or in cases of intraductal papillary mucinous neoplasms (IPMN). *Methods:* We perform an early approach of the retroportal lamina (RPL) from behind the pancreatic head, before pancreatic transection. This is accomplished after lymphadenectomy and adequate mobilisation of the specimen from the vessels, on either the neck or the body, according to the tumor extension. *Results:* We successfully used this approach during 28 PD. There were 21 patients to whom we detected anatomic variants of right hepatic artery (RHA), which was spared in 19 cases; arterial reconstruction was required in one case. We also used this technique in 5 patients with IPMN - 3 PD extented to the body and 2 total pancreatectomies, and in other 2 patients with adenocarcinoma involving the porto-mesenteric jonction, requiring limited venous resection and reconstruction. *Conclusions*: Retropancreatic approach with early RPL dissection is an useful technical variant of pancreaticoduodenectomy which we recommend in selective indications.

KEYWORDS: PANCREATICODUODENECTOMY, POSTERIOR APPROACH, RIGHT HEPATIC ARTERY, SUPERIOR MESENTERIC ARTERY, INTRADUCTAL PAPILLARY MUCINOUS NEOPLASM.

List of abbreviations: CBD- common bile duct; Ct- celiac trunk; IPMN- intraductal papillary mucinous neoplasm; HA- hepatic artery; MDCT- multidetector computed tomography; PD- pancreaticoduodenectomy; PH- porta hepatis; PV- portal vein; RPL- retropancreatic lamina; RHA- right heparic artery; RCHA- replaced common hepatic artery; SMA- superior mesenteric artery; SMV- superior mesenteric vein.

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INTRODUCTION

Pancreaticoduodenectomy (PD) is still considered nowadays a challenging operation with a postoperative mortality rate of less than 5% but a high morbidity rate of close to 40%, even in recent series [1,2]. It is mostly indicated for malignant tumors of the pancreatic head, uncinate process and periampullary region [3], for some benign pancreatic tumors [4,5], but also recommended for advanced gallbladder carcinoma or mid-to-distal common bile duct (CBD) cancers, (either in hepatoduodeno-pancreatectomy operation or for removal of retro pancreatic lymph nodes) [6,7].

* received date: 10.12.2010
accepted date: 08.01.2011

Since the first PD performed by Whipple in 1937, more than 65 improvements of the technique were made, concerning mainly pylorus preservation or reconstruction of pancreaticodigestive continuity [1,8]. Durind resection, PD is usually performed backward, with transsection of the pancreatic neck before division of the RPL close to the SMA [9-13].

Recently, indications of PD have extended to IPMN [14,15] and periampullary tumors invading the mesenterico-portal vein [16,17]. In these last two conditions, division of the pancreatic neck may be impossible or inappropriate so that division of the pancreatic body can be preferred. Moreover, the latter indication carries a high risk for palliative resection owing to involvement of the RPL [18]. For these reasons, we perform in such cases a retropancreatic approach PD, with early division of the retroportal tissue close to the origin of SMA, to assess radicality of resection, variant pattern of the arterial blood supply to the liver , to properly mobilize the specimen before pancreatic division, and, if necessary, to safely perform venous clamping [5]. This technical variant was firstly suggested by Leach and then reported by Machado and Pessaux [12, 19-21].

The purpose of the current study is to describe how, when and why we perform this approach during PD, with pancreatic transection as the last step of resection.

METHODS

Incision and exploration. We routinely use an upper abdominal midline incision as a standard approach. The surgical exploration is completed by intraoperative ultrasonography to confirm preoperative imaging data. The pancreas head exposure is obtained by the Kocher maneuver and opening the lesser sac by separating the greater omentum from the transverse colon. Dorsal to the pancreatic head, the dissection must pass beyond the aorta, to get full posterior mobilisation of the duodenopancreas to the patient`s left, in order to render evident the plane between the superior mesenteric vein (SMV) and the SMA. Liver and peritoneal exploration is performed as well as the palpation of the mesenteric root and biopsy examination of aortocaval nodes with frozen section.

Dissection of porta hepatis (PH) (Fig 1). After cholecystectomy we perform dissection and exposure of the CBD, portal vein (PV) and HA.

Fig. 1 *Dissection of porta hepatis*

The common and proper HA, when they exist as such, are first identified, dissected and put on tapes. We divide the right gastric vessels and then to identify and clamp the gastroduodenal artery to make sure that arterial flow either in hepatic and gastric arteries remains normal and there is no unrecognized celiac trunk (Ct) stenosis. The gastroduodenal artery is then divided, as well as the the CBD above the entry of the cystic duct. These two last maneuvers improve the exposure on the PV. Care must be taken during dissection and lymphadenectomy on the right side of the PV, because this area may contain an accessory or replaced RHA originating from the SMA, aorta or even the Ct, but also a replaced common hepatic artery (RCHA) arising from the SMA or aorta. This aberrant vessel is usually running upwards behind the PV and CBD, within the hepatic pedicle. We usually dissect and isolate it on a tape, formerly in its segment belonging to PH (Fig. 2).

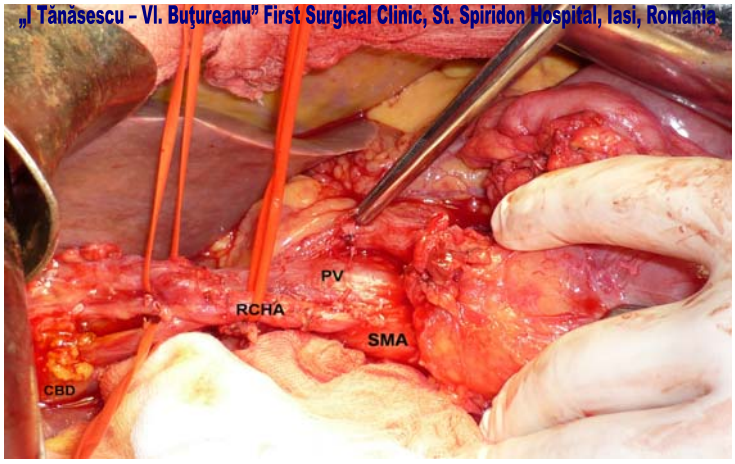

Fig. 2 *Replaced common hepatic artery (RCHA) arising from the SMA*

We carry on downwards the retropancreatic dissection, revealing the inferior vena cava and its left side, the left renal vein with its upper margin, and in between, the origin of the SMA (Fig 3).

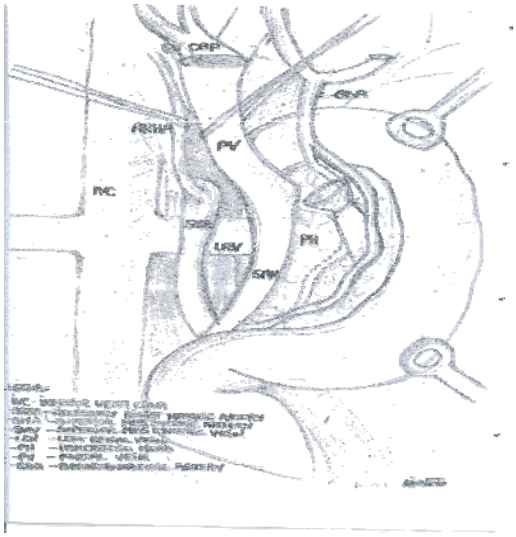

Fig. 3 *Disection of the SMA*

Disection of the SMA and RPL. The key of the intervention is to reveal the SMA origin, by dissecting and removing the RPL, which is inserted on the right aspect of the SMA. We dissect all soft tissues and lymph nodes located in this retropancreatic plane from the origin of the SMA, along 4 cm towards its entry into the mesentery, after progressive exposure and gentle medial retraction of the PV (Fig. 3). This step allows safe exposure and dissection of an accessory or replaced RHA, or RCHA arising from the SMA, aorta or Ct. We dissect and set free the aberrant vessel from the RPL , from its origin, upwards the PH. However, RHA or RCHA originating SMA can course *behind*, *within* the pancreatic head, or rarely *along the ventral side* of the pancreas (Fig. 4). Care must be taken also in case of accessory or replaced RHA, arising from the Ct, because this vessel usually courses behind the upper border of the pancreatic head, crosses the posterior aspect of the PV, to gain a dorsolateral position within PH (Fig 5). For certain, before dissecting and preserving the aberant RHA, we could not confirm its course. To facilitate the SMA and aberrant RHA or RCHA dissection, the pancreatic head and duodenum are retracted en bloc ventrally and to the left (Fig 2). With this exposure, the SMA and an accessory, replaced RHA or RCHA, originating in SMA, aorta or Ct, are easily identified and carefully dissected. We advocate to limit the dissection along the right side of the SMA, in order to avoid an extensive removal of perivascular nervous plexus, resulting in postoperative intestinal motility troubles (diarrhoea).

Fig. 4 *CT exam – RHA arising from SMA*

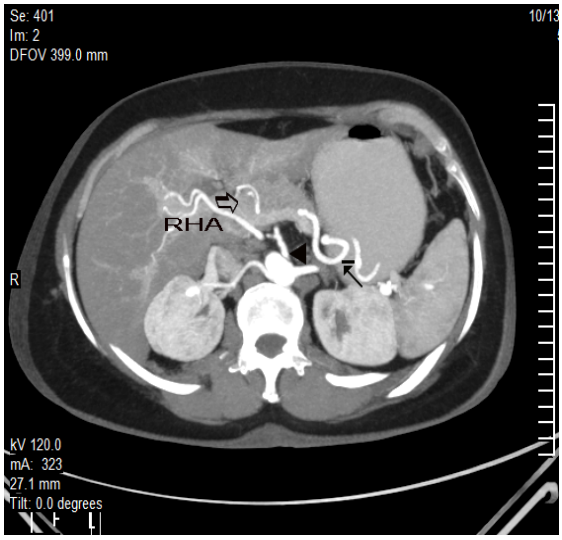

Fig. 5 *CT exam – RHA arising from Ct*

The SMV dissection and uncinate exposure. The SMV then is entirely dissected at the inferior margin of the pancreas. The right gastroepiploic vein and all veins drainining the uncinate process into SMV, are ligated and divided. The uncinate is exposed up to the the right side of the SMA.

Mobilisation of the duodenojejunal jonction. The division of the Treitz ligament, equally by a posterior approach, allows full mobilisation of the duodenojejunal jonction and retraction of the first jejunal loop under the superior mesenteric vessels, so that the specimen to be removed reaches the right side of the mesenteric root. The inferior pancreaticoduodenal artery, wich usually originates from the first jejunal artery, is identified and ligated. When the SMA is supposed to be involved by the tumor,

according to preoperative imaging, SMA dissection with tissue sampling for frozen section can be performed, without any previous section of the digestive tract or pancreatic continuity, thus avoiding the risk for nonradical resection. As the SMA involvement is proven, the arterial and venous vascular structures of the duodenopancreas are preserved and both a hepatojejunostomy and gastroenterostomy still can be performed.

Jejunal and gastric division. Once radicality of PD is established, the proximal jejunum is divided, 10 to 15 cm from the duodenojejunal jonction, by a GIA stapling device. The mesentery is divided from jejunal division towards the SMA , sparing the first jejunal vessels. The uncinate is mobilised from the SMA with lymph node dissection, performing successive ligations af all retropancreatic tissue and vessels situated on the posterior and right sides of the SMA. The distal stomach is then divided using a GIA stapler.

Pancreas division

The last step of the resection phase is the transection of the pancreatic neck, when adequate, just in front of the portal vein. When we must perform the pancreatic division on the body, owing to the intrapancreatic extension of an IPMN, division of both the dorsal pancreatic artery (originating usually from the Ct or the proximal splenic artery) and collaterals of both the SMA and the SMV (from the inferior edge of the pancreas), are required. In case of pancreatic head tumor involving the portomesenteric confluence, we performe en bloc mobilisation and the splenic vein can be controlled behind the body. Adequate mobilization of the mesentery and of the right colon is necessary to perform safely „en bloc'' resection and reconstruction after segmental resection of the vein. We estimated this mobilization as useful in case of isolated and limited portomesenteric invasion, for avoiding vein grafting during venous reconstruction. In case of PMN, the retro-pancreatic mobilization is carried on towards the left and can be prolonged by dissection of splenic vessels with successive ligation of their collaterals. When the pancreatic body is mobilized enough from splenic vessels, we can divide the pancreas at any level, or even entirely remove it if necessary. Anyway, frozen section analysis can be performed on the cut surface of the specimen, to assess the malignant status of the remnant pancreas. Intraoperative methods to assist in determining the extent of the resection were not routinely used: frozen section analysis in 3 cases. As about the *reconstruction phase* after the PD, we always perform a pancreaticojejunal end-to-side "duct-to- mucosa" temporary stented anastomosis with 6-0 PDS sutures. Standard hepatico-jejunostomy and gastro-jejunostomy are the final steps of the procedure**.** Drains placement and postoperative care were similar to those from standard PD.

RESULTS

In our surgical department**,** the early posterior approach PD has become since 2007 the standard in patients with RHA anatomic variants. RHA anomalies were detected in 21 patients, 18 of them having malignant tumors of the pancreatic head or periampullary region and 3 patients having neuroendocrine tumors of the inferior pancreatic head. Fifteen cases had accessory or replaced RHA arising from SMA [13] or from the Ct (two cases of replaced RHA). Six cases had a RCHA originating in SMA. The HA anatomy was preoperatively assessed in all patients by multidetector computed tomography (MDCT) with angiography, which showed the aberrant HA in 20 cases.

In one case, despite preoperative MDCT findings of normal HA anatomy, we intraoperatively found out an inadvertent division of a 2-mm diameter accessory RHA. As the patient had also a proper HA with a good backflow from the stump of the accessory RHA, we decided to ligate the latter with no postoperative problem.

In another case, a RCHA originating from the SMA was involved by an enlarged lymph nodes mass, located behind the pancreatic head. A segmental resection of the involved RCHA had to be performed. Whereas after the RCHA clamping, an inadequate blood flow in the liver was registered (by Doppler ultrasound intraoperative examination), a vascular reconstruction was decided. The proximal stump of the RCHA was ligated and the arterial reconstruction was made using the gastroduodenal artery stump which was sutured to the distal stump of the RCHA.

We also used this posterior approach in 2 patients with ductal adenocarcinoma involving the portomesenteric confluence which required en bloc-vascular resection, mobilization of the right colon and the root of mesentery followed by mesentericoportal end to end anastomosis. The postoperative course was uneventful. In the patients requiring vascular reconstruction, the Doppler ultrasound examination revealed a good arterial supply to the liver and a good portal flow as well. For these 3 patients, clamping time did not exceed 20 minutes.

We additionally used this posterior approach in 5 patients with IPMN (3 PD extented to the body - IPMN in the head, neck or uncinate process, and 2 total pancreatectomy- IPMN diffusely involving the pancreatic duct). In patients with IPMN, preoperative imaging consisted in abdominal MDCT and endoscopic ultrasound with guided fine needle aspiration. No postoperative complication was noted, particularly related to this approach.

DISCUSSION

Because of recent decrease in mortality rate, PD is now performed in case of malignant tumors of the pancreatic head and periampullary region, but also for IPMN, or periampullary tumors invading the mesentericoportal vein. We have described herein our technique of early RPL during PD, with the division of the retroperitoneal soft tissue on the right side of the SMA, before the digestive and pancreatic continuity should be interrupted. We believe that this technique is the best option particularly during PD in case of: (1) HA anatomic variant, with RHA (accessory or replaced) or RCHA arising from the SMA or Ct; (2) suspected involvement of the SMA; (3) IPMN extended from the head to the body; (4) tumoral involvement of the portomesenteric confluent by a head or neck tumor, the last two conditions requiring en bloc resection and pancreatic division of the body.

Classically, PD includes the creation of a tunnel between the pancreatic neck and and the underlying portomesenteric confluent, followed by the neck transsection. Thus, pancreatic continuity is interrupted before radicality of the resection could be assessed close to the SMA. Even in some recent series, nonradical PD still represents 9 to 25 % cases [22,23]. Moreover, in the standard PD, dissection of an accessory or replaced RHA or of a RCHA , is usually performed late, when bleeding from the resection specimen decreases the exposure of the SMA and of an aberrant RHA origin. Early neck transsection is not suitable when the neck is involved by the tumor, as in pancreatic head ductal cancer involving the portomesenteric confluence [16,17] or in IPMN extended from the pancreatic head to the body [15].

One of the difficulties of PD is variability of peripancreatic vessel anatomy. Assessment of variant pattern of the arterial blood supply to the liver in patients who are about to undergo a PD is a challenging but mandatory procedure, that can lead to avoid or minimize unnecessary complications, as fatal hepatic injury [24,25].

Accidental ligation of aberrant HA may result in hepatic necrosis, ischemic biliary injury or anastomotic complications [26]. However, the importance of sparing this artery during PD lies not so much in preventing hepatic ischemia, but in preventing a breakdown of bilioenteric anastomosis, because the blood supply to the cranial part of the bile duct is entirely dependent on the RHA after PD [25,27]. Preoperative assessment of celio–mesenteric vascular pattern (variants, strictures) by imaging methods is of the upmost importance for the surgeon.

MDCT with angiography is the method of choice, since enables rapid acquisition of thin- slice-high-resolution images of the abdominal arteries, as well as 3D reconstructions. The most likely aberrant HA expected during planning or performing PD is replaced or accessory RHA originating in SMA (9,82-11%) followed by RCHA arising from SMA (1,5-2,8 %) [28-30].

RHA or RCHA from SMA may course behind, within, or along the ventral side of the pancreas [31,32]. Michels [33] found that half of the RHA actually coursed through the pancreatic parenchyma, whereas the other half passed posterior to the pancreas. If RHA or RCHA courses in the pancreas head parenchyma, this artery can be preserved by dividing the parenchyma. However, RHA or RCHA coursing along the posterior side of the pancreas can be dissected and spared formerly on its origin from the SMA and then along its retropancreatic course, under direct vision, up to PH. Before dissecting and preserving the aberrant RHA, we could not confirm its course. If an accessory RHA can usually be ligated with no adverse effects, ligation of a predominant replaced RHA can result in definitive ischemic damage of the liver and biliary tree [27].

Ductal carcinoma with venous limited involvement can be safely resected with a long-term survival similar to that observed after radical resection without venous involvement [16,19,34,35]. In this situation, venous resection is best performed en bloc to obtain disease-free margins. Another advantage of this technique is that it results in the tumor being attached only to the involved veins, so clamping of the portomesenteric confluence may be easier and shorter [36].

Mobilisation of the right colon and the root of mesentery is useful for avoiding vein grafting during reconstruction of the PV [36]. It is expected that, because pancreatic transection is performed at the end, congestion and bleeding are less likely whereas venous drainage of both the specimen and bowel are compromised minimally during most of the procedure.

Another new indication for performing a PD is IPMN. The most frequent localization is the pancreatic head, but involvement of the body can occur to some patients as well [14,15]. In this setting and particularly in malignant tumors, en bloc resection requires a PD with pancreatic division located to the body. In these cases, final transection of the pancreas, instead of neck transection followed by additional body resection, can be performed at the desired place if enough mobilized from the splenic vessels, preventing the tumor from opening, which might disseminate cancer into the abdomen. Furthermore, dissection along the splenic vessels can be extended up to the splenic hilum and allows splenic preservation if the whole pancreas must be resected, which is encountered in 2% to 15 % of patients with IPMN [14,15].

CONCLUSION

Early retropancreatic dissection is an useful approach to better expose the retropancreatic mesenteric vasculature during PD. We advocate this approach in selective situations, such as: HA anatomic variants with RHA or RCHA arising from the SMA or Ct, suspected SMA involvement, limited invasion of the mesentericoportal confluence and IPMN. Moreover, by adequate retropancreatic mobilization from right to left towards the body, pancreatic transection can be performed at any level. This approach improves both the safety and radicality of PD, by an early vascular control and enlarged lymphadenectomy.

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