IMAGING CHALLENGES AND PITFALLS OF PANCREATIC DUCTAL ADENOCARCINOMA

Khaled Y. Elbanna, MD Hyun-Jung Jang, MD Tae Kyoung Kim, MD Joint Department Medical Imaging, University Health Network/Mount Sinai Hospital/Women's College Hospital, University of Toronto

Pancreatic Ductal adenocarcinoma

- In spite of recent imaging advances, PDAC still has a poor prognosis [5-year survival rate: 6–7% and ~ 1/3 of patients present with locally advanced CA]:
 Tumor biological behaviour
- > Difficult diagnosis at early-stage. No reliable blood markers for early detection

Challenges

- Missed/delayed diagnosis
- > Iso-attenuating/small
- > Uncinate process
- Evolving concepts of tumor-vessel relationship
- Imaging of post-neoadjuvant therapy
- Extra-panctreatic perineural invasion
- Celiac artery stenosis

PDAC mimics

- Benign
- > Autoimmune pancreatitis
- ➢ Focal pancreatitis
- \succ Focal fat infiltration
- Malignant
- Neuroendocrine tumor
- ➤ Metastasis
- ➤ Lymphoma

Iso-attenuating & small PDAC

• Iso-attenuating PDAC: 5-10% of all-size tumors and 30% in ≤2 cm

CT: **90%** sensitivity & specificity for all sizes



60-75 % sensitivity for small (≤ 2 cm) and isoattenuating

Red Flags

- MPD abrupt cut-off +/- upstream ductal dilatation
- Pancreatic atrophy distal to MPD stricture
- Irregular pancreatic contour at MPD stricture

Iso-attenuating & small PDAC

MRI: hypointense on T1 fat suppressed

Positive Red flags....**further** workup rather than follow-up **US:** hypoechoic lesion

EUS: high suspicion but inconclusive imaging + advantage of tissue biopsy

PET CT: controversial

Case: 72 year-old man



6 months later

Case: 72 year-old man



Case: 68 year-old man

Two month later



Uncinate process PDAC

• Incidence ~2-11% of all PDAC

Relatively distant from CBD & MPD

Closer to SMV & SMA

Rich nerve plexus

Hidden area on CT



Late presentation (abd. pain>jaundice)

Early vascular invasion

Higher incidence EPNI

Easily missed at early stage

Case: 47 year-old man



Case: 81 year-old man



Case: 71 year-old man

10 months later









Case: 63 year-old man



Uncinate process PDAC

- Duodenal Invasion ~70% in uncinate process compared to ~40% in other head PDAC
- On CT: contiguous tumor extension within the duodenal wall and focal interruption of normal mural enhancement of duodenum

Case: 63 year-old man



One month later

Evolving concept of tumor resectibility

- CT is the modality of choice for the assessment of vascular invasion
- Biphasic CT: pancreatic (40-50 sec) & portal venous phases (65-70 sec)
- Thin slice thickness (< 3 mm, preferably 0.5-1 mm if available)
- Multiplanar reformatting: circumferential & longitudinal tumor-vessel contact
- Tumor **abutment**: ≤180° circumferential tumor contact with the vessel
- Tumor encasement: >180° tumor contact with the vessel

Case: 63 year-old man



<u>Resectable</u>

- No Tumor contact with any vessel
- The only exception ≤180° Tumor contact with SMV/PV WITHOUT venous contour irregularity

<u>Unresectable</u>

- Metastasis "including non-regional LN"
- >180° Tumor contact with CA or SMA
- Any contact with Aorta
- <u>Unreconstructible SMV/PV (tumor invasion or</u> <u>bland/tumor thrombosis)</u>
- <u>Tumor contact with the most proximal</u> draining jejunal branch into SMV

None is Applicable

Border-line resectable

- Higher likelihood of positive resection margin
- Neoadjuvant therapy increases probability for (R0)

Border-line resectable

<u>Arterial BR</u>

- ≤180° Tumor contact with CA/SMA
- Tumor contact with **CHA** WITHOUT extension to **CA** or **HA** bifurcation
- Tumor contact with a **variant arterial anatomy**

Venous BR

- >180° Tumor contact with SMV/PV
- ≤180° Tumor contact with SMV/PV + venous contour irregularity or thrombosis if the vein is reconstructible
- Tumor contact with IVC

Consensus of International Association of Pancreatology (IAP) for Defining Border-line Tumor Resectibility (2016)

1-Anatomical criteria

- Determined by the degree of tumor-vessel relationship
- <u>The inferior border of the duodenum</u>: anatomic landmark to discriminate BR from unresectable PDAC in Venous involvement

2-Biological criteria

- Suspicious but uncertain distant metastasis
- Serum carbohydrate antigen (CA 19-9) >500 U/ml

<u>3-Conditional criteria</u>

• Performance status of the patients

Arterial Border-line resectable



Extrapancreatic Perineural Invasion (PNI)

- Tumor spread along the perineural spaces of the surrounding nerves >>>>
 alternative pathway for metastasis
- Significantly associated with +ve surgical margins and postoperative tumor recurrence
- On CT: extra-pancreatic soft-tissue infiltration extending from the tumor along the **peripancreatic arteries**
- Medial-posterior fat area of the pancreatic head as a mass or coarse reticulations >2 mm continuous with the primary tumor.





Case-11: 60 year-old man



Imaging findings after neoadjuvant therapy

 CRT downstage and improve resectibility of non-metastatic locally-advanced PDAC

Attenuation: necrosis/edema cannot be differentiated from from residual tumor tissue

Tumor size: can be overestimated on CT due to treatment-related necrosis and edema

Reduction of tumor-vessel contact: significantly associated with R0 resection regardless of the tumor size reduction or the extent of tumor-vessel contact

FDG-PET-CT can be a useful tool to monitor response of the tumor





Case-12: 64 year-old man

2 months after neoadjuvant R





Case-13: 62 year-old man

2 months after neoadjuvant R



Celiac artery stenosis

- 2–8% of patients undergoing PD
- In PD, collaterals from SMA to CA will be terminated >>>> risk of hepatic arterial ischemia
- Sagittal images should be in CT checklist for patients undergoing PD
- MAL compression syndrome: MAL indentation on CA >>>> "J-shaped" + post-stenotic dilatation and enlarged peripancreatic collaterals.
- Atherosclerotic stenosis: ostium + atherosclerotic changes
- Intraoperative Doppler US can assess hepatic arterial flow after clamping
 GDA >>>> A significant reduction in the hepatic arterial flow justifies for arterial reconstruction



Case-10: 60 year-old man



MIMICS OF PDAC

Autoimmune Pancreatitis (AIP)

- Great mimicker of PDAC and accounts for 2-3% of surgical resections for clinically suspected cancers
- Chronic fibroinflammatory pancreatitis with a dramatic response to steroid therapy.
- **Type 1** "lymphoplasmacytic sclerosing pancreatitis", commonly:
- > Asian males at old age
- > IgG4-related extra-pancreatic disease present
- **Type 2** "Idiopathic duct-centric chronic pancreatitis", commonly:
- > Europe and USA, at a younger age without gender predominance.
- > IgG4-related extra-pancreatic disease absent.

The International Association of Pancreatology consensus criteria for the diagnosis of AIP

Criteria	Description	Caveat
Imaging	 Diffuse pancreatic enlargement with 	 NO hypoattenuating pancreatic
• CT/MRI	delayed enhancement +/- capsule-like rim	mass
• ERP/MRCP	 Long (at least 1/3 of MPD) or multiple 	 NO MPD dilatation or cut-off
	stricture(s)	
Serology	 <u>î</u>î Serum IgG4 > double upper normal limit 	Occasionally, False positive in PDAC
lgG4-related	 2ry sclerosing cholang., Renal lesions, 	Not a feature of PDAC
disease	Retroperit. Fibrosis, Enlarged Salivary Glands	
Histopathology	 Periductal lymphoplasmacytic infiltrate and 	only required in type 2
	storiform fibrosis	
Steroid therapy	• 🔱 CA 19-9	Resolved cancer-induced pancreatitis
	 Improving imaging findings (weeks-months) 	can be falsely interpreted as steroid
		response

Case-14: 50 year-old man



Case-15: 55 year-old man



Case-16: 68 year-old man





10 months later

Case-17 : 60 yearold man



Case-18: 63 year-old man



Case-19: 71 year-old man



Case-20: 44 yearold man



3 months later



Groove Pancreatitis (GP)

- Uncommon chronic pancreatitis affecting the groove between the pancreatic head, duodenum and CBD, commonly young males and associated with alcohol abuse
- Sheet-like lesion in the PD groove associated with mural thickening and luminal narrowing of the duodenal C-curve
- > Variable-sized cysts in duodenal wall or in groove (true/pseudo-cysts)
- > Severe GP may cause duodenal stenosis and obstruction
- Pure form, limited to the groove
- Segmental form extends to involve the adjacent pancreatic head >>>> Mass like appearance and may cause mild upstream MPD dilatation

Groove Pancreatitis (GP)

PDAC and GP

- Low SI on fat supressed T1-WI
- Intermediate to high
 SI on T2-WI
- Similar pattern of enhancement

Key features on MRI (imaging modality of choice) 1) Focal mural thickening (>3 mm) 2) Hyper-enhancing D2 3) Cystic changes around the accessory pancreatic duct The combined three signs >>>> diagnostic for GP with accuracy of 87% and 93% NPV for cancer > Long smooth stricture of mid-distal CBD that is displaced away from the duodenal wall. \succ No significant CBD or MPD dilatation > EUS-guided FNA may be required for definitive diagnosis

Case-34: 55 yearold man



Case-35: 60 year-old man



Case-36: 59 yearold man



After gastrojejunostomy



Focal Fat Infiltration

Anterior fat Infiltration Mimic hypoattenuating tumor on CT

Posterior fat sparing Mimic hypoechoic tumor on US > Distinct border between the anterior and posterior portions Preserved course and calibre of CBD \succ On CT, the posterior portion is platelike normally enhancing pancreatic tissue around the common bile duct > Chemical shift MRI: drop of signal intensity in out-of-phase relative to in-phase T1 WIs

Case-21: 85 year-old man



Case-22: 39 year-old man



Pancreatic Endocrine Tumor (PET)

- 1-3% of all pancreatic neoplasms with 5-year survival in more than 60% of patients
- CE CT/MRI imaging , typically homogeneous hyperenhancement on arterial and portal venous phases
- In 42-49% arterially iso- or hypo-enhancing relative to the pancreatic parenchyma
- MRI: a well-circumscribed mass, iso-to hyperenhancing relative to the normal pancreas during the portal venous phase with milder degree of upstream MPD dilatation and less pronounced distal pancreatic atrophy

Case-30: 53 year-old man



Case-31: 52 year-old woman



Metastasis

- Uncommon (2%-5%) of malignant pancreatic lesions
- The majority from RCC followed by breast, lung , colorectal, and melanoma
- Solitary mass (most commonly), diffuse infiltrative mass or multiple masse
- Mets from RCC and HCC: Hypervascular.
- Mets from lung , breast and colorectal cancers: Hypovascular , quite similar to PDAC
- > A known history of primary malignancy
- Extrapancreatic metastasis
- > Multiplicity of pancreatic lesions can help in the diagnosis of metastasis
- > But biopsy may be required

Cases-23, 24, 25



Papillary thyroid cancer

Melanome

Melanome

Lymphoma

- <0.5 % of all pancreatic tumors
- 1ry or, more commonly, 2ry to extension from peripancreatic LN (NHL commonly)
- Focal pancreatic head mass in 80% of cases; or a diffuse pancreatic enlargement simulating pancreatitis
- Key Features:
- > Absent significant MPD dilatation even with sizable tumor
- > Lymphadenopathy below the level of the renal veins
- > Infiltrative nature of the tumor with multiorgan involvement
- > Encase the nearby vessels without significant vascular invasion or occlusion

Case-32: 50 year-old man



Case-33: 56 year-old man



Conclusion

- Secondary signs warrant further workup to exclude early PDAC
- Uncinate process can be missed at early stage
- Tumor resectibility and its contingency is continuously changeable and varies among different institutions particularly in the era of neoadjuvant therapy
- Mimickers of PDAC could be benign entities such as focal fat infiltration, autoimmune and groove pancreatitis, or malignant tumors such as neuroendocrine tumor, metastasis, lymphoma

Thank You