BILIARY IMAGING:
EMPHASIS ON MRCP

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GOALS AND OBJECTIVES
• Review commonly used Modalities for application in biliary imaging
  • Technique
  • Benefits and limitations
  • Common Findings
  • Emphasis on MRCP imaging

COMMON INDICATIONS FOR BILIARY IMAGING
• Choledocholithiasis
• Bilary Obstruction or Stricture
• Pancreatitis – Recurrent/Chronic, Pseudocyst, Secretin study
• Primary Sclerosing Cholangitis
• Ascending Cholangitis
• Periampullary Tumors (inlet disruption)

ULTRASOUND

1st line modality for gallbladder/biliary abnormalities
• Cholelithiasis and choledocholithiasis
  • Sensitivity for gallstones in gallbladder >90% (~25 million Americans have gallstones)
  • Sensitivity for choledocholithiasis: 75% with ductal dilation / 50% without dilation (~15%)
• Biliary Obstruction: wide range of reported sensitivities (32%–100%) and specificities (71%–97% depending on context of study. Cause often remains unclear.
• Pancreatic Masses/Cysts: Challenging sensitivity reported highly variable (~70%) depending on context of study. Cause often remains unclear.

COMPUTED TOMOGRAPHY

• Widely available
• View all anatomy
• Short exam time
• Multiplanar reformations
• Give contrast
• Unexpected findings for alternative diagnosis

Limitations:
• Radiation
• Expensive

COMMON INDICATIONS FOR BILIARY IMAGING
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**COMPUTED TOMOGRAPHY**

- Cholelithiasis and Choledocholithiasis
  - Sensitivity for gallstones in gallbladder: ~70% (well calcified stones)
  - Sensitivity for the detection of ductal stones: ~75% for ductal stones ("bulls-eye" sign)
  - Sensitivity for choledocholithiasis: ~50% with ductal dilation
  - Sensitivity for gallbladder cancer: ~70% if well defined (thickening, invasion into adjacent structures)
  - Sensitivity for choledocholithiasis: ~25% if duct is not dilated

- Biliary obstruction: wide range of reported sensitivities (20%–70%) depending on context of study

- Cause often remains unclear

**Pancreatic Masses/Cysts**

- Sensitivity ~95% (primary modality for pancreas CA detection and staging)
- Cystic lesions are better characterized with MRCP

**HEPATOBILIARY NUCLEAR**

- Benefits:
  - Widely available
  - Relatively inexpensive
  - Functional imaging

- Limitations:
  - Limited anatomy
  - Radiation
  - Long exam time
  - Radiotracer shortages becoming more common
  - Patient prep (NPO and no narcotics for at least 4 h before exam)

**HEPATOBILIARY NUCLEAR**

- IDA analog (similar structure to lidocaine)
  - Follows similar metabolic pathway to bilirubin
  - Cholec and Hepatolite are 2 primary agents
  - 5 mCi (10 mCi for high bilirubin)

- FUNCTIONAL STUDY
  - Anatomy is very limited. Low resolution.
  - Patient prep critical to decrease false positives
  - CCK: pretreat in cholestasis OR stimulate GB to measure EF%

  - Morphine: increase sphincter of Oddi tone to cause back pressure and fill GB

- Second line modality for biliary function
  - Cystic duct obstruction (acute)
  - Biliary dyskinesia (chronic)
  - Bile leak (post-op)

**Acute Hepatitis**

**ERCP**

- Benefits:
  - Gold standard for ductal anatomy and assessing biliary obstruction
  - INTERVENTION!!

- Limitations:
  - Operator dependent
  - Availability (equipment/specialty physician)
  - Radiation
  - Anesthesia
  - Invasive
  - Post-ERCP pancreatitis
  - Expensive
MRCP

**Benefits:**
- Excellent ductal anatomy near to ERCP
- No radiation
- Risk for intervention
- Unanticipated findings common for alternative diagnosis

**Limitations:**
- Limited availability
- Expensive
- Patient dependent for cooperation breathing/hold still/claustrophobia
- Moderate exam time (long if combined with complete MR abdominal with contrast)

**SO WHAT IS MRCP EXACTLY?**
- MR abdomen sequences with strong emphasis on fluid sensitive sequences (T2 weighted)
- This section imaging and attempts to decrease breathing artifact to display ductal anatomy
- Most sequences used are part of routine abdomen exam
- Often combined with a routine abdomen exam with contrast. Pancreatic mass or Pancreatitis
- Attempt to create images that are analogous to traditional ERCP or intraoperative Cholangiogram images to aid clinical/surgical staff in planning interventions.

**COMMON SEQUENCES FOR MRCP**
- **COR T2 HASTE (No FS)**
- **Ax T2 HASTE (No FS)**
- **Ax T2 HASTE IS**
- **COR axial T2 MRCP IS**
- **COR 2D MRCP 1mm. RespGated**
- **Ax T1 GRE In/Out (optional)**
- **Ax T2 TSE Resp Triggered FS (optional)**

**CHOLEDODCHOLITHIASIS**
- Low signal filling defect
- MRCP
  - 81-100% Sens.
  - 85-100% Spec.
- 15-25% of patients with acalculous cholecystitis will have choledocholiths, could go undiagnosed at surgery.

**CHOLEDODCHOLITHIASIS**
- Routinely see stones down to 2mm. Always check sources thin section images (1mm) slab for small stones, or MIP, and 2D slab MRCP images have more volume average of small stones with surrounding fluid signal which may hide the stone.
- DDx: air, sludge, stones, flow voids, surg susceptibility
- Pneumobilia will layer dependently in the duct if dilated.

[Griffin et al. Insights Imaging 2012]
BILIARY OBSTRUCTION

- Comparable to ERCP
- Sens 95%, Spec 100%, Accuracy 95%
- MRCI has advantage of physiologic imaging, increased pressure from ERCP reconstruction and relaxes sphincter of Oddi
- Pre-cholecystectomy patients can have associated liver and peripancreatic biliary dilatation. Check for old films, avoid unnecessary workup.
- Ampullary can be problematic if the site of obstruction
- Site of ampulla CA, inflammatory conditions, pseudo obstruction are better imaged with MRCI

BENIGN BILIARY STRICTURE

- 80% of benign biliary strictures are related to biliary ductal injury during cholecystectomy
- Other benign causes include pancreatitis, infection, stone passage, PSC, ischemia, chemotherap, AIDS/HIV
- Sens 95%, Spec 100%, PPV 94%, NPV 94%
- Beware because normal duct below a high stricture can be collapsed artifactually increasing the apparent length of the stricture.

PITFALLS

- Pseudo-strictures
- Crossing ducts or arteries
- Surgical susceptibility artifact
- Pseudo-dilation
- Ducts running parallel
- Vascular flow running parallel
- RVG signal mimicking right accessory duct
- Right hepatic artery crossing
- Vascular pulsation from GDA

PRIMARY SCLEROSIS CHOLANGITIS

- Autoimmune fibrosing inflammatory process affecting all bile ducts. Highly associated with IBD, especially UC
- “Prune” tree appearance from alternating dilation and strictures
- Secondary sclerosing cholangitis has same appearance but seen with HIV/AIDS, parasites, ischemia, bacterial infection, cholangitis, chemotherapy

MALIGNANT STRICURE

- Pancreatic neoplasms most commonly
- ERCP, US, CT, MRCP, lymphadenopathy, metastases
- Dual phase contrast exam usually demonstrate the mass in pancreatic head
- Stable duct sign (pancreatic and biliary ductal dilation from pancreatic head mass, highly specific) (Note: Dubreuil sign may limit interpretation if the lesion is not confined to the head)
- Pancreatic masses are typically T2 and T1 hypointense as well as enhance
- Biliary duct wall thickening >1mm is neoplastic
- ERCP is superior if the diagnosis is suspected because appearance overlaps with benign strictures but ability to biopsy during procedure is key.
- MRCP accuracy
  - Benign - location and cause 95% PPV 90% NPV
  - Malignant - location and cause 50% PPV and 90% NPV

MALIGNANT STRICURE

- Ampullary CA
- Klatskin
- Panc CA
- Ampullary CA

Griffin et al. Insights Imaging 2012
**PANCREATITIS**

- Chronic
  - Side branch ectasia is most common MRCP finding and most specific.
  - Other findings: Main duct dilatation, parenchymal stricture, pancreatic ductal strictures, pseudocysts, filling defects from calculi, mucinous deletions, and irregular ductal contour
- Pseudocysts
  - Acute or chronic disease
  - Simple fluid
  - Communicate with pancreatic duct, look for site of communication. Commonly is difficult or impossible to find. MRCP with secretin may help.

**CONGENITAL PANCREATICOBILIARY DUCTAL VARIANTS**

- Occurs in up to 50%
- MRCP 98% accurate in identifying clinically relevant variants.
- Variation with high risk of ductal injury at cholecystectomy
  - Aberrant right hepatic duct inserting into the common bile duct or cystic duct
  - Long intramural cystic duct with low insertion
  - Medial cystic duct insertion
- Main pancreatic duct (Wirsung) is primary drainage in 91%
- Minor Santorini duct present in 44%
- Pancreas Divisum – most common pancreatic variant
  - Cross-over sign – separate Santorini and Wirsung ducts (Santorini is primary drainage for main duct)
- MRCP nearly 100% accurate
- Saccular dilations are the duct orifices (Wirsungocele, Santorinicele)
- Increased incidence with recurrent pancreatitis.

**SECRETIN STIMULATED MRCP**

- Physiologic/functional imaging for Pancreatic Ductal Disease
- Secretin stimulates bicarbonate rich fluid secretion and creates transient physiologic ductal dilation
- 0.2 ug/kg IV (usually 16ug in a normal adult) 1 min to avoid cramping abdominal pain.
- Prepare patient with NPO 4 hours prior to study and either commercially available Gastromark or Pineapple/Blueberry juice. Total of 320 cc. (These contain Mn2+ which acts as a negative contrast agent)
- Use MRCP 2D slab SSFSE 4mm thick. Every 30 seconds for 10 minutes
- Peak dilation usually at 2-3 minutes, complete return to normal at 10 minutes. Dilation usually at least 1mm
SECRETIN STIMULATED MRCP

• Indications
  • Acute Recurrent or Necrotizing Pancreatitis – Duct Disruption
  • Chronic Pancreatitis – Strictures, Stones, Est. secretory volume
  • Pancreatic Cystic Neoplasm – 18/FNA from Pseudocyst or other cystic neoplasm.
  • Post-op pancreas – Duct stenoses/disruption/stricture/filling defect
  • Ductal anomalies – Divisum and other variants.

Acute Necrotizing Pancreatitis (a) Ductal Disruption

Acute Necrotizing Pancreatitis (b) Ductal Disruption

Chronic Pancreatitis with Stricture

CHRONIC PANCREATITIS

• Cambridge Classification
  • Developed in 1984 for chronic pancreatitis but secretin MRCP is sensitive enough now to use this system.

Quantifying Exocrine Function

<table>
<thead>
<tr>
<th>Grade</th>
<th>Main Pancreatic Duct</th>
<th>No. of Abnormal Side Branches</th>
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<tr>
<td>Normal</td>
<td>Normal</td>
<td>None</td>
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<tr>
<td>Everted</td>
<td>Normal</td>
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<td>3 or more</td>
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<tr>
<td>Moderate changes of chronic pancreatitis</td>
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</tr>
<tr>
<td>Severe changes of chronic pancreatitis</td>
<td>Abnormal</td>
<td>3 or more</td>
</tr>
</tbody>
</table>
REFERENCES

• ACR appropriateness criteria (2020): RUQ pain, Jaundice, Pancreatic Mass, Pancreatic Cyst, Acute Pancreatitis [acr.org]