Atlas of Radiological Modalities in the Evaluation of Ampullary Masses

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Agenda

- Patient Presentation
- Normal anatomy of the hepato-pancreatico-biliary system
- Differential diagnosis for a periampullary mass
- Menu of tests
- Radiological evaluation of the ampulla of Vater
- Categorizing the lesion with imaging
- Discussion of ampullary carcinoma
- Correlating findings with prognosis
Patient 1: HPI

• 58 yo M who presented with symptomatic obstructive jaundice. Developed pruritus and dark urine of 3 weeks duration before presentation. Mild weight loss over past 3 months. No abdominal pain, nausea, vomiting, alcohol use.
  – PMH significant only for glaucoma – takes timolol
  – Father passed away from unknown GI malignancy

• Labs were significant for following:
  – ALT: 192 IU/L
  – AST: 133 IU/L
  – Total bilirubin: 1.9 mg/dl
  – Lipase: 1498 IU/L
  – CA 19-9: 36 (normal < 34 U/ml)
Patient 1: Initial CT+ contrast

CBD
Pancreatic duct
Pancreas
Splenic artery
Celiac artery
SMV
IVC
Aorta

C+ axial CT abdomen & pelvis
Patient 1: Initial CT+ contrast

The common bile duct and the pancreatic duct are dilated.

This finding is known as the “double duct sign”
Patient 1: Initial CT+ contrast

Dilated common bile duct and pancreatic duct on coronal imaging

Distended gallbladder in absence of clear obstructing lesions or stones
Patient 1: Initial CT+ contrast

Duodenum with pancreatic duct and CBD converging in periampullary region.

No overt mass seen
Anatomy of the periampullary region
Anatomy of the ampulla

From Martin & Moser, Ampullary carcinoma, UpToDate
Differential Diagnosis

• **Benign periampullary masses**
  – Duodenal adenoma
  – Ampullary adenoma
  – Gallstones (choledocholithiasis or gallstone pancreatitis)

• **Periampullary cancers**
  – Pancreatic ductal adenocarcinoma
  – Carcinoma of the bile duct
    • Cholangiocarcinoma (extra-hepatic)
  – Carcinoma of the ampulla itself
  – Carcinoma of the periampullary duodenum
Let’s continue with several CT images of companion patients with other periampullary cancers.
Companion Patient 2: Cholangiocarcinoma on CT

Ill-defined hypodense mass seen near common bile duct stent with a dilated gastroduodenal artery. The pancreas is atrophic.
Companion Patient 3: Pancreatic adenocarcinoma on CT

Hypoenhancing mass in pancreatic head consistent with pancreatic adenocarcinoma.
Menu of tests

- Transabdominal US
- Abdominal CT
- MR and MRCP
- ERCP
- EUS
- IDUS
- Percutaneous transhepatic cholangiography (PTC)
Transabdominal US

- First imaging technique in pts with jaundice
- Can potentially assess vascular involvement, biliary dilation, liver lesions
- Overall accuracy in finding ampullary masses only 15%
  - If no gallstones or obvious pancreatic head mass → proceed to other modality
- For patient 1, US was not initially done
  - No abdominal pain, low suspicion for stones
CT – abdominal

- Once ampullary mass suspected → order “pancreatic mass protocol”
- Water as “oral contrast” and IV contrast
  - water distends duodenum but w/o high attenuation of usual contrast
    - allows vessels to be clearly visualized
  - contrast allows for arterial- and venous-phase imaging
- Acquire images 1.0 to 2.5 mm intervals (helps see pancreas)
CT – abdominal (cont’d.)

• **Pros:**
  - More sensitive than US in assessing periampullary region
  - Can pick up distant mets
  - Visualize regional lymph nodes, liver, peritoneum, lungs, and bone

• **Cons:**
  - Inadequate for staging because lacks spatial resolution for invasion of nearby structures
  - Can not see small ampullary neoplasms
    • Detection as low as 20%

• For **patient 1**, he subsequently had CTA abdomen & pelvis several days after initial CT abdomen
Patient 1: CTA abdomen

CBD Stent

Ampullary mass

C+/- coronal CTA abdomen
Patient 1: CTA abdomen

Air in central intrahepatic ducts
Pneumobilia

Air in central intrahepatic ducts and pneumobilia secondary to CBD stent placement
MR and MR cholangiopancreatography (MRCP)

- Usually, in patients where ERCP contraindicated
- Masses usually appear isointense or hypointense on T1- and T2-weighted images
- When mass not seen on MR, bulging duodenal papilla may be only indication of ampullary cancer
  - Bulging caused by dilated pancreatic and bile ducts
- MRCP — noninvasive way to visualize pancreaticobiliary tree
- Some signs that differentiate one periampullary cancer from another
  - So-called “four segment sign” on MR in pancreatic adenocarcinoma
MR and MR cholangiopancreatography (MRCP)

Companion Patient 4

From Kim JH et al., Differential Diagnosis of Periampullary Carcinomas at MR, 2002
Endoscopic retrograde cholangiopancreatography (ERCP)

- Combines endoscopy and fluoroscopy
- Visualizes stomach, duodenum, ampulla
  - Cannot evaluate extent of local tumor invasion
- Fluoroscopy with contrast allows for radiographic visualization of bile ducts and pancreatic duct
- Diagnostic and therapeutic
  - Removal of some stones
  - Insertion of stent (retrograde)
  - Dilation of strictures
  - Biopsy
- Does have some contraindications, complications
Normal ERCP

From Greenberger NJ, Blumberg RS, Burakoff R, CURRENT Diagnosis & Treatment, 2nd Edition
Patient 1: Ampullary lesion on ERCP

- Mass was visualized and biopsied.
  - Stent placed → obstruction relieved

From Martin & Moser, Ampullary carcinoma, UpToDate

**Patient 1: ERCP Results (cont’d.)**

- **Fluoroscopy image sequence:**
  - Stent placed → obstruction relieved

  ![Fluoroscopy image sequence](image1)

  **Dilated common bile duct on cholangiogram**

  ![Fluoroscopy image sequence](image2)

  **Stricture of distal CBD due to ampullary mass**

  ![Fluoroscopy image sequence](image3)

  **Stent being placed**

  ![Fluoroscopy image sequence](image4)

  **Stricture, obstruction, and dilation relieved**
Endoscopic Ultrasound (EUS)

**Pros:**
- Higher spatial resolution than CT/MRI
- Can show surrounding anatomy including lymph nodes
- Discerns duodenal wall and pancreas interface
- More accurate in detecting ampullary tumors than US and CT
  - As in 100% accurate
- FNA ability
- Great for preop planning and T-stage
  - 70-90% accurate in T-stage

**Cons:**
- Technically challenging
- Operator dependent
- No stent ability
- Less adept at nodal-staging in comparison to tumor-staging

*Especially useful when ERCP has found low-grade dysplasia*
→ Could allow for local resection
Companion Patient 6: Tumor on EUS

DL: duodenal lumen
T: tumor mass
CBD: common bile duct
m: muscularis propria
nLN: non-metastatic lymph node
P: pancreas

From Skordilis P et al., Is endosonography an effective method for detection and local staging of the ampullary carcinoma?, 2002
Intraductal ultrasound (IDUS)

- Small miniprobes ~2mm
- From endoscope into biliary or pancreatic duct
- Only modality that can differentiate sphincter of Oddi muscle from papilla
- Useful in identifying tumor strictures when no mass seen on imaging or indeterminate strictures
  - Increases accuracy of ERCP

From: Stavropoulos S et al., Intraductal ultrasound for the evaluation of patients with biliary strictures, 2005
Patient 1: Diagnosis & Surgery

- **Cytology sent from ERCP brushings**
  - “Adenomatous mucosa with villous and papillary features, and at least high grade dysplasia” – Path Report BIDMC

- **Given HGD → surgery**
  - **Whipple:** pancreaticoduodenectomy
  - In this case, Robot-assisted, pylorus-preserving
Carcinoma of ampulla of Vater: Some facts

• 6-35% of pancreaticoduodenal malignancies
  – But, rare: 4-6 cases per million people
  – Average age of diagnosis for sporadic cases → 60-70
    • Can be earlier in genetic syndromes, e.g. FAP w/increased risk
  – Male-to-female ratio 2:1

• Papillary orifice of ampulla commonly involved by tumor
  – Means symptoms appear early
  – Abdominal pain, pruritus, obstructive jaundice, steatorrhea, weight loss

• Survival is ~25% at 5 years for pts with +LNs and 50% in those without involved nodes
  – 80% thought to be resectable at Dx
Ampullary carcinoma: location correlates with prognosis

→ which correlates with histology

Large overall size, small invasive component, best overall prognosis.

3-y survival, 73%

From: Adsay V, et al., Ampullary Region Carcinomas, 2012
Ampullary carcinoma: location correlates with prognosis

→ which correlates with histology

Largest, highest incidence of LN mets. Minimal intra-amp lumen. Mostly intestinal histology (75%).

3-y survival, 69%

From: Adsay V, et al., Ampullary Region Carcinomas, 2012
Ampullary carcinoma: location correlates with prognosis

→ which correlates with histology

Ulcero-nodular tumors, does not show features of other subtypes. Intermediate tumor size.

3-y survival, 54%

From: Adsay V, et al., Ampullary Region Carcinomas, 2012
Ampullary carcinoma: location correlates with prognosis

→ which correlates with histology

Smallest but worst prognosis, presumably due to the pancreatic histology or origin (in 86%).

3-y survival, 41%

*From: Adsay V, et al., Ampullary Region Carcinomas, 2012*
Ampullary carcinoma: location correlates with prognosis

→ which correlates with histology

From: Adsay V, et al., Ampullary Region Carcinomas, 2012
Patient 1: Subsequent course

- **Final path of mass:**
  - Ampullary adenocarcinoma, moderately differentiated, 1+ node of 29
  - T1N1 → tumor limited to Ampulla of Vater w/regional LN met. Negative margins

- **Unfortunately, pancreaticobiliary histology**
  - Cytokeratin 7 (CK7) and CK20 have recently (2013) been shown to differentiate between pancreaticobiliary and intestinal ampullary histology
  - CK20 → intestinal type; CK7 → pancreaticobiliary type
  - **Patient 1** was CK7+/CK20−, which is pancreaticobiliary

- **Now, receiving adjuvant chemo**
  - Still experimental: gemcitabine 1000 mg x2 weekly, 3 weeks on, 1 week off for 4-6 months

- **He will f/u with surgeon in 3 months for staging**
Diagnostic-Therapeutic Algorithm

Figure 1 Proposed algorithm for the investigation and subsequent management of a suspected lesion of the ampulla of Vater. EUS, endoscopic ultrasound; EMR, endoscopic mucosal resection; LGD, low-grade dysplasia; HGD, high-grade dysplasia; ADC, adenocarcinoma; R0, resection margin clear of disease.

Summary

• Ampullary masses can be difficult to assess on cross-sectional imaging
• CT and trans-abdominal US will usually be done to rule out other processes
• ERCP is first-line modality for suspected malignant strictures, supplemented by EUS
• MR with MRCP and IDUS in special circumstances
• Future refinement of radiological modalities to help correlate with new path subdivisions which predict prognosis
References


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