To Whipple or Not to Whipple, that is the Question:
Evaluating the Resectability of Pancreatic Adenocarcinoma

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Agenda

• Our Patient
• Background information about Pancreatic Cancer
• Anatomy of the Pancreas
• Menu of Tests
• Criteria for Unresectability
• Film Interpretation
• Conclusions
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- **Our Patient**
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Our Patient C.B.: Clinical Presentation

**CC**: 75F w/ epigastric pain

**History**
- Evaluated by PCP following an episode of post-prandial epigastric pain to back
- Also, jaundice, clay-colored stools, dark urine
- PCP performed US and found an enlarged gallbladder
- The patient was referred to a gastroenterologist
  - ERCP w/ brushings was performed and showed CBD dilatation and narrowing at pancreas
  - Additionally, the patient’s labs revealed elevated LFTs, Alkaline Phosphatase, and T billirubin
- There was high clinical suspicion of a pancreatic head mass and patient underwent a CTA
  - CTA revealed hypoattenuating mass at the head of the pancreas
Our Patient C.B.: Diagnosis and Treatment

- **Diagnosis:** Pancreatic Adenocarcinoma
- **Management:** Whipple Procedure
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Pancreatic Cancer

• **Epidemiology**
  - ~30,000 cases/yr are diagnosed in the U.S.
  - 4th most frequent cause cancer death
  - 5% survival at 5 yrs
  - 80% diagnosed after age 60

• **Etiology**
  - Majority ductal adenocarcinoma
    - Usually in head of pancreas
  - >10% islet cell and cystadenocarcinoma

• **Risk Factors**
  - Family history
  - Smoking
  - Diabetes
  - Alcohol

Shaib et al, 2006
Lawrence, 2006
Brand, 2001
Pancreatic Cancer Cont.

- **Clinical Presentation**
  - Weight loss
  - Abdominal pain radiating to back
  - Jaundice (Obstructive)
    - Clay-colored stools
    - Dark urine
    - Pruritus
  - Palpable gallbladder (Courvoisier's sign)

- **Treatment**
  - **Resectable**
    - Whipple Procedure
      - May increase 5 year survival to 24%
  - **Unresectable**
    - Endoscopic biliary stenting
    - Surgical palliation: double bypass procedure

Brand, 2001
Lawrence, 2006
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The pancreas and duodenum are intimately associated, and even share the same blood supply (gastroduodenal artery).

It is obvious from this diagram why a pancreatic head mass would cause obstructive jaundice by occluding the common bile duct.

Furthermore, the pancreas is located near several important vessels: superior mesenteric artery and superior mesenteric vein, splenic vein, and portal vein.
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Menu of Tests

• **Common Tests**
  - CT scan
  - MRI
  - Ultrasound

• **Special Tests**
  - MRCP
  - ERCP
Let’s review some of the advantages and disadvantages of using CT and also study the appearance of a normal pancreas on CT.
Companion Patient 1: Normal Pancreas on CT

- **Computed tomography** is the best study for detecting and staging pancreatic adenocarcinoma
- **Advantage:** Faster than MRI, ability to generate reconstructions
- **Disadvantage:** Exposure to ionizing radiation

**Approach:**
- Morphology (size, shape position)
- Lucencies/Opacities
- Mass
- Duct dilatation
- Abnormal fat
- Vessels and nodes
- Peritoneal fluid
- Surrounding structures

Hanbridge, 2002
Lieberman, Gillian.
http://eradiology.bidmc.harvard.edu/interactivetutorials/

Abdominal C+ CT, Axial View
www.joplink.net/prev/200407/01_fig2.jpg
CT is the current **gold standard** for diagnosing and staging pancreatic cancers. Therefore, radiologists use a very specific template for evaluating and dictating pancreatic masses.

In the next slide, you will see this template.
Approach to Evaluating Pancreatic Tumors

Evaluate for:

I: Is the pancreatic tumor present:
   a) Location, Size, Enhancement relative to pancreas
   b) Confined to pancreas with clear fat planes
   c) Remaining pancreas

II. Is lymphadenopathy present:
   a) Size and location of largest lymph node:
   b) Necrosis in lymph nodes
   C) Size of gastroduodenal artery node, “node of importance”

III. Is metastatic disease, definitely present

IV: Is there ascites/peripancreatic fluid

V: Is there vascular tumor involvement
   a) Celiac involvement
   b) SMA involvement
   c) SMV involvement and percent encasement:
   d) Less than 1 cm SMV between tumor and first major SMV branch
   e) Portal vein involvement:
   g) Splenic vein involvement
   h) Splenic artery involvement and distance from tumor to celiac artery bifurcation
   i) Vascular Involvement, Vi: Is there thrombosis of any vessel

VI: Is there thrombosis of any vessel
As you saw in the last slide, the template for evaluating pancreatic masses is quite detailed. **It is not important that you memorize all of those details.** However, it is important to understand that the template is a systematic way of evaluating the resectability of pancreatic masses.

In the next slide you will see the specific criteria for unresectable pancreatic cancer.
Summary: Criteria for Unresectability

- >50% encasement of peripancreatic vessels
- Lymph node metastasis
- Distant metastasis
- Extrapancreatic invasion of adjacent tissues
- Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
Now that we have seen learned about the advantages of CT, viewed a normal pancreas on CT, and reviewed a systematic approach to evaluating pancreatic masses, let’s now take a look at the CT scan from our patient C.B.
Our patient C.B. has a mass located at the head of the pancreas causing pancreatic ductal dilatation. Can you identify these findings?
Our Patient C.B.: Pancreatic Mass on CT

Film Findings:
Pancreas head with hypodense mass
Pancreas body with ductal dilatation
Now let’s learn about the advantages and disadvantages of MRI, and evaluate a normal pancreas on MRI.
Companion Patient 2: Normal Pancreas on MRI

- MRI is useful for imaging equivocal masses on CT
- **Advantage:** Better duct visualization, no exposure to ionizing radiation
- **Disadvantage:** Lower resolution than CT

**Approach:**
- Morphology (size, shape position)
- Mass
- Duct dilatation
- Abnormal fat
- Vessels and nodes
- Peritoneal fluid
- Surrounding structures

Abdominal T1 Weighted C-MRI, Axial View
PACS, BIDMC

Hanbidge, 2002
Lieberman, Gillian.
http://eradiology.bidmc.harvard.edu/interactivetutorials/
Now that we have examined a normal pancreas on MRI, let’s see what pancreatic adenocarcinoma looks like on MRI.
Companion Patient 3: Pancreatic Mass on MRI

This patient also has a pancreatic head mass and pancreatic ductal dilatation. Can you identify these findings?
Companion Patient 3: Pancreatic Mass on MRI

Film Findings:
- Pancreas with hypointense mass and ductal dilatation

Film Findings:
- Pancreas with hyperintense dilated duct
As you saw on the images from Patient 3, pancreatic adenocarcinoma typically appears *hypointense* on T1 weighted MRI. Also, T2 weighted MRI is ideal for identifying pancreatic ductal dilatation, as static pancreatic fluid appears bright on this imaging modality.

Now, let’s learn about the utility of ultrasound in evaluating the pancreas.
Companion Patient 4: Normal Pancreas on Ultrasound

- May be used if CT/MRI contraindicated
- **Advantage**: Fast and inexpensive, ability to assess blood flow, no ionizing radiation
- **Disadvantage**: highly user dependent, patient dependent, bowel gas

**Approach:**
- Morphology (size, shape position)
- Echotexture
  - Focal changes in echotexture
- Masses
- Duct dilatation
- Vessel patency
- Peritoneal fluid

Hanbidge, 2002
Lieberman, Gillian.
http://eradiology.bidmc.harvard.edu/interactivetutorials/
Now that we have examined a normal pancreas on ultrasound, let’s take a look at the appearance of pancreatic adenocarcinoma on ultrasound.
Patient 5 also has a mass in the head of the pancreas. Finding anatomical structures can be difficult on US. The MRI is shown to help orient you. Can you find the mass?
Companion Patient 5: Pancreatic Mass on US and MRI

Film Findings:
Hypoechoic mass in head of pancreas
Confluence SMV and splenic vein
Superior Mesenteric Artery
As you saw on the images from Patient 5, pancreatic adenocarcinoma typically appears *hypoechoic* on ultrasound.

Now, let’s learn about the utility of magnetic resonance cholangiopancreatography (MRCP) in evaluating the pancreatic ducts.
Companion Patient 6: Normal Bile and Pancreatic Ducts on MRCP

- May be used to visualize biliary tree and pancreatic duct
- **Advantage**: Noninvasive, 3D reconstruction, no ionizing radiation
- **Disadvantage**: Not specific for masses

**Approach:**
- Stenosis
- Dilatation
- Filling defect
- Outpouching

Hanbidge, 2002

MRCP
As you saw on the previous slide, a normal pancreatic duct is thin, smooth, and gradually tapers.

Let’s take a look at a patient with a pancreatic adenocarcinoma obstructing the pancreatic duct.
Can you identify the dilated pancreatic duct?

And can you see the obstructing cancer?
Companion Patient 7: Pancreatic Duct Dilatation on MRCP

Film Findings:
- Pancreatic duct
- Obstructing mass
- Common bile duct
- Gallbladder

MRCP
PACS, BIDMC
As you saw on the images from Patient 7, the pancreatic duct was dilated and failed to taper distally. Also, an obstructing pancreatic head mass appears as a filling defect on MRCP.

Now, let’s learn about the utility of endoscopic retrograde cholangiopancreatography (ERCP) in evaluating the pancreatic ducts.
Companion Patient 8: Normal Pancreatic and Biliary Ducts on ERCP

- ERCP be used to visualize biliary tree and pancreatic duct if MRCP contraindicated
- **Advantage**: Obtain biopsy/brushings during procedure
- **Disadvantage**: Not specific for masses, invasive, may cause pancreatitis

Approach:
- Stenosis
- Dilatation
- Filling defect
- Outpouching

Hanbidge, 2002
Lieberman, Gillian.
http://eradiology.bidmc.harvard.edu/interactivetutorials/
Similar to the findings on MRCP, a normal pancreatic duct is thin, smooth, and gradually tapers on ERCP.

Let’s take a look at our patient C.B.’s ERCP. As you recall, she presented with the symptoms of obstructive jaundice due to obstruction of her common bile duct.
Our patient C.B.’s pancreatic mass extrinsically compressed her common bile duct. Can you identify the area of stenosis?
Our Patient C.B.: Common Bile Duct Stenosis on ERCP

Film Findings:
- Dilated common bile duct
- Narrowing of common bile duct due to pancreatic mass
We have now reviewed the appearance of the normal pancreas and pancreatic adenocarcinoma on various imaging modalities. We will now take a look at some patients with unresectable pancreatic cancer.

Let’s first review the criteria for unresectability.
Review: Criteria for Unresectability

- Encasement of peripancreatic vessels
- Lymph node metastasis
- Distant metastasis
- Extrapancreatic invasion of adjacent tissues
- Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
Review:
Criteria for Unresectability

• **Encasement of peripancreatic vessels**

• Lymph node metastasis

• Distant metastasis

• Extrapancreatic invasion of adjacent tissues

• Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
This patient has a superior mesenteric vein that is completely occluded by the pancreatic cancer. Can you identify this finding?
Companion Patient 9: Peripancreatic Vascular Encasement on CT

**Film Findings:**
Hypodense mass encasing confluence of SMV and splenic vein

**Film Findings:**
Pancreatic mass occluding SMV
Review: Criteria for Unresectability

- Encasement of peripancreatic vessels
- **Lymph node metastasis**
- Distant metastasis
- Extrapancreatic invasion of adjacent tissues
- Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
Companion Patient 10: Distant Lymph Node Metastasis on CT

Imaging Findings:

Lymphadenopathy

Lymphadenopathy is difficult to identify on CT scanning, and is not specific for lymph node metastasis.

This patient underwent surgical exploration and the diagnosis of metastasis was made based on tissue pathology.
Review: Criteria for Unresectability

• Encasement of peripancreatic vessels
• Lymph node metastasis
• Distant metastasis
• Extrapancreatic invasion of adjacent tissues
• Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
This patient was actually worked up for a small liver mass, and was found to have metastatic pancreatic cancer. Can you identify the liver metastasis and the pancreatic mass?
Imaging Findings:

- Hypodense liver mass

Imaging Findings:

- Hypodense mass at pancreas head
- Venous involvement at confluence of SMV and splenic vein
Review: Criteria for Unresectability

- Encasement of peripancreatic vessels
- Lymph node metastasis
- Distant metastasis
- Extrapancreatic invasion of adjacent tissues
- Peritoneal carcinomatosis

Diehl, 1998
Zamboni, 2007
Unfortunately, this patient presented with late stage pancreatic cancer that seeded to the omentum. Can you identify the ascites, pancreatic mass, and omental seeding?
Companion Patient 12: Peritoneal Carcinomatosis on MRI

**Imaging Findings:**
- Hypointense pancreatic mass
- Metastasis
- Ascites

**Abdominal T1 Weighted C- MRI, Axial View**

PACS, BIDMC
Conclusions

• Clinical features of pancreatic cancer
  • Appropriate imaging studies

• Identify the pancreas in different modalities
  • Identify pancreatic masses

• Understand the critical role of radiologists in diagnosing and staging pancreatic cancer
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References