Radiology

Pancreatic Ductal Adenocarcinoma Radiology Reporting Template: Consensus Statement of the Society of Abdominal Radiology and the American Pancreatic Association[1]

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Pancreatic ductal adenocarcinoma is an aggressive malignancy with a high mortality rate. Proper determination of the extent of disease on imaging studies at the time of staging is one of the most important steps in optimal patient management. Given the variability in expertise and definition of disease extent among different practitioners as well as frequent lack of complete reporting of pertinent imaging findings at radiologic examinations, adoption of a standardized template for radiology reporting, using universally accepted and agreed on terminology for solid pancreatic neoplasms, is needed. A consensus statement describing a standardized reporting template authored by a multi-institutional group of experts in pancreatic ductal adenocarcinoma that included radiologists, gastroenterologists, and hepatopancreatobiliary surgeons was developed under the joint sponsorship of the Society of Abdominal Radiologists and the American Pancreatic Association. Adoption of this standardized imaging reporting template should improve the decision-making process for the management of patients with pancreatic ductal adenocarcinoma by providing a complete, pertinent, and accurate reporting of disease staging to optimize treatment recommendations that can be offered to the patient. Standardization can also help to facilitate research and clinical trial design by using appropriate and consistent staging by means of resectability status, thus allowing for comparison of results among different institutions.

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Pancreatic ductal adenocarcinoma (PDA) is the second most common gastrointestinal malignancy after colorectal cancer. It is a highly aggressive tumor that carries a high mortality rate and is the fourth most common cause of cancer-related death in the United States in both men and women, with an estimated 43 920 new cases diagnosed and approximately 37 390 deaths in 2012 (1,2). The high mortality rate is due to the aggressive disease biology and the delayed diagnosis of most cases at an unresectable stage. Owing to the high percentage of advanced disease at the time of diagnosis and limited efficacy of current treatment options, mortality rates have remained the same over the past 2 decades. Furthermore, the incidence of PDA is increasing, with a reported annual percentage change of 1.2% between the years 1999 and 2010, compared with a negative change in the preceding years (3). A recent report predicts that, based on current trends, PDA will become the second most common cause of cancer-related deaths in the United States by 2020 (4).

With limited advances in the treatment of advanced PDA, the main hope for improved patient survival and potential cure lies in early detection of the disease when complete surgical resection is feasible and in supplementation with more effective therapeutic agents. Currently only 15%–20% of patients have potentially resectable disease at the time of presentation (5,6). Patients with complete, incomplete, or margin-positive resection (R0 no residual or R1 residual microscopic or R2 residual macroscopic disease, respectively) have progressively decreasing survival rates. Patients with R2 resections have survival rates similar to patients with comparable stage and performance status who have not undergone resection. Accordingly, these patients do not benefit from surgical resection (7,8). Therefore, accurate staging of PDA at the time of presentation carries substantial implications for appropriate recommendation to patients of the most suitable treatment option, thus maximizing the survival benefit for patients in whom complete resection can be achieved and minimizing the morbidity from unnecessary laparotomy or major surgery in patients with high risk of residual disease following resection. Finally, proper and uniform staging facilitates more accurate enrollment in clinical trials, aiding in the analysis of clinical trials results and comparison to other studies.

Imaging evaluation plays a central and primary role in the initial decision-making process of patients with PDA (9). There are, however, limitations in the current reporting of these imaging studies. These include variability of the descriptive terminology that attempts to define disease extent and incomplete documentation of disease sites which may affect prognosis and adversely affect treatment planning by surgeons, medical and radiation oncologists, and gastroenterologists. To develop a template that can be used for uniform, comprehensive, and reproducible reporting of imaging findings in patients with PDA, a multi-institutional group of 15 experts that included radiologists, hepatopancreatobiliary surgeons, and gastroenterologists, composed of members of the Society of Abdominal Radiology and the American Pancreatic Association, convened a consensus conference during the annual American Pancreatic Association meeting (Chicago, November 2011). Existing templates at each member institution were provided to the group at the meeting. A draft template including the most appropriate findings chosen from the available templates based on the state of knowledge and available pertinent literature was developed by consensus during the meeting. After the conference, a final draft was prepared by the lead author (M.M.A.) and sent to all participants for review, comments, and approval. This consensus statement addresses the integration of the appropriate descriptive terms defining the stage based on the disease extent, suggests a lexicon to be used in the reporting of the imaging findings to avoid

Advances in Knowledge

- Given the variability in expertise and definition of pancreatic ductal adenocarcinoma (PDA) disease extent among different practitioners, adoption of a standardized template for radiology reporting, using universally accepted and agreed on terminology for solid pancreatic neoplasms, is needed.
- A consensus statement by a multi-institutional group of experts in treating patients with PDA is presented.

Implications for Patient Care

- Adoption of a standardized imaging reporting template should improve the decision-making process for the management of patients with PDA.
- Standardization of radiology reports in PDA can also help to facilitate research and clinical trial design by using appropriate consistent staging of patients by means of resectability status, thus allowing for comparison of results among different institutions.

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Abbreviations:
CHA = common hepatic artery
MPV = main portal vein
NCCN = National Comprehensive Cancer Network
PDA = pancreatic ductal adenocarcinoma
SMA = superior mesenteric artery
SMV = superior mesenteric vein

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Conflicts of interest are listed at the end of this article.

confusion in terminology, and provides a structured template to improve the completeness of radiology reporting in cases of PDA.

PDA Staging

PDA staging is based on the determination of tumor size, location within the pancreas, local extent which may involve surrounding vessels, and the presence of metastatic lesions. The reported imaging data must allow clinicians to translate the information in the imaging report into established clinical staging systems thereby facilitating appropriate treatment selection, eligibility for clinical trials, and prognosis. Commonly used staging systems in the United States are from the American Joint Committee on Cancer and the National Comprehensive Cancer Network (NCCN).

The American Joint Committee on Cancer staging system, which is based on the TNM staging system, is used to assess the immediate and long-term clinical prognosis and to generate survival data for patients on the basis of the stage of disease (10,11). The T stage is based on the size of the tumor and whether the lesion extends beyond the pancreas with or without contact with the adjacent vessels. The regional lymph node (N) and distant metastasis (M) stages are based on the absence or presence of metastasis to the regional lymph nodes or other distant sites, respectively. Of note, only the regional lymph nodes located along the lymphatic drainage pathways that would be included in the surgical field and will be resected with the primary tumor are included in the N categories. Metastases to lymph nodes outside the normal drainage pathways or the ones not routinely included in the surgical resection are classified as M1 stage.

The NCCN consensus report guidelines define a staging system based on tumor extent and offer treatment recommendations accordingly (12,13). The NCCN criteria defining resectability status are based on the American Hepato-Pancreatico-Biliary Association consensus report (14,15).

Figure 1

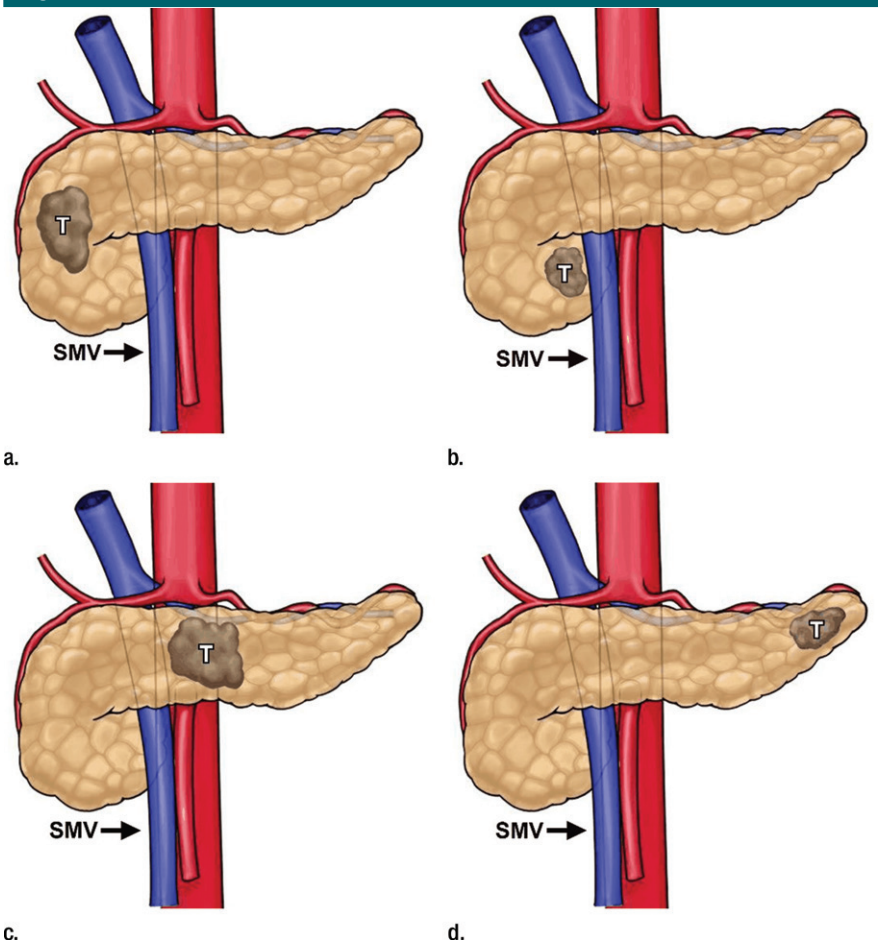


Figure 1: Tumor location. Tumor located to the right of the superior mesenteric vein (SMV) in the **(a)** pancreatic head or **(b)** uncinate process is potentially suitable for a Whipple procedure or pancreaticoduodenectomy procedure. Tumor located to the left of the SMV in the **(c)** pancreatic body or **(d)** tail is potentially suitable for distal pancreatectomy. *T* = tumor.

In the absence of metastatic disease, pancreatic cancer cases are classified into three main categories—resectable, borderline resectable, or locally advanced/unresectable disease. The disease category selection depends on tumor location within the pancreas (Fig 1) and the arterial or venous involvement (Figs 2 and 3). In the guidelines, less than or equal to 180° tumor contact of the vessel circumference is described as "abutment" and more than 180° tumor contact of the vessel circumference is referred to as "encasement."

According to the location and extent of vascular involvement, staging of PDA in patients according to the latest NCCN guidelines (16) is summarized in Table 1.

There are, however, several additional imaging findings not explicitly described in the NCCN guidelines criteria defining resectability that are pertinent for surgical planning and should be included in the radiology template:

1. The presence of tumor or bland venous thrombosis;

2. Extension of tumor contact with the common hepatic artery (CHA) to the level of the origins of right and left hepatic arteries;

3. Extension of tumor contact to first superior mesenteric artery (SMA)

Figure 2

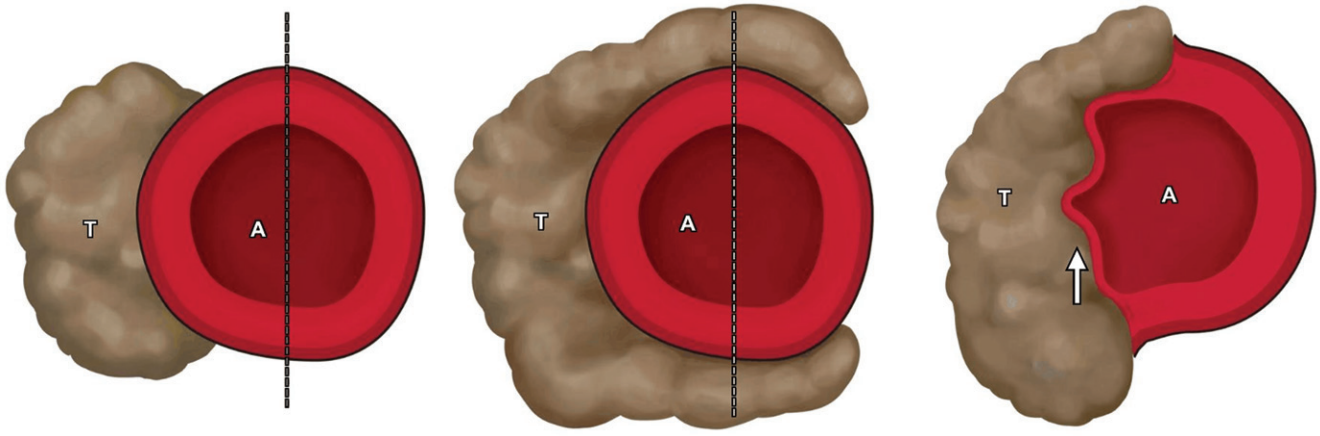


Figure 2: Arterial tumor contact. **(a)** Less than or equal to 180° tumor contact without deformity. **(b)** More than 180° tumor contact without deformity. **(c)** Tumor contact with deformity (arrow). *A* = artery, *T* = tumor. Dashed line = 180° of lumen circumference.

Figure 3

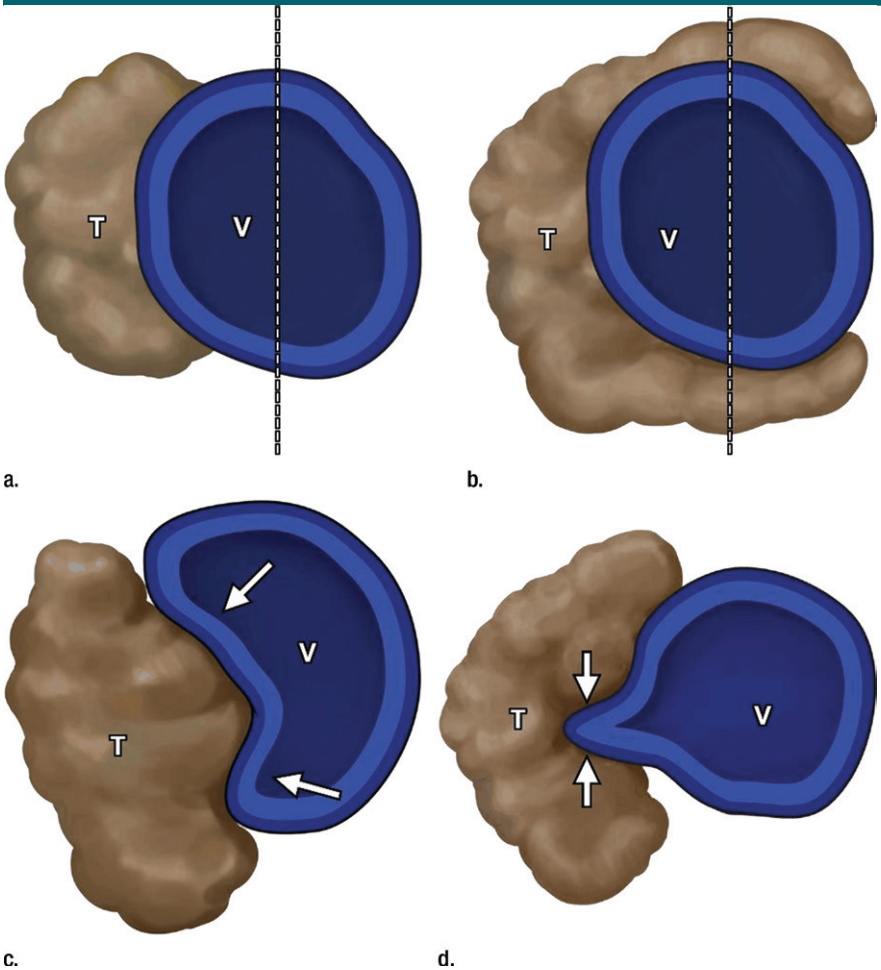


Figure 3: Venous tumor contact. **(a)** Less than or equal to 180° tumor contact without deformity. **(b)** More than 180° tumor contact without deformity. **(c)** Less than or equal to 180° tumor contact with deformity (arrows). **(d)** Tear drop deformity (arrows). *T* = tumor, *V* = vein. Dashed line = 180° of lumen circumference.

Table 1

NCCN Criteria for PDA Staging

Stage	Arterial	Venous
Resectable	Clear fat planes around CA, SMA, and HA	No SMV/portal vein distortion
Borderline resectable	Gastroduodenal artery encasement up to the hepatic artery with either short segment encasement or direct abutment of the hepatic artery without extension to the CA. Tumor abutment of the SMA not to exceed greater than 180° of the circumference of the vessel wall	Venous involvement of the SMV or portal vein with distortion or narrowing of the vein or occlusion of the vein with suitable vessel proximal and distal, allowing for safe resection and replacement
Unresectable*‡	Aortic invasion or encasement. Based on tumor location: Pancreatic head—More than 180° SMA encasement, any CA abutment, IVC Pancreatic body/tail—SMA or CA encasement greater than 180°	Unreconstructible SMV/portal vein occlusion

Note.—CA = celiac axis, HA = hepatic artery, IVC = inferior vena cava.

* The presence of distant metastasis, including metastases to lymph nodes beyond the field of resection, renders the patient unresectable irrespective of the type of vascular involvement.

‡ Extension to adjacent structures such as transverse colon or mesocolon, stomach, spleen, adrenal gland, or kidney is not a definite contraindication to surgical resection, since these structures can be resected along with the primary tumor.

branch and to most proximal draining vein into SMV;

4. Presence of increased hazy attenuation/stranding contact with the vessel, particularly in patients who received prior radiation therapy; and

5. Arterial variants, in particular origin of the right hepatic artery from the SMA.

Structured Reporting

To accurately stage the disease in patients to guide appropriate treatment, the radiology report should include all the criteria outlined above in the commonly used staging systems, as well as any additional findings that may affect surgical planning. The radiology report must document the lesion size, location, presence and detailed extent of vascular involvement, presence of arterial variants with or without tumor contact, and presence of nodal or metastatic disease. The imaging features that define disease extent, in particular the definition of vascular involvement and extension, should be based on established criteria that have appropriate levels of sensitivity and specificity. These criteria should provide the basis for consistent image interpretation within and between practices or departments. There is a growing expectation by oncologists and surgeons for standardized radiology reports that are reproducible and easily understood (17). A study of referring clinicians showed a preference for structured or template radiology reporting, as used in other medical specialties such as pathology, over the current predominantly prevailing mode of radiologic reporting using freestyle dictation (18). Freestyle dictation can potentially be confusing to the referring clinicians because information that is critical to treatment planning may be buried in excessively verbose text, may not be presented concisely in a manner that makes the information easily interpretable by everyone on the patient care team (physicians, nurses, data managers, and social workers), or may not even have been included in the report. This can be avoided by using systematic and standardized template reporting (19–21).

In recent years, several professional radiology organizations have attempted to introduce standardized structured template form reporting into radiology practice (eg, the Radiological Society of North America's radiology reporting initiative [22], among others). The goal of structured radiology reporting is to improve the completeness, accessibility, and interpretability of radiologic reports to the referring physician. These structured templates utilize a standardized lexicon developed by radiologists in conjunction with other medical specialties to reach mutually understandable and agreed on nonambiguous terminology which avoids the use of vague and imprecise nomenclature. Standardized template reporting can also simplify the process, perhaps even in an automated fashion, of organizing the structured reports to create a database that can be used for clinical outcomes analysis or to assist in clinical decision making (23). The adoption of structured reporting has been shown to be acceptable by radiologists, particularly in academic tertiary centers (24).

Imaging Evaluation

Pancreatic CT Protocol

Multidetector computed tomography (CT) angiography, performed by using a dedicated dual-phase pancreatic protocol, is the preferred method for initial imaging evaluation in patients in whom PDA is suspected (9,25,26). Magnetic resonance (MR) imaging has been shown to be equally sensitive and specific in staging pancreatic cancer and can be used interchangeably (27); however, it is not as widely used as the primary imaging modality in most centers because of cost and availability. In most centers, MR imaging is predominantly utilized for problem solving in patients with isoattenuating pancreatic lesions or to better characterize indeterminate liver lesions identified at prior CT examinations. Endoscopic ultrasonography (US) can assist in the detection of small tumors and in patients when the primary tumor is not visualized or is

Table 2

Multidetector CT Dedicated Pancreatic Protocol Parameters

Parameter	Details
Scan type	Helical
Section thickness (detector configuration)	Preferably submillimeter (0.5–1 mm)
Interval	Same as section thickness
Oral contrast agent	Neutral or low-Hounsfield units oral agent
Intravenous contrast agent	Preferably high iodine concentration [> 300 mg I/mL] at an injection rate of 3–5 mL/sec
Scan acquisition	Pancreatic parenchymal phase at 40–50 sec; portal venous phase at 65–70 sec
Image reconstruction	Axial 2–5 mm thickness Multiplanar reformats in the coronal plane at 2–3 mm thickness, and per institutional preference, the sagittal plane Maximum intensity projections or three-dimensional volumetric thick sections for vascular evaluation

Table 3

Morphologic Evaluation

Parameter	Finding
Appearance (in the pancreatic parenchymal phase)	Hypo-, iso-, or hyperattenuating
Size (maximal axial dimension in centimeters)	Measurable or nonmeasurable (isoattenuating tumors)
Location (head right of SMV, body left of SMV)	Head/uncinate or body/tail
Pancreatic duct narrowing/abrupt cut-off with or without upstream dilatation	Present or absent
Biliary tree abrupt cut-off with or without upstream dilatation	Present or absent

isoattenuating on CT images (28). Endoscopic US with fine-needle aspiration has an established role in cytohistologic confirmation before treatment initiation and in negative cross-sectional evaluation with CT or MR imaging and persistent strong clinical suspicion of PDA (28). The availability of high-quality pancreatic multidetector CT angiography (preferably 16–detector row or greater) combined with expertise in interpreting these studies has been shown to improve preoperative staging and alter management in a significant proportion of patients (29,30). Multidetector CT angiography protocol for pancreatic imaging consists of a biphasic examination (Table 2) (9). In the pancreatic parenchymal phase (acquisition time is shortly after the arterial phase and before the portal venous phase), there is maximal pancreatic parenchymal enhancement, producing optimal visual contrast differences between the enhanced pancreatic parenchyma and the usually hypoattenuating tumor. The peripancreatic arteries are usually well opacified during this phase, allowing for their concomitant evaluation. In the second portal venous phase acquisition, the portomesenteric venous system is well opacified, allowing for better evaluation of the portal venous system; furthermore, the liver is maximally enhanced, improving detection of hepatic metastases which are usually hypoattenuating compared with the enhanced hepatic parenchyma. The smallest available section thickness or detector configuration should be used to enable the production of high-fidelity reformatted and volumetric images from the nearly isotropic voxels acquisition (31,32). The nearly isotropic acquired data set will allow high-quality reformatted images in any plane, either as maximum intensity projections or three-dimensional volumetric images, which may be necessary to allow full assessment of the circumferential and longitudinal vascular contact, detection of change in vessel caliber, or the presence of contour deformity secondary to tumor, which may not be appreciated on the axial images alone. These reformats also help in assessing vascular anatomic variants and potentially significant vascular disease or collaterals if present.

Accurate imaging assessment is critical for optimal treatment selection; however, frequently the diagnosis of PDA is made on routine single-phase CT studies obtained in the portal venous phase. Although these routine CT studies may be sufficient to diagnose pancreatic adenocarcinoma, they are inadequate in some cases for the assessment of the local tumor extent because of the absence of multiphasic contrast enhancement and thicker-section images that are commonly obtained in these examinations. These factors limit the ability to generate the high-quality reformatted images and three-dimensional reconstructions that are often necessary for accurate staging. It is therefore essential that these patients undergo repeat imaging with a dedicated pancreatic CT examination that includes biphasic multidetector CT angiography.

Morphologic Evaluation

Morphologic evaluation of PDA includes documentation of tumor size (longest diameter in the axial plane), appearance, location, and associated biliary or pancreatic duct dilatation/abrupt interruption (Table 3).

In the majority of cases, PDA is usually hypoattenuating when compared to the pancreatic parenchyma, in particular during the pancreatic parenchymal phase of enhancement. In a small percentage of cases the tumor is isoattenuating to the surrounding pancreatic parenchyma and is difficult to visualize; however, the presence of tumor can frequently be inferred from associated secondary findings, including a focal

Table 4

Arterial Evaluation

Parameter	Finding
SMA	Present or absent
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity	Present or absent
Extension to first SMA branch	Present or absent
Celiac axis	Present or absent
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity	Present or absent
CHA	Present or absent
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity	Present or absent
Extension to celiac axis	Present or absent
Extension to bifurcation of right/left hepatic artery	Present or absent
Arterial variant	Present or absent
Variant anatomy	Accessory right hepatic artery, replaced right hepatic artery, replaced CHA, others (origin of replaced or accessory artery)
Variant vessel contact	Present or absent
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity	Present or absent

Figure 4

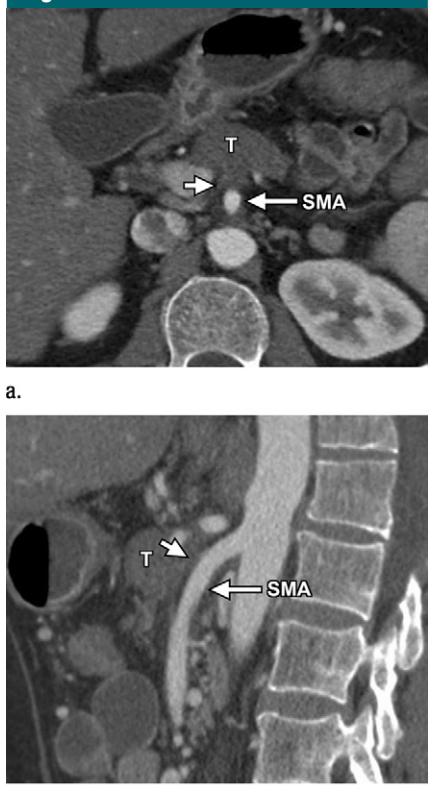


Figure 4: Images in a 60-year-old man with less than 180° of circumferential tumor contact with the SMA. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic body mass *(T)* directly contacting less than 180° of the SMA circumference without contour deformity (short arrow). **(b)** On the sagittal reformatted image, the length of tumor contact and vessel caliber are better delineated (short arrow). Finding less than 180° of tumor contact with the SMA places the patient in the borderline resectable category.

bulge in the pancreatic contour, abrupt interruption of the biliary or pancreatic duct (with or without upstream dilatation), and proximal (upstream) pancreatic atrophy (33–35). PDA rarely contains calcifications, which are more frequently seen in other types of solid pancreatic neoplasms, such as neuroendocrine tumors.

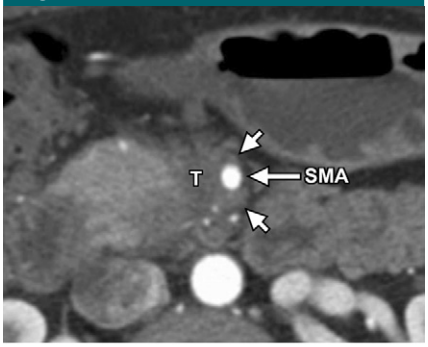
Vascular Evaluation

In the absence of distant metastasis, the presence and degree of contact between the tumor and the peripancreatic vessels is of paramount importance in determining surgical resectability.

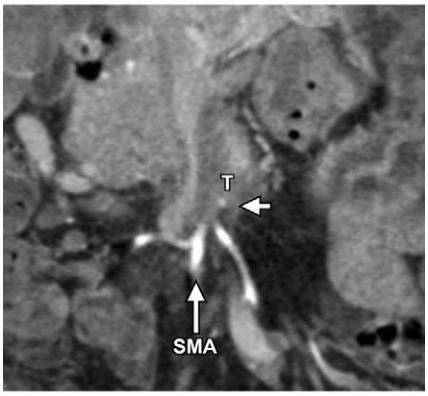
Lu et al (36) initially described a system for determining the likelihood of vascular involvement by the pancreatic tumor based on the percentage of circumferential surface contact between the tumor and the adjacent vessel, and they concluded that more than 180° of tumor-vessel contact is highly specific for tumor unresectability. Irregularity of the vessel contour (including "tear drop" deformity) or change in caliber is also considered a sign of vascular invasion regardless of the degree of contact between tumor and vessel (37). The positive predictive value of CT for determining nonresectability is very high (89%–100%); however, it is lower for predicting resectability (45%–79%) since the diagnostic criteria for vascular invasion that have been developed are more specific than sensitive, to minimize the number of patients inappropriately denied surgery and potential cure. Following neoadjuvant chemotherapy and radiation therapy, the solid tumor vascular contact may be replaced by perivascular haziness or fat stranding that can be due to posttreatment fibrosis or viable tumor, making assessment of tumor resectability on cross-sectional images difficult (38–40). Occasionally inflammatory stranding from pancreatitis secondary to ductal obstruction due to the tumor or from recent procedures such as endoscopic retrograde cholangiopancreatography or endoscopic US with biopsy may also produce perivascular haziness that can be difficult to differentiate from solid tumor.

Arterial evaluation.—The evaluation of the celiac axis, SMA, CHA, and arterial variants, if present, is an important component of the assessment of the patient's imaging study (Table 4). The analysis of arterial contact (less than or equal to 180° versus more than 180°) as well as the presence of change in the vessel caliber (focal narrowing) or contour irregularity should be noted and documented in sufficient detail in the standardized report (Figs 4–6).

Figure 5



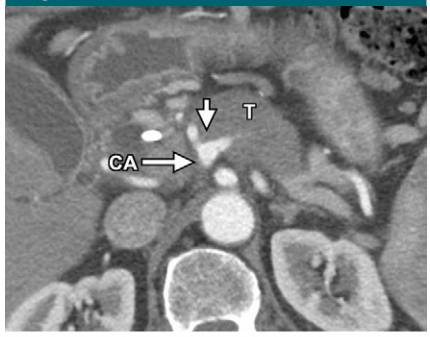
a.



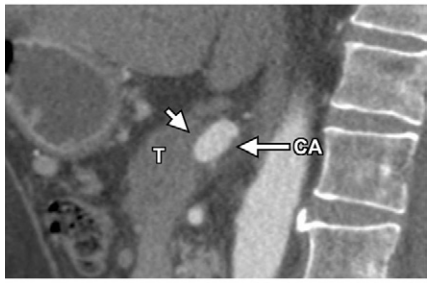
b.

Figure 5: Images in a 73-year-old woman with more than 180° of circumferential tumor contact with the SMA. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic head mass *(T)* contacting more than 180° of the SMA circumference (short arrows). **(b)** Extension and involvement of the first SMA branch (short arrow) is better delineated on the coronal reformatted image. The presence of greater than 180° of tumor in contact with the SMA and tumor in contact with the SMA branch places the patient in the unresectable category.

Figure 6



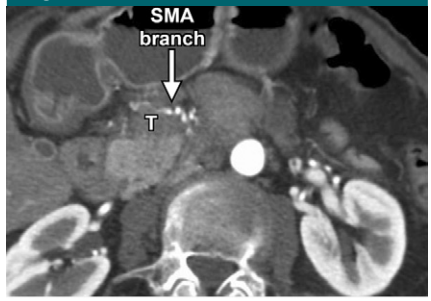
a.



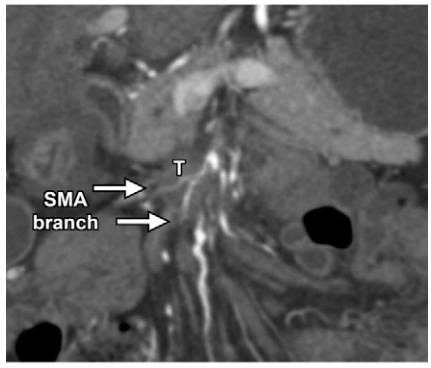
b.

Figure 6: Images in a 71-year-old woman with tumor involvement of the celiac axis *(CA)*. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a mass in the pancreatic body *(T)* that is in contact with less than 180° of the celiac axis circumference (short arrow). **(b)** On the sagittal reformatted image, the contact with the celiac axis is better delineated (short arrow). The presence of less than 180° of tumor contact with the celiac axis places the patient in the borderline resectable category.

Figure 7



a.



b.

Figure 7: Images in a 58-year-old man show tumor contact with several SMA branches. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic head mass *(T)* in contact with the adjacent SMA branches. **(b)** The SMA branches involvement on the coronal reformatted image. The tumor involvement of the SMA branches places the patient in the unresectable category.

On posttreatment staging scans following neoadjuvant chemotherapy and radiation therapy, where the solid tumor contact can be replaced by increased hazy attenuation or stranding, the degree of contact of the haziness or stranding with the vessel should be noted. Additional pertinent information includes:

1. SMA: tumor extension to first SMA branch, since involvement of the proximal SMA branches such as the jejunal or colic arteries can affect the decision to resect (Fig 7).

2. CHA: in pancreatic head lesions, tumor extension that can affect the staging and the type of vascular reconstruction performed includes tumor contact with the gastroduodenal artery extending to involve the hepatic artery, which would change the staging from resectable to borderline resectable, CHA tumor contact extension to involve the celiac axis and extension to involve the proper hepatic artery division into the right or left hepatic arteries, which will render the tumor unresectable (Fig 8).

3. Arterial variants: reporting of arterial variants involving the celiac axis or SMA, particularly the presence of a replaced right hepatic artery from the SMA, can assist in surgical planning. Similarly, reporting regarding the presence or absence and degree of vascular tumor contact or surrounding haziness with the variant vessel should be described. In addition, relevant arterial disease such as median arcuate ligament compression or significant SMA stenosis should be described, as it may affect surgical planning.

Venous evaluation.—The most important veins that can affect tumor resectability include the portal vein and SMV. The circumferential degree of tumor-vessel contact (less than or equal to 180° versus more than 180°) (Figs 9–11), or the presence of increased hazy attenuation/stranding at presentation or following neoadjuvant chemotherapy and radiation therapy treatment, should be described

Figure 8

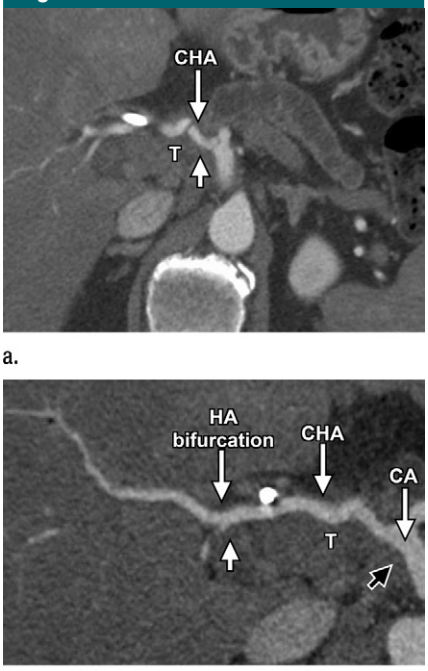


Figure 8: Images in a 70-year-old man with tumor in contact with the CHA. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a mass in the pancreatic head mass *(T)* in contact with the CHA (short arrow). **(b)** The length of contact is better delineated on the curved planar reformatted image through the length of the vessel, which shows that the tumor contact extends to the hepatic artery bifurcation (short white arrow) and the celiac axis (short black arrow). The extension to the celiac axis places the patient in the unresectable category. *HA* = hepatic artery.

Figure 9

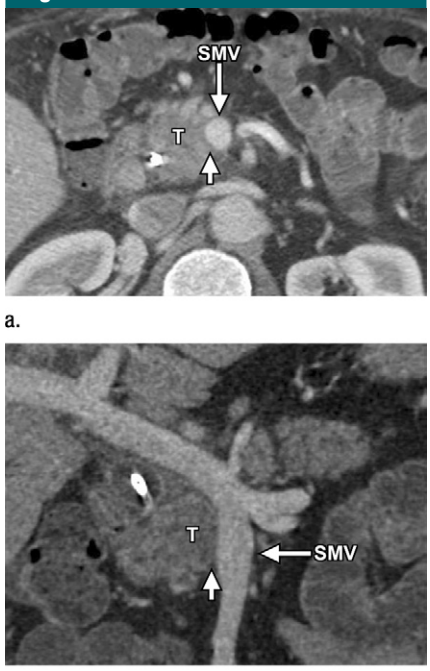


Figure 9: Images in a 55-year-old women with tumor with less than 180° of contact with the SMV. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic head mass *(T)* contacting less than 180° of the SMV circumference without contour deformity or focal narrowing (short arrow). **(b)** The length of contact and vessel caliber is better delineated on the coronal reformatted image (short arrow). The limited tumor contact with the SMV and the identification of suitable vessel proximal and distal to the lesion, which allows safe resection and venous replacement, places the patient in the borderline resectable category.

Figure 10

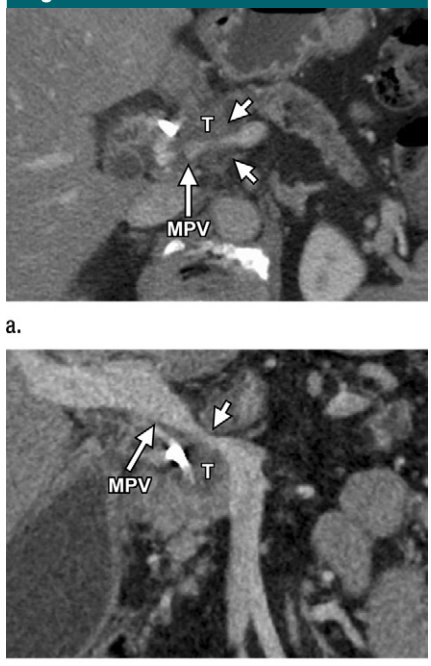


Figure 10: Images in a 76-year-old man with tumor with more than 180° contact with the main portal vein (MPV). **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic head mass *(T)* with tumor contact extending more than 180° around the MPV (short arrows). **(b)** The focal vessel narrowing and length of contact is better delineated on the coronal view (short arrow). Despite the degree of tumor contact with the MPV, the presence of suitable vessel proximal and distal to the narrowing potentially allows for safe resection and venous replacement, which places the patient in the borderline resectable category.

(Fig 12). Additional features including the presence of tumor or bland thrombus, focal caliber narrowing, contour irregularity, or tear drop deformity should be described (Fig 13). Similar to the SMA contact, extension of the tumor to the most proximal veins draining into the SMV should be recorded (Table 5).

Extrapancreatic Evaluation

The presence of extrapancreatic tumor extension, either local or distant, should also be described (Table 6). Direct local extension into surrounding adjacent structures such as stomach, small bowel or colon/mesocolon, kidneys, adrenal glands, inferior vena cava, aorta, or spleen should be noted as it can affect the surgical decision making.

If focal hepatic lesions are present that demonstrate suspicious features concerning for metastasis (poorly defined margins, rim enhancement) or are indeterminate if the lesion is too small to characterize by means of CT, then further imaging or tissue sampling to arrive at a final diagnosis may be warranted (Fig 14).

Peritoneal nodules or the presence of ascites (in the absence of other potential causes of ascites such as mesenteric venous occlusion, underlying systemic conditions) suggest disseminated disease that would render the patient unsuitable for a curative resection.

The presence of enlarged lymph nodes can also affect surgical resectability and indicate need for additional therapy. The presence and location of suspicious lymph nodes (defined as short axis > 1 cm, abnormal round morphology, heterogeneity, or central necrosis) should be noted. This is especially true for enlarged lymph nodes which are outside the immediate local drainage pathways based on tumor location (ie, aortocaval or paraaortic lymph nodes), as these can alter

Figure 11

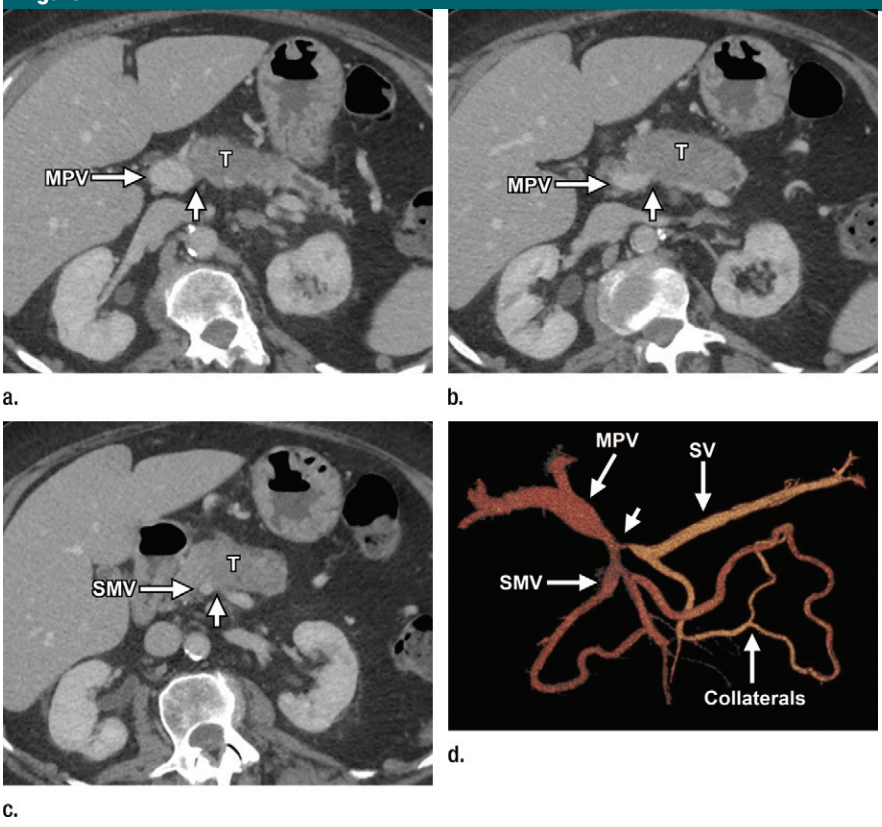


Figure 11: Three-dimensional volume rendered display of multivessel tumor involvement. **(a–c)** Axial contrast-enhanced biphasic multidetector CT angiograms demonstrate a mass in the body of the pancreas *(T)* with more than 180° of contact with the MPV, splenic vein, and SMV and narrowing of the vessels (short arrow). **(d)** The multifocal narrowing and the length of tumor contact, as well as the presence of collaterals, are better delineated on the three-dimensional volume rendered display (short arrow). This degree of tumor contact with the MPV and SMV places the patient in the borderline resectable category. *SV* = splenic vein.

Figure 12

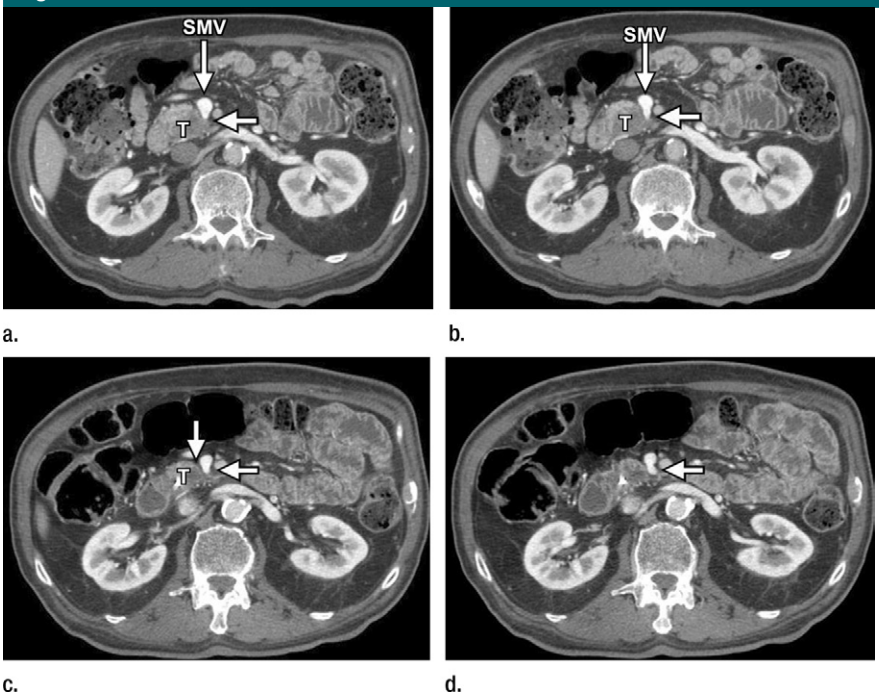
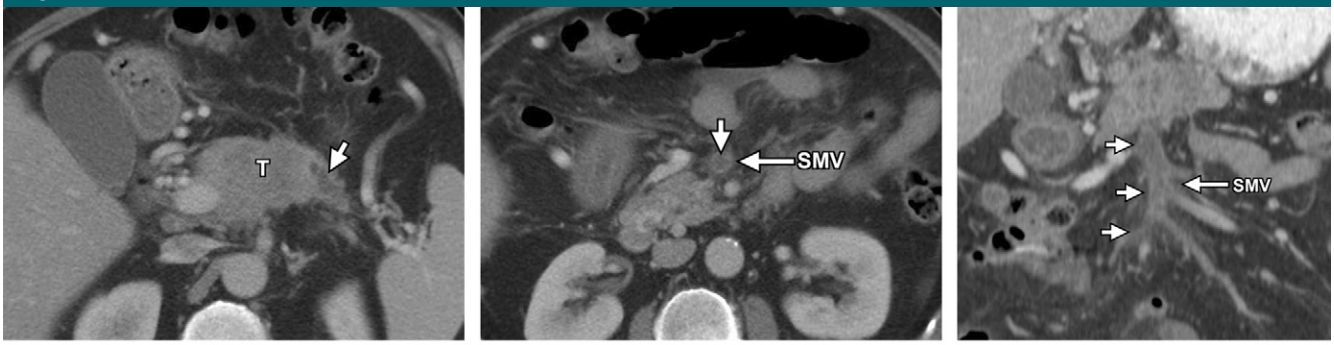


Figure 12: Images in a 68-year-old woman with pancreatic head mass and perivascular increased haziness or stranding. **(a, b)** Axial contrast-enhanced biphasic multidetector CT angiogram shows a mass in the pancreatic head *(T)*. Tumor contacts less than 180° of the SMV circumference and there is extension to the first draining vein (short arrow). The tumor involvement of the SMV and draining vein places the patient in the unresectable category. **(c, d)** Following chemotherapy and radiation therapy, there is shrinkage of the tumor and replacement of the solid tumor contact with the SMV and the draining branch by increased haziness, likely representing fibrosis rather than tumor (short arrows). The tumor was resected with negative margins.

Figure 13



a. b. c.

Figure 13: Images in a 55-year-old man with venous thrombosis. **(a)** Axial contrast-enhanced biphasic multidetector CT angiogram demonstrates a pancreatic body mass *(T)*. Note the upstream dilatation of the pancreatic duct (short arrow). **(b)** Image at a lower level shows bland intraluminal thrombus in the SMV (short arrow). **(c)** Coronal reformatted CT image displays the extent of the thrombosis (short arrows).

Table 5

Venous Evaluation

Parameter	Finding
MPV	Present, absent, or complete occlusion
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity (tethering or tear drop)	Present or absent
SMV	Present, absent, or complete occlusion
Degree of solid soft-tissue contact	≤180° or >180°
Degree of increased hazy attenuation/stranding contact	≤180° or >180°
Focal vessel narrowing or contour irregularity (tethering or tear drop)	Present or absent
Extension to first draining vein	Present or absent
Thrombus within vein	Present or absent (MPV, SMV, or splenic vein), (tumor, bland)
Venous collaterals	Present or absent (around pancreatic head, porta hepatis, root of the mesentery, or left upper quadrant)

staging from local node involvement to metastatic disease.

Conclusion

The central role of high-quality imaging for the diagnosis and proper description of the extent of tumor at the time of tumor staging is of great importance for optimal therapeutic decision making and for ongoing management in patients with PDA. Complete, accurate, and reproducible radiology reporting of disease extent is therefore essential. For accurate disease staging, the panel recommends that all patients who have no obvious metastatic disease or extensive local invasion at initial routine abdominal CT examinations undergo a repeat examination with dedicated pancreas protocol multidetector CT angiography.

A standardized template for PDA staging created by consensus and endorsed by two major national organizations (the Society of Abdominal Radiology and the American Pancreatic Association) is presented in this article. The adoption of this suggested standardized imaging reporting template using universally accepted and agreed on terms should improve the preoperative staging and surgical decision making for the management of patients with PDA. The imaging reporting template should summarize all the pertinent findings; however, the decision regarding resectability status should be decided in consensus at multidisciplinary meetings/discussions. Standardized reporting can also help facilitate research and clinical trial design by classifying patients' resectability status based on precise imaging parameters and can also facilitate comparison of results among different institutions. The full, standardized template is available in Appendix E1 (online).

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Table 6

Extrapancreatic Evaluation

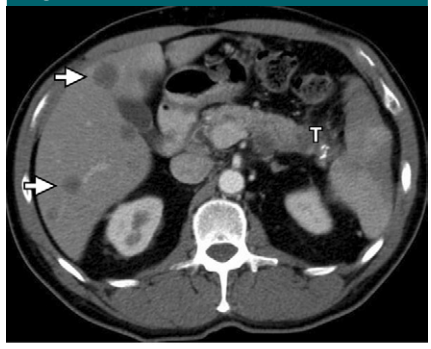
Parameter	Finding
Liver lesions*	Present or absent Suspicious/indeterminate or likely benign
Peritoneal or omental nodules	Present or absent
Ascites	Present or absent
Suspicious lymph nodes†	Present or absent (porta hepatis, celiac, splenic hilum, paraaortic, aortocaval)
Other extrapancreatic disease (invasion of adjacent structures)‡	Present or absent

* Suspicious liver lesion features include a poorly defined margin or rim enhancement. Indeterminate lesions = too small to characterize at CT or no confident diagnosis can be made at CT. Likely benign lesions = confident diagnosis can be made (such as a cyst or hemangioma).

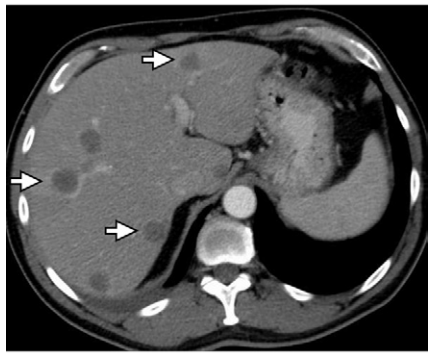
† Suspicious lymph nodes features include any of the following: short axis > 1 cm, abnormal round morphology, heterogeneity, or central necrosis.

‡ Structures involved: inferior vena cava, aorta, adrenal gland, kidney, spleen, stomach, colon, mesocolon, small bowel, or other organs.

Figure 14



a.



b.

Figure 14: Liver metastases in a 59-year-old man with a mass in the pancreatic tail. **(a, b)** Axial contrast-enhanced multidetector CT images obtained in the portal venous phase show a mass in the pancreatic tail *(T)* as well as multiple solid liver lesions with poor margins and complete rim enhancement (arrows).

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