Diagnosis and Staging of Pancreatic Cancer: The Role of Imaging

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Pancreatic ductal adenocarcinoma (PDA)

• Highly aggressive tumor which carries a high mortality rate

• Fourth most common cause of cancer-related death in the US in both males and females

• Incidence is increasing

Pancreatic ductal adenocarcinoma (PDA)

Accurate diagnosis and staging

- Only 15-20% have potentially resectable disease at the time of their presentation

- Patients with complete, incomplete or margin positive resection (R0 or R1 residual microscopic / R2 residual macroscopic disease respectively) have progressively decreasing survival rates

- Complete margin negative surgical resection (R0 resection) remains the main hope of improved survival and potential cure of the tumor


Pancreatic cancer staging

Accurate staging and determination of the disease extent

Appropriate treatment arm allocation

Adequate imaging → Proper reporting
**Imaging modalities**

- Endoscopic Ultrasound
- Computed Tomography
- Magnetic Resonance Imaging/Cholangiopancreatography

**Endoscopic Ultrasound**

- Direct interface with pancreas
- High resolution images (can help in detection of small tumors which are not visible or have similar density to surrounding pancreatic parenchyma on CT & MR)
- Allows tissue sampling
Computed Tomography

- MDCT angiography
  - Thin slice acquisitions
  - High spatial resolution

- Multi-planar reformats (coronal, sagittal and curved planar)
Computed Tomography

- MDCT angiography
  - Thin slice acquisitions
  - High spatial resolution
  - Multi-planar reformats (coronal, sagittal and curved planar)
  - 3D reconstruction of vessels

Computed Tomography

- MDCT angiography
  - Biphasic acquisition (pancreatic and portal venous phase)
  - Detection of most PDA which are hypo-attenuating compared to pancreas and best visualized on the pancreatic phase
Imaging Role is to evaluate:
I. The appearance, size and location of the lesion
II. The surrounding vessels for possible involvement
III. Extra-pancreatic extension and metastasis

PDA Appearance

Pancreatic versus portal venous conspicuity of PNC lesion
Computed Tomography

- MDCT
- Small but significant number of tumors are iso-attenuating on CT which are indirectly assessed through secondary signs (ex: Abruptly interrupted PD or CBD dilatation, focal pancreatic contour bulge, localized atrophy)

Kim JH, et al. Visually isoattenuating pancreatic adenocarcinoma at dynamic-enhanced CT: frequency, clinical and pathologic characteristics, and diagnosis at imaging examinations. Radiology 2010

Computed Tomography

Computed Tomography

- MDCT
  - secondary signs (ex: Abruptly interrupted PD or CBD dilatation, focal pancreatic contour bulge, localized atrophy)
Magnetic Resonance Imaging (MRI)

- Similar sensitivity and specificity to MDCT to stage PDA
- Limited use due to availability, expertise, cost, spatial resolution
- Best role as problem solving for iso-attenuating pancreatic lesions and characterization of indeterminate hepatic lesions on MDCT


CT versus MR
MR Cholangiopancreatography (MRCP)

Interrupted CBD and PD ducts
(Double Duct sign)

Grading of vascular contact

• Graded vessel involvement using a 0- to 4-point scale based on circumferential contiguity of tumor to vessel

• If > 50% tumor contact (grades 3 and 4), the tumor would not be resectable (sensitivity and specificity for unresectability is 84% and 98%)

Vascular assessment (Arterial)

Vascular assessment (Venous)
**Arterial contact**

Assessment based on:
- degree of tumor contact with the vessel circumference
- whether vessel caliber narrowing or contour deformity is present

**Venous Contact**

Less than 180  
More than 180  
Deformity  

Tear drop Deformity
Why

• The variability in expertise and definition of disease extent among different practitioners

• Frequent lack of complete reporting of pertinent imaging findings

• Need for standardized template for radiology reporting, using universally accepted and agreed on terminology

• Clinicians need
How

• Expertise in the field from all disciplines involved

• Consensus on the necessary acceptable requirements for adequate diagnostic exam and basic complete imaging findings reporting necessary for the accurate disease extent staging

Aim

• Standardize nomenclature for imaging finding

• Establish a template structure that would provide complete, pertinent, and accurate reporting to optimize treatment recommendations

• Proper and uniform staging facilitates more accurate enrollment in clinical trials, aiding in the analysis of clinical trials results and comparison across institutions
Reporting Template

- Three parts:
  - Arterial assessment
  - Venous assessment
  - Local and distant tumor extension
    - Adjacent organs involvement
    - Lymph nodes status and metastasis (liver, peritoneal, others)

- Vascular assessment
  - Degree of arterial contact
  - Solid tumor contact
  - Hazy fat density (frequently post treatment)
  - Caliber narrowing or contour deformity
  - Extension along SMA and SMV jejunal branches, CHA branches
  - Thrombosis

Morphologic evaluation

- Appearance
  - Hypo, iso or Hyper attenuating

- Size

- Location
  - Head or body

- Pancreatic duct narrowing

- CBD narrowing

- Calcifications
**Morphologic evaluation**

- Location: Head/uncinate or Body/tail
  - **Right of SMV** potentially suitable for a pancreatoduodenectomy
  - **Left of SMV** potentially suitable for distal pancreatectomy

**Arterial evaluation**

- List every relevant vessel
  - SMA
  - CA
  - CHA
  - Arterial variants if present

- Describe degree of contact
  - ≤ 180 degree of the vessels circumference
  - > 180 degree of the vessels circumference

- Presence of caliber narrowing or contour deformity
  - Most specific for vessel involvement

- Particular attention to
  - CHA branches (RHA and LHA) involvement
  - SMA jejunal branches involvement
**Arterial evaluation SMA contact**

Less than 180 degree contact

More than 180 degree contact

**Arterial evaluation SMA contact**

SMA jejunal branches involvement
Arterial evaluation CA contact

Less than 180 degree contact

Arterial evaluation CHA contact
Arterial evaluation R RHA contact

Venous evaluation

- List every relevant vessel
  - MPV
  - SMA

- Describe degree of contact
  - ≤ 180 degree of the vessel’s circumference
  - > 180 degree of the vessel’s circumference
  - Thrombosis or collaterals if present

- Presence of caliber narrowing or contour deformity (including tear drop deformity)
  - Most specific for vessel involvement

- Particular attention to
  - SMV jejunal branches involvement
Venous evaluation SMV

Less than 180 degree contact

Venous evaluation SMV

More than 180 contact and deformity
Venous evaluation SMV

More than 180 degree contact with narrowing and collaterals

Venous evaluation SMV

SMV occlusion
Venous evaluation Thrombosis

Extra-pancreatic evaluation

- Liver lesions
  - Suspicious/Indeterminate
  - Benign

- Peritoneal nodules

- LN
  - Location (important if local or distant), can change staging to metastatic

- Invasion of surrounding organs
Extra-pancreatic evaluation Liver

Suspicious lesions

Extra-pancreatic evaluation LN

Aortocaval LN
Extra-pancreatic evaluation LN

Impression

- Tumor
  - Size and location

- Vascular contact
  - Which vessels are involved
  - Degree of contact

- Metastatic evaluation
**NCCN Guidelines Version 1.2016**

**Pancreatic Adenocarcinoma**

### CRITERIA DEFINING RESECTABILITY STATUS

<table>
<thead>
<tr>
<th>Resectability Status</th>
<th>Arterial</th>
<th>Venous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resectable</td>
<td>No arterial tumor contact (celiac axis [CA], superior mesenteric artery [SMA], or common hepatic artery [CHAA])</td>
<td>No tumor contact with the superior mesenteric vein (SMV) or portal vein (PV) or SV of &gt;150° contact without vein contour irregularity.</td>
</tr>
</tbody>
</table>
| Borderline Resectable| Pancreatic head/uncinate process:  
- Solid tumor contact with OHA without extension to celiac axis or hepatic artery bifurcation allowing for safe and complete resection and reconstruction.  
- Solid tumor contact with the SMA of >150°  
- Presence of variant arterial anatomy (i.e., accessory right hepatic artery, replaced right hepatic artery, replaced OHA and the origin of replaced or accessory artery) and the presence and degree of tumor contact should be considered as present as it may affect surgical planning.  
- Pancreatic body/tail:  
  - Solid tumor contact with the CA of <150°  
  - Solid tumor contact with the CA of >150° without involvement of the aorta and with intact and uninvolved gastroduodenal artery (some members prefer this criteria to be in the unresectable category). |  
- Solid tumor contact with the SMV or PV of >150°, contact of >150° with contour irregularity of the vein or thrombosis of the vein but with suitable vessel proximal and distal to the site of involvement allowing for safe and complete resection and vein reconstruction.  
- Solid tumor contact with the inferior vena cava (IVC). |
| Unresectable         | Distant metastasis (including non-regional lymph node metastasis)  
- Head/uncinate process:  
  - Solid tumor contact with SMA of >150°  
  - Solid tumor contact with the CA of >150°  
  - Solid tumor contact with the first jejunal SMA branch  
- Body and tail:  
  - Solid tumor contact of >150° with the SMA or CA  
  - Solid tumor contact with the CA and aortic involvement | Head/uncinate process:  
- Unreconstructible SMV/PV due to tumor involvement or occlusion (can be due to tumor or bland thrombus)  
- Contact with the most proximal draining jejunal branch into SMV  
- Body and tail:  
  - Unreconstructible SMV/PV due to tumor involvement or occlusion (can be due to tumor or bland thrombus) |

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## Pancreatic Adenocarcinoma

### Arterial Evaluation

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<tbody>
<tr>
<td>SMA Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of solid soft-tissue contact</td>
<td>≤180</td>
<td>&gt;180</td>
</tr>
<tr>
<td>Degree of increased hazy attenuation/stranding contact</td>
<td>≤180</td>
<td>&gt;180</td>
</tr>
<tr>
<td>Focal vessel narrowing or contour irregularity</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Extension to first SMA branch</td>
<td>Present</td>
<td>Absent</td>
</tr>
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<thead>
<tr>
<th>Feature</th>
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<tbody>
<tr>
<td>Celiac Axis Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of solid soft-tissue contact</td>
<td>≤180</td>
<td>&gt;180</td>
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<tr>
<td>Extension to celiac axis</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Extension to bifurcation of right/left hepatic artery</td>
<td>Present</td>
<td>Absent</td>
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<tr>
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<tr>
<td>Variant anatomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessory right hepatic artery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replaced right hepatic artery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replaced common hepatic artery</td>
<td></td>
<td></td>
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<tr>
<td>Others (origin of replaced or accessory artery)</td>
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<tr>
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### Venous Evaluation

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<thead>
<tr>
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<tbody>
<tr>
<td>MPV Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of solid soft-tissue contact</td>
<td>≤180</td>
<td>&gt;180</td>
</tr>
<tr>
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<td>Absent</td>
</tr>
<tr>
<td>Extension</td>
<td>Present</td>
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<thead>
<tr>
<th>Feature</th>
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<tr>
<td>Thrombus within vein (tumor, bland)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMV</td>
<td></td>
<td></td>
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<tr>
<td>Splenic vein</td>
<td></td>
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<thead>
<tr>
<th>Feature</th>
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</tr>
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<tbody>
<tr>
<td>Venous collaterals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Around pancreatic head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portal hepatis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rupt of the mesentery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left upper quadrant</td>
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Reporting Template

Morphologic Evaluation

- Appearance (is the pancreatic parenchyma hypervascular or hypovascular?)
- Size (minimal and dimension in centimeters): measure or measureable (involving tumor)
- Location (head, body, tail of the PANCA tumor)
- Nodal status (is there evidence of metastatic disease present or absent?)
- Bilary tree (is there evidence of dilatation: present or absent?)

Arterial evaluation

- SMA: Present or absent
- Degree of vessel narrowing: <50%, >50%
- Degree of increased haustration (positive or negative)
- Extent of increased tortuosity or arterial irregularities: present or absent

Celiac Artery (Present or absent)

- Degree of vessel narrowing: <50%, >50%
- Degree of increased haustration (positive or negative)
- Extent of increased tortuosity or arterial irregularities: present or absent

CHAs: Present or absent

- Degree of vessel narrowing: <50%, >50%
- Degree of increased haustration (positive or negative)
- Extent of increased tortuosity or arterial irregularities: present or absent

Method: Present or absent

- Venous contact: present or absent
- Venous contact: absent (vein involved and extent)
- Mesenteric: absent or present location

Vascular evaluation

- SMA: Present, absent, or complete occlusion
- Degree of stenosis: <50%, >50%
- Degree of increased haustration: present or absent
- Extent of increased tortuosity or arterial irregularities: present or absent

PVV: Present, absent, or complete occlusion

- Degree of stenosis: <50%, >50%
- Degree of increased haustration: present or absent
- Extent of increased tortuosity or arterial irregularities: present or absent

SUV: Present, absent, or complete occlusion

- Degree of stenosis: <50%, >50%
- Degree of increased haustration: present or absent
- Extent of increased tortuosity or arterial irregularities: present or absent

PVV: Present, absent, or complete occlusion

- Degree of stenosis: <50%, >50%
- Degree of increased haustration: present or absent
- Extent of increased tortuosity or arterial irregularities: present or absent

PANC-A

Reporting Template

Pancreatic Adenocarcinoma

PRINCIPLES OF DIAGNOSIS, IMAGING, AND STAGING

PANCREATIC CANCER RADIOLOGY REPORTING TEMPLATE

Extrapancreatic Evaluation

Liver lesions

- Present
  - Suspicious
  - Indeterminate
  - Likely benign
- Absent

Peritoneal or peripancreatic nodules

- Present
- Absent

Ascites

- Present
- Absent

Suggestive lymph nodes

- Present
  - Porta hepatis
  - Celiac
  - Splenic hilum
  - Pancreatic
  - Aortocaval
  - Other
- Absent

Other extrapancreatic disease (invasion of adjacent structures)

- Present
  - Organs involved
- Absent

Impression

Tumor size:

- Present
- Absent

Vascular contact

- Present
  - Vessel involved
- Absent

Metastases

- Present (Location)
- Absent

Reporting Template

Conclusion

• For patients with PDA optimal imaging techniques and adequate reporting of imaging findings (complete, pertinent, and accurate) is essential for proper disease extent evaluation.