Hands-On MRI 2017
Abdomino-pelvic MRI
February 1-3, 2017
Paris/FR
Pancreas & MRCP MRI:
indications, protocols, compromises and challenges

M Zins, S Hervo, W Khaled, L Corno, S Béranger, I Boulay-Coletta
Saint Joseph Hospital, Paris
To describe a useful MRI protocol for assessment of pancreatic diseases

To illustrate and discuss the technique and results of MRI in the detection and staging of pancreatic adenocarcinoma, neuroendocrine tumours, cystic tumours and inflammation.
Pancreas MR Imaging

*Standard Protocol: preparation*

- Fasting during 3-6h
- Negative oral contrast (pineapple juice)
- Antiperistatic agent (glucagen)
Pancreas MR Imaging

Standard Protocol

- Axial T2 2D FSE fat sat Resp Trigg
  - Assessment of pancreas and liver +++
  - SSFSE T2: part of MRCP but also used for liver assessment
Pancreas MR Imaging

Standard Protocol

- 2D GE fat sat T1 pre contrast
- 3D T1 Dual-Echo pre-contrast
  - Including the entire liver
- High NPV +++

Pancreas MR Imaging

Standard Protocol

- 2D GE fat sat T1 pre contrast
- 3D T1 Dual-Echo pre-contrast
  - Including the entire liver
- High NPV +++

Pancreas MR Imaging

*Standard Protocol*

- **3D GE T1 post Gd**
  - Art / HR *1.6mm native*
  - Portal, Equilibrium / *2.4mm native* (3min coro, 5min axial)

---

Pancreas MR Imaging

*Standard Protocol*

- **2D MRCP:**
  - Short TE (axial and coronal)
  - Long TE (coronal, oblique, radial)

- **3D MRCP**
  - 1.5T > 3T
Secretin-enhanced MRCP:

- No more used for functional assessment of chronic pancreatitis
- Used for assessment of «stenosis»

2D MRCP long TE
Pancreas MR Imaging

Standard Protocol

- **EPI-DWI**
  - Free breathing
  - \( b=1000 \) reversed black/white
  - Multi \( b \) value (0/50/500)

- **Focused Diffusion**
  - Multi \( b \) value (0/50/500)


Ichikawa T et al. High \( b \) value diffusion weighted MRI for detecting pancreatic adenocarcinoma AJR, February 2007
Pancreatic Tumours
Adenocarcinoma

- **Challenges**
  - To accurately detect early cancer
    - Resectable and with Free margins (R0)
    - No distant lesions (liver mets+++)
  - Third Player: EUS?
  - Increasing role for Neoadjuvant treatment

- **Imaging studies**
  - CT still considered as the reference technique
  - MRI is not mentioned
Pancreatic Tumours
Adenocarcinoma

- MDCT: Direct signs at Pancreatic Phase
  - Focal Hypoattenuating Mass, ill defined
    - 80-90 %
  - Never Hyperattenuating ++
Pancreatic Tumours
Adenocarcinoma

- MDCT: Indirect signs +++
  - Ductal dilatation (CBD, MPD)
    - 85-90 %, double duct sign (for right sided tumours)
The prevalence of isoattenuating pancreatic cancers was significantly higher among 20mm or smaller (P = .033) and well-differentiated (P = .001) tumors.

- 130 pts surgically proven PC < 30mm
- 33 pts with missed PC < 30mm
- Isoattenuating PC: 19%

- 70 tumours < 20mm
  - Prevalence of Isoattenuating PC: 27%
- 63 tumours: 21-30mm
  - Prevalence of Isoattenuating PC: 13%
Pancreatic Tumours
Adenocarcinoma

**Early Radiological Signs**

- Ductal dilatation
- Contour abnormalities
  
  \((76\% \text{ of tumors } < 20 \text{ mm}, \ 99\% \text{ of tumors } 21–30 \text{ mm}) \ (P: \ 0.001)\)
Pancreatic Tumours
Adenocarcinoma

Visually Isoattenuating Pancreatic Adenocarcinoma at Dynamic-Enhanced CT: Frequency, Clinical and Pathologic Characteristics, and Diagnosis at Imaging Examinations

**Purpose:** To retrospectively determine the frequency, clinical and pathologic characteristics, and computed tomographic (CT) findings of visually isoattenuating pancreatic adenocarcinomas and to investigate the utility of magnetic resonance (MR) imaging and positron emission tomography (PET) CT for detecting them.

**Materials and Methods:** Institutional review board approval was obtained. Patient informed consent was waived. Of 743 consecutive patients with pathologically proved pancreatic cancer, 644 patients (352 men, 292 women; mean age, 50 years ± 9.5 [standard deviation]) who had undergone both arterial and portal phase contrast material-enhanced CT were included.

**Survival**

- **Better survival** after curative-intent surgery
  - Adjusted Hazard ratio 0.43 (p = 0.006)
- **Pathologic Characteristics**
  - Less cellularity, Less necrosis

**Sensitivity**

- MRI: 79.2%
- Pet-CT: 73.7%
Pancreatic Tumours
Adenocarcinoma
Pancreatic Adenocarcinoma

Tumor detection: CT or MR?

- Mean Sensitivity : 90%
- Better tumor conspicuity (Az value) compare to MDCT
- 66 pts: Sens 95%, Spe 82%
  - FP cases: mass forming chronic pancreatitis


Pancreatic Adenocarcinoma

Tumor detection: CT or MR?
Pancreatic Adenocarcinoma

*Tumor detection: CT or MR?*
Pancreatic Adenocarcinoma

Tumor detection: Best sequence?

Arterial 3D T1 FS GRE sequence: best sequence for T Conspicuity

Table 3. Qualitative and quantitative evaluations of detectability

<table>
<thead>
<tr>
<th>Qualitative conspicuity&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>( C_{tumor/proximal , pancreas} ) (( n = 10 ))&lt;sup&gt;c&lt;/sup&gt;</th>
<th>( C_{tumor/distal , pancreas} ) (( n = 19 ))&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Best sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS T1</td>
<td>0.17 ± 0.11</td>
<td>0.14 ± 0.11</td>
<td>1</td>
</tr>
<tr>
<td>Arterial</td>
<td>0.24 ± 0.18</td>
<td>0.24 ± 0.14</td>
<td>11</td>
</tr>
<tr>
<td>Portal</td>
<td>0.14 ± 0.18</td>
<td>0.13 ± 0.08</td>
<td>1</td>
</tr>
<tr>
<td>Delayed</td>
<td>0.14 ± 0.10</td>
<td>0.09 ± 0.06</td>
<td>4</td>
</tr>
<tr>
<td>T2</td>
<td>0.14 ± 0.11</td>
<td>0.10 ± 0.08</td>
<td>0</td>
</tr>
<tr>
<td>DWI</td>
<td>0.25 ± 0.12</td>
<td>0.13 ± 0.12</td>
<td>5</td>
</tr>
</tbody>
</table>

DWI, diffusion-weighted imaging; FS, fat-suppressed

<sup>a</sup> Mean ± SD
<sup>b</sup> Evaluated on a 3-point scale (1–3)
<sup>c</sup> Except for diffusion-weighted imaging (\( n = 8 \))
<sup>d</sup> Except for diffusion-weighted imaging (\( n = 17 \)
80 patients with proved PA, 3T, DWI (b=1000)

Only 47% of hyperintense lesions with clear borders

- Hyperintensity of the distal pancreatic parenchyma
  - Obstructive Pancreatitis
Pancreatic Adenocarcinoma

**DWI: A role for characterization?**

- **DWI using IVIM:** Ten b-values ranging from 0 to 1000 s/mm²
  - Lower ADC value in malignant tumors
  - 93 patients: 39 AK, 17 NETs, 37 IPMN, 7 CP
  - f factor: Perfusion Fraction and D fast > ADC value and D slow
    - For differentiation of AK vs NETs

Pancreatic Tumours
Adenocarcinoma
Pancreatic Tumours
Adenocarcinoma

R1 Resection!
Pancreatic Adenocarcinoma

Staging, MRI or MDCT?

- MRI: high accuracy
  - High Sens (>90%) for detection
    - No significant difference with MDCT
  - High accuracy for vascular assessment
    - No significant difference with MDCT
  - No difference for liver mets detection
    - 3T, isotropic dynamic 3D T1
    - Limited sample size+++
Pancreatic Adenocarcinoma

**Results: Staging**

Venous involvement
Tumour « borderline resectable »
M.D Anderson Criteria for Resectability of PC

- Tumor abutment < 180° with SMA
- Short segment encasement of the common Hepatic Artery
- Short segment occlusion of the SMV or PT
- Goal: R0 Resection = Co-adjuvant chemo-radiationtherapy

Pancreatic Tumours
Adenocarcinoma
Failure: Peritoneal and liver mets < 10 mm

- Is there a role for MRI?
- Liver-Specific contrast agent, DWI ++
- 100 pts with proved PC
  - No sign diff for detection
  - MR > MDCT for liver mets
    - (85% vs 69%, \( P = .046 \))
Pancreatic Adenocarcinoma: diagnosis and staging

Staging: peritoneum and liver

Female, 56y, « borderline resectable » PC
Pancreatic Adenocarcinoma: diagnosis and staging

**Staging: peritoneum and liver**

Female, 56y, « borderline resectable » PC
Pancreatic Tumours
Neuroendocrine

- Challenges
  - High spatial resolution +++
    - Functional tumors
  - Third Player: EUS +++

- Imaging studies
  - Search for calcification
  - Early Phase is needed
    - Pitfalls with splenic vessels or pedunculated lesions
Pancreatic Tumours
Neuroendocrine
50% of FN: close proximity to vessels

Fidler et al: preoperative detection of pancreatic insulinomas on Multiphasic Helical CT, AJR 2003;181: 775-780
Pancreatic Tumours
Neuroendocrine

Portal

Art 1

Art 2

Art 3
Pancreatic Tumours

Neuroendocrine

43 yrs female with 5mm size Serotonin producing endocrine tumor
Pedunculated insulinoma on the anterior border of the head of the pancreas: an unusual location to be aware of.
Pancreatic Tumours
Neuroendocrine
Pancreatic Tumours
Neuroendocrine
Challenges

- Differentiating serous from mucinous Cystadenoma
  - Calicification, septas, central scar
- Diagnosis of IPMNs
  - Communication with the MPD
- Third Player: EUS

Imaging studies

- MRI > CT except for calcification
  - Follow up of IPMNs =MRI +++
Itoh S et al. Assessment of the pancreatic and intrapancreatic bile ducts using 0.5-mm collimation and multiplanar reformatted images in multislice CT. Eur Radiol 2003;13:277-85.
32 yrs old female. Typical appearance of Mucinous Cystadenoma
65 yrs old male. IPMN involving both branch ducts and main pancreatic duct
Pancreatic Cystic Tumours

IPMN: Demonstrating communication with the MPD

MR is the preferred tool for Follow up in branch duct type
Pancreatic Inflammation

- **Challenges**
  - Chronic pancreatitis
    - Early diagnosis and severity of disease
  - Rare form of Chronic pancreatitis (AIP, Paraduodenal)
    - Differential diagnosis with pancreatic cancer
  - Acute pancreatitis
    - Assessing severity, pancreatic duct rupture?

- **Imaging studies**
  - MRI > CT except for calcification and vascular complications of CP
    - MRI not widely used in acute pancreatitis
Pancreatic Inflammation
Pancreatic Inflammation
Pancreatic Inflammation

41 yrs old male. Type 2 AIP with pancreatic tail cut-off sign
Pancreatic Inflammation

41 yrs old male. Type 2 AIP with pancreatic tail cut-off sign
Pancreatic Inflammation

57 yrs old female. Type 1 AIP with diffuse pancreatic involvement
Pancreatic Inflammation

57 yrs old female. Type 1 AIP with diffuse pancreatic involvement

After 6 Weeks of steroid
Pancreatic Inflammation
Acute Pancreatitis

45 yrs old male, acute pancreatitis; Day 32

Courtesy AM Chuong
Pancreatic Inflammation
Acute Pancreatitis

45 yrs old male, acute pancreatitis; Day 32

Courtesy AM Chuong
Pancreatic Inflammation
Acute Pancreatitis

From Celso Matos, Radiographics 2002
MR and CT are not in competition and should be used in combination for evaluating most pancreatic diseases.

In pancreatic adenocarcinoma CT remains the workhorse for local staging. MRI is clearly indicated in case of isodense lesion at CT and for assessment of Liver mets in all patients with « resectable » lesion at CT or after neoadjuvant therapy when curative-intent surgery is discussed.
MR is the preferred technique for early detection of Chronic pancreatitis and assessment of cystic tumors as well as for the follow up of branch duct IPMNs.

MR should be more often used after CT in assessment of acute pancreatitis or detection of neuroendocrine tumors.