IMAGING OF ACUTE AND CHRONIC PANCREATITIS, INCLUDING EXOCRINE FUNCTION

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Disclosures

• Grant support – National Pancreas Foundation

• In-kind support - ChiRhoClin
Outline

• Acute pancreatitis
• Chronic pancreatitis
ACUTE PANCREATITIS (AP)
Background

- Increasing incidence in children, approaching incidence in adults
- Diagnosis of AP
  - 2 of 3 criteria:
    1. Abdominal pain c/w AP
    2. Serum lipase 3x normal
    3. Imaging findings of AP (CT, MRI or US)
- 5-10% of adult patients develop necrotizing pancreatitis / peripancreatitis
- Most children have mild disease

Imaging of Acute Pancreatitis

- Ultrasound
- CT
- MRI
  - Avoid if unstable
  - ? More sensitive
  - Better for assessing complexity of collections (necrosis)
  - IV contrast
    - May add value for acute (non-liquefied) necrosis
    - Adds value for delayed assessment of local complications
  - +/- negative oral contrast
  - Avoid secretin during acute attack, may add value for duct assessment after resolution of acute attack
Basic MR Imaging Sequences

- Parenchymal assessment
  - Axial T2w (RTr, propeller)
  - Axial T1w fat-sat (Dixon, LAVA/Thrive)
  - +/- post-contrast fat-sat

- Duct assessment
  - Non-fat-sat SSFSE! – axial, coronal (3-5 mm, no gap)
  - 3D MRCP
    - Resp triggered, BH, Navigator
    - TE optimized to balance background suppression, fluid signal (~600)
  - Thick slab MRCP
    - Angled to duct
MR of AP – What to Look For

- Parenchymal findings of AP
- Causes of AP
  - Stones – GB, CBD, panc duct
  - Duct anomalies – divisum, long common channel
- Local complications*
  - Peripancreatic
  - Vascular
  - Necrosis
  - Infection – gas in tissues

*presence increases severity classification

MR of AP – What to Look For

• Revised Atlanta Criteria
  – Adults
  – 2 types of AP
    • Interstitial edematous
    • Necrotizing
  – Specific definitions for findings of AP

Findings of AP

- Swollen pancreas
- Abnormal parenchymal signal
  - Normal: T1w hyper to liver
    T2w iso to liver
- Peripancreatic inflammation
- Peripancreatic fluid
- Necrosis
  - Pancreatic
  - Peripancreatic
Findings of AP

- Swollen pancreas
- Abnormal parenchymal signal
- Peripancreatic inflammation
- Peripancreatic fluid
  - Acute peripancreatic fluid collection (APFC)
    - ONLY fluid
    - Confined by fascial planes
- Necrosis
  - Homogeneous enhancement
Findings of AP

• Swollen pancreas
• Abnormal parenchymal signal
• Peripancreatic inflammation
• Peripancreatic fluid (APFC)
• Necrosis
  – Pancreatic
  – Peripancreatic
Findings of AP

• Necrosis
  – Imaging in first week may underestimate
  – Pancreatic
    • Non-enhancing parenchyma
  – Peripancreatic
    • Acute necrotic collection (ANC)
      – Heterogenous fluid (solid components)
Findings of AP

• Delayed (gen >4 weeks*)
  – Organized – well defined, enhancing wall
  • Pseudocyst
    – Never necrosis
    – Status-post necrosectomy
    – No solid components
• Walled off necrosis (WON)
  – Pancreatic or peripancreatic
  – Solid components / debris
CHRONIC PANCREATITIS (CP)
Background

- 1-5 per 100,000 incidence in young adults
- Genetic mutations in 73%
  - PRSS-1, SPINK-1, CFTR, CTRC
- Diagnosis of CP
  - Imaging findings
  - One of the following
    1. Abdominal pain consistent with pancreatic origin
    2. Evidence of exocrine pancreatic insufficiency
    3. Evidence of endocrine pancreatic insufficiency
Imaging of CP

- Ultrasound
- CT
  - Better for calcifications / calcified stones
- MRI
  - Best for duct abnormalities
  - +/- IV contrast
  - +/- negative oral contrast
    - May confound exocrine function assessment
  - +/- secretin
  - Emerging techniques
Basic MR Imaging Sequences

• Parenchymal assessment
  – Axial T2w (RTr, propeller)
  – Axial T1w fat-sat (Dixon, LAVA/Thrive)
  – +/- Post-contrast fat-sat

• Duct assessment
  – Non-fat-sat SSFSE! – axial and coronal (3 mm, no gap)
  – 3D MRCP
    • Resp triggered, BH, Navigator
    • TE optimized to balance background suppression, fluid signal (~600)
  – Thick slab MRCP
    • Angled to duct

• Emerging techniques*

SAME AS FOR AP*
Findings of CP

• Duct dilation (main & side branch)
• Duct irregularity, stricture
• Gland atrophy
• Calcification
• Delayed post-contrast enhancement
Findings of CP

- Duct dilation (main & side branch)
- Duct irregularity, stricture
- Gland atrophy
- Calcification
- Delayed post-contrast enhancement
## Findings of CP - Cambridge

### Table: Chronic pancreatitis – Image grading

<table>
<thead>
<tr>
<th>ERP</th>
<th>US and CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Normal</td>
<td>Quality study visualising whole gland without abnormal features</td>
</tr>
<tr>
<td>2 Equivocal</td>
<td>Less than three abnormal branches</td>
</tr>
<tr>
<td>3 Mild</td>
<td>More than three abnormal branches</td>
</tr>
<tr>
<td>4 Moderate</td>
<td>Abnormal main duct and branches</td>
</tr>
<tr>
<td>5 Marked</td>
<td>As above with one or more of: Large cavities (&gt;10 mm) Gross gland enlargement (&gt;2×N) Intraduct filling defects or calculi Duct obstruction, structure or gross irregularity Contiguous organ invasion</td>
</tr>
</tbody>
</table>

- One sign only
  - Main duct enlarged (<4 mm)
  - Gland enlarged (up to 2×N)
  - Cavities (<10 mm)
  - Irregular ducts
  - Focal acute pancreatitis
  - Parenchymal heterogeneity
  - Duct wall echoes increased
  - Irregular head/body contour
Findings of CP

- Duct dilation (main & side branch)
- Duct irregularity, stricture
- Gland atrophy
- Calcification
- Delayed post-contrast enhancement

Ultrasound

Secretin

- Stimulates bicarbonate secretion
  - Vs. dPFT (also CCK)
- Dosing:
  - 0.2 µg / kg, max 16 µg
  - Test dose (atopy, asthma)
- Uses:
  - Duct dilation
  - Exocrine function assessment
Secretin – Exocrine Fxn Assessment

- Qualitative
- Quantitative
Assessment of Exocrine Fxn

• Qualitative
  – Dynamic thick slab imaging or serial static images
  – Matos grading
    • Grade 0 – no secretion
    • Grade 1 – filling of bulb
    • Grade 2 – filling to genu inferius
    • Grade 3 – filling beyond genu inferius
  – sMRCP graded per Matos correlates with bicarbonate secretion by endoscopic PFTs

Assessment of Exocrine Function

- Qualitative
  - Matos not validated in children
Assessment of Exocrine Function

- Qualitative
- Quantitative
  - Total secreted fluid volume
    - Dual time-point imaging
  - Flow rate (mL / min)
    - Multi-time-point imaging
Assessment of Exocrine Function

- Image segmentation
  - Pre- and post-secretin imaging parameters should be identical
- Fluid pixels
  - Threshold
  - Water standard
- Fluid area per slice
- $\Sigma(\text{area} \times \text{slice thickness})$
Assessment of Exocrine Function

• Normative data exist for adults
  – 111.8 ± 49.8 mL at 11.9 ± 2.8 minutes

• No normative data for pediatrics
  – We are working on this
Other Emerging Techniques

- T1 signal intensity ratio
- T1 mapping
- MR elastography
- Fat fraction
- DWI IVIM
Other Emerging Techniques

• T1 signal intensity ratio
  – 51 CP patients
    • 29 normal bicarb
    • 22 low bicarb by intraductal stim test
  – Signif diff in SIR between normal and low bicarb groups
    • Cut-off of 1.2
      – AUROC = 0.89
      – Sens = 77%
      – Spec = 83%

• T1 mapping

Other Emerging Techniques

• **T1 mapping**
  - 98 patients with suspected mild CP
    - 53 normal, 45 mild CP based on hx, MRCP and ERCP
  - T1 relaxation times longer in mild CP vs. normal
    - Cut-off of 900 msec
      - AUROC = 0.81
      - Sens = 80%
      - Spec = 69%

Other Emerging Techniques

• MR elastography (MRE)
  – Special driver
  – 3D MRE
  – Limited studies
  • Suggestion that stiffness decreases w/ CP, possibly due to volume loss, fatty infiltration
THANK YOU

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