



Innovations in macroscopic evaluation of pancreatic specimens and radiologic correlation



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ABSTRACT

The purpose of this study was to evaluate the feasibility of a novel dissection technique of surgical specimens in different cases of pancreatic tumors and provide a radiologic pathologic correlation. In our hospital, that is a referral center for pancreatic diseases, the macroscopic evaluation of the pancreatotomy specimens is performed by the pathologists using the axial slicing technique (instead of the traditional procedure with longitudinal opening of the main pancreatic and/or common bile duct and slicing along the plane defined by both ducts). The specimen is sliced in an axial plane that is perpendicular to the longitudinal axis of the descending duodenum. The procedure results in a large number of thin slices (3–4 mm). This plane is identical to that of CT or MRI and correlation between pathology and imaging is straightforward. We studied 70 cases of suspected different solid and cystic pancreatic tumors and we correlated the tumor size and location, the structure–consistency (areas of necrosis–hemorrhage–fibrosis–inflammation), the degree of vessels' infiltration, the size of pancreatic and common bile duct and the distance from resection margins. Missed findings by imaging or pitfalls were recorded and we tried to explain all discrepancies between radiology evaluation and the histopathological findings. Radiologic-pathologic correlation is extremely important, adding crucial information on imaging limitations and enabling quality assessment of surgical specimens. The deep knowledge of different pancreatic tumors' consistency and way of extension helps to improve radiologists' diagnostic accuracy and minimize the radiological-surgical mismatching, preventing patients from unnecessary surgery.

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1. Introduction

Pancreatic tumors represent a heterogeneous group of diseases presenting with different imaging characteristics. Malignant potential cannot always be decided on the basis of imaging findings and despite the advantages of multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI), there is a well-known underestimation of pancreatic adenocarcinoma extent as well as a grey zone concerning mainly the treatment decision on cystic lesions.

In any case, imaging reflects the tumor characteristics on histopathology. Radiologic-pathologic correlation is a well estab-

lished way to understand and explain the imaging findings and realize the potential preoperative limitations. In our center, which is dedicated to hepatico-biliary and pancreatic surgery, we have recently adopted the axial slicing technique in pancreatic specimens. This technique permits the accurate correlation with axial MDCT and/or MRI images.

This is the first study to be performed on this novel technique of pancreatotomy specimen slicing, and there are not similar studies in the literature. The axial slicing technique offers many advantages in accurate estimation of tumors extend and in evaluation of possible discrepancies between the radiological and the histopathological findings. It can be applied as an important learning tool for the radiologists increasing their diagnostic capabilities in difficult or atypical cases of pancreatic tumors.

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2. Materials-methods

2.1. Patients group

This study is based on 70 cases of suspected pancreatic neoplasms evaluated by multi-detector computed tomography (MDCT) and/or Magnetic Resonance Imaging (MRI) who underwent surgery in our hospital. The patients' age ranged between 37 and 81 years old, 39 men and 31 women.

67 patients were considered as resectable while in three cases they met the criteria of borderline resectable disease and underwent surgery following chemotherapy as decided during the Multidisciplinary Team meeting. For resectability evaluation, the recent NCCN guidelines [1] as well as the consensus statement of the International Study Group of Pancreatic Surgery [2] were used.

2.2. Imaging evaluation

MDCT or MRI using a dedicated pancreatic protocol and state of the art techniques [3] was performed, no more than two weeks before surgery. The triple contrast phases taken on MDCT included a nonenhanced phase, a late arterial phase (10-s delay from the time of peak aortic enhancement), and a portal venous phase (35-s delay). Contrast-enhanced phases were performed craniocaudally, with thin collimation (0.5 or 0.625 mm), 120 kVp, and automatic modulation of the milliamperes. Three-millimeter axial images and 5 × 5-mm coronal and sagittal reformatted images were sent to the picture archiving and communication system and 0.5-mm-thick sections were sent to workstations for post processing (multiplanar reformations, maximum intensity projections, volume rendering and curved planar reformations) [4].

For the evaluation of resectability in locally advanced lesions Multi detector CT angiography was applied (MDCTA) using an additional early arterial phase. We routinely use bolus tracking with automatic power injectors and we set a region of interest on the abdominal aorta at the level of the celiac axis with a pre-defined enhancement threshold at 150HU. The maximum degree of circumferential contact (CC), the length of contact (LC) of the tumor with major vessels and the luminal narrowing of vessels (venous deformity, [VD]) were evaluated. For the reporting we used the standardized adenocarcinoma radiology reporting template as published in the consensus statement of the Society of Abdominal Radiology and the American Pancreatic Association [5].

The sequences applied on MRI/MRCP were: T1-weighted gradient-echo; T2-weighted axial and coronal sequences, usually turbo spin echo; two dimensional (2D) and three dimensional (3D) MRCP; and T1-weighted 3D gradient-echo (GRE) before and after intravenous administration of gadolinium. Detection of pancreatic adenocarcinoma on MRI was based on unenhanced T1W (fat-suppressed) images and pancreatic-phase postgadolinium T1W spoiled GRE. Adenocarcinomas were expected to present as hypovascular lesions, while neuroendocrine tumors were expected to appear as hypervascular lesions. Magnetic Resonance Cholangiopancreatography (MRCP) was always done for tumors located in the pancreatic head and for periampullary lesions.

In equivocal cases Endoscopic Ultrasound (EUS) was performed and final decision for surgery was taken after the evaluation of EUS-FNA results.

2.3. Surgical techniques

All cases were reviewed preoperatively in our Multidisciplinary team meeting, where the optimal treatment strategy for each patient is decided. Staging laparoscopy in assessing pancreatic cancer resectability is not routinely used [6]. Pancreatectomies were performed using a standard technique whereas in the majority

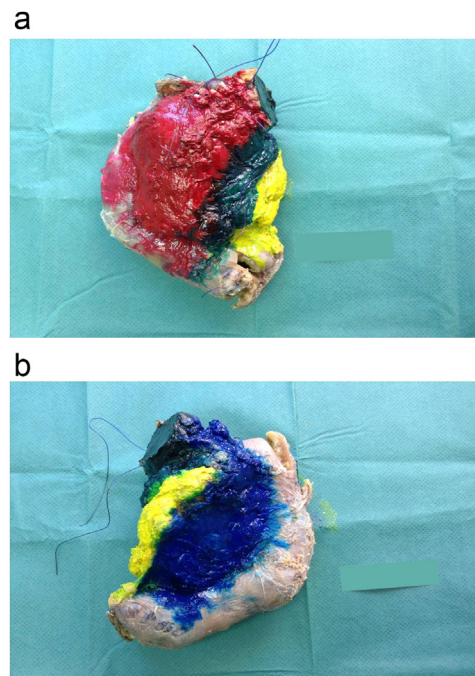


Fig. 1. Circumferential resection margins in a pancreatoduodenectomy specimen: anterior surface (red) (a), facing the SMV (green) (a), facing the SMA (yellow) (a,b) and posterior surface (blue) (b). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

of cases pylorus was preserved (pylorus-preserving pancreaticoduodenectomy: PPPD). Total pancreatectomy was carried out in cases of intraoperative repeated frozen section positive margins and in cases of multifocal intraductal papillary mucinous neoplasm (IPMN). Moreover total pancreatectomy was performed in patients where the pancreatic anastomosis could not be carried out with safety, mainly in those with soft and friable pancreatic texture.

Nowadays, despite the fact that clear and widely accepted definitions of resectability and borderline resectability exist, it seems that surgeons' capabilities can define resectability in many cases. The presence of distant metastases along with extensive, circumferential encasement of superior mesenteric artery or celiac abutment is considered as a non-resectable disease. Occurrences of inferior vena cava or aortic invasion and presence of unreconstructible portomesenteric occlusion are also included in the definition of unresectable disease [7].

However, as mentioned above, surgeons' capabilities and experience, especially in high volume centers, have led to pancreatic surgery toward a new era regarding vascular reconstructions. There is clear evidence supporting straightforward exploration and resection in cases of reconstructible involvement of the mesentericoportal axis where complete tumor excision (R0) can be achieved [7–9]. On the other hand, arterial reconstruction cannot be regarded as a “gold standard”. Although there are reports in favor of SMA or celiac axis resection and reconstruction, there is lack of level I evidence regarding the benefits of arterial resection [7,8,10]. Another critical issue, often debated, is the extend of lymphadenectomy. We routinely perform standard lymphadenectomy as proposed by the ISGPS group [8,11].

2.4. Histopathology evaluation

In our hospital, the macroscopic evaluation of the PPPD specimens is performed by the pathologists using the axial slicing technique. After fixation and prior to slicing, inking of the margins and specimen surfaces is performed (Fig. 1a and b). Different col-

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