Liver, Pancreas and Biliary System

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Objectives

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Outline

• Anatomy
• Imaging Techniques
• Common Diseases
Outline

• Anatomy
• Imaging Techniques
• Common Diseases
Liver anatomy

Morphological anatomy: 3 lobes

- Right lobe
- Left lobe
- Caudate lobe

- Median fissure
- Middle hepatic vein
- Ligamentum venosum
Liver anatomy

- Anterior segment
- Posterior segment
- Medial segment
- Lateral segment
- Right lobe
- Left lobe
- Right fissure
- Median fissure
- Portoumbilical fissure with falciform ligament
- Left fissure
- Gall bladder
- IVC
Liver anatomy
Caudate lobe

Fissure for ligamentum venosum
Pancreas anatomy
Pancreas anatomy
Pancreas anatomy
Pancreas anatomy
Outline

• Anatomy
• Imaging Techniques
• Common Diseases

- Plain film radiograph
- Ultrasonography
- Computed tomography
- Magnetic resonance imaging
- ERCP

Endoscopic retrograde cholangiography
Outline

• Anatomy
• Imaging Techniques
  ◆ Plain film radiograph
  ◆ Ultrasonography
  ◆ Computed tomography
  ◆ Magnetic resonance imaging
  ◆ ERCP
    \textit{Endoscopic retrograde cholangiography}
• Common Diseases
Plain film radiograph

- Air
- Fat
- Soft tissue
- Calcification
- Metallic

- Organomegaly
- Abnormal air
- Abnormal calcification
- Foreign bodies
Plain film radiograph

- ✔
- ✔
- ✔

- ✔ Low sensitivity, low specificity
  ✔ Radiation

- ✔ Pregnancy
Outline

• Anatomy
• Imaging Techniques
   Plain film radiograph
   Ultrasonography
   Computed tomography
   Magnetic resonance imaging
   ERCP
  *Endoscopic retrograde cholangiography*
Ultrasonography

Convex probe: 2-6 MHz
- Abdomen
- Pelvis

Linear probe: 7-12 MHz
- Breast
- Thyroid
- Testis
Ultrasonography

• Preparation
  - Upper abdomen
  - Lower abdomen
    "Fasting 4-6 hr"
  - Whole abdomen = upper + lower
Ultrasonography

• Preparation
  ➢ Upper abdomen
  ➢ Lower abdomen

“ No fasting
  But full bladder ”

➢ Whole abdomen = upper + lower
Ultrasonography

• Preparation
  - Upper abdomen
  - Lower abdomen
  - Whole abdomen = upper + lower
Ultrasonography
Ultrasonography
Ultrasonography
Ultrasonography
Ultrasonography

• Indication
  - RUQ mass
  - Abnormal liver function test
  - Abdominal pain
  - Jaundice
  - Abnormal vascular structures
  - Abdominal trauma
Ultrasonography

- Indication

  - Search for liver metastasis
  - Search for occult primary neoplasm
  - Guidance for biopsy/ drainage procedure
  - Treatment follow-up
Ultrasonography

- No radiation
- No intravenous contrast media administration
- Portable

- Obesity
- Gas
- Operator dependent
- Distal common bile duct: difficult to evaluate
Ultrasonography
Endoscopic Ultrasound (EUS)

High resolution because of proximity of pancreas to the probe

Utility: Diagnosis small tumors, and for which a biopsy is needed.
Outline

• Anatomy
• Imaging Techniques
  - Plain film radiograph
  - Ultrasonography
  - Computed tomography
  - Magnetic resonance imaging
  - ERCP
    - Endoscopic retrograde cholangiography
• Common Diseases
Computed tomography
Computed tomography
Computed tomography

- Contrast agent: iodine based contrast media
- Preparation
  - Fasting 4-6 hr
  - History
    - allergy, asthma, renal insufficiency
- Indication
  - Mass
  - Infiltrative disease
  - Abdominal pain
  - Abnormal calcification
Computed tomography

• Indication

  ➢ Biliary tract obstruction
  ➢ Abnormal vascular structure
  ➢ Abdominal trauma
  ➢ Tumor staging, treatment planning
  ➢ Treatment follow-up
Computed tomography

- ✔ Fast
- ✔ Multiplanar imaging
- ✔ High sensitive to detection of calcification and gas

- ✔ Radiation
- ✔ Risk of contrast allergy
- ✔ Risk in patient with renal insufficiency

- ✔ Pregnancy
Multiphase or Dynamic contrast enhanced CT scan

- **Intravenous contrast**: marker for where blood travels in tissue

![Diagram showing intravascular and extracellular spaces](image)
Multiphase or Dynamic contrast enhanced CT scan

• *Intravenous contrast:* marker for where blood travels in tissue

• Disease **alter** blood flow to affected tissues

• *Contrast enhancement:*
  - character of disease
  - character of underlying organ
Multiphase or Dynamic contrast enhanced CT scan

- Alter in blood flow characteristic can be imaged by different times following contrast media

- Liver: dual blood supply
Phase of hepatic contrast enhancement

Contrast enhancement (HU)

Time (s)

15-30s Arterial P  60-70s Portovenous P

Aorta
PV
Liver
Liver protocol

- Noncontrast study
- Arterial phase study
- Porto-venous phase study
Liver protocol

• Noncontrast study
  - Calcification, hemorrhage, iron deposit
  - Determination of precontrast attenuation

• Arterial phase study

• Porto-venous phase study
Liver protocol

• Noncontrast study

• Arterial phase study
  ➢ 15-30 s
  ➢ Hypervascular masses: HCC, hemangioma, hypervascular metastasis

• Porto-venous phase study
Liver protocol

- Noncontrast study

- Arterial phase study

- Porto-venous phase study
  - 60-70 s
  - Hypovascular masses
  - Intrahepatic duct dilation
CT: liver mass

Hypervascular mass in cirrhosis: HCC

Multiple hypovascular masses: metastases
Outline

• Anatomy
• *Imaging Techniques*
• Common Diseases
  - Plain film radiograph
  - Ultrasonography
  - Computed tomography
  - **Magnetic resonance imaging**
MRI upper abdomen with MRCP

- MRI upper abdomen: pre and postcontrast

- MRCP "Magnetic Resonance Cholangiopancreatography"
MRI

• Contrast agent: Gadolinium based contrast agent

• Preparation
  ➢ Fasting 4-6 hr
  ➢ Remove all metallic objects
  ➢ History: contraindication for Gadolinium
    ❖ Severe renal insufficiency, acute renal failure,
    ❖ Pregnancy
GBCA in Severe Renal Insufficiency and AKI
Nephrogenic systemic fibrosis (NSF)

- Systemic disorder characterized by widespread tissue fibrosis, affects many organs (lungs, heart, MSK etc.) but predominantly skin

- Relatively spares the face and neck unlike systemic sclerosis

- Strongly correlated with exposure to GBCAs

- Usually manifests within 2-10 wks of exposure

- **Diagnosis:** Clinical presentation in the setting of severe renal insufficiency (GFR < 30) + Confirmatory cutaneous histopathological findings.
Causes and Associations

- GBCAs administrations:
  - Stability: Linear < Macrocyclic
    - Non-ionic < Ionic
  - High-dose and multiple exposure
  - Most unconfounded cases:
    - Gadodiamide (Omniscan)
    - Gadopentetate (Magnevist)
    - Gadoversetamide (Optimark)

- Chronic kidney disease
  - Stage 4: Severe CKD, GFR 15 – 29
  - Stage 5: End-stage CKD, GFR < 15 (or dialysis)

- Acute kidney injury of any severity

- Hepatic sufficiency/ Hepatorenal syndrome

- Vascular injury, venous thrombosis*

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* Fuluru K Radiographics 2009
ACR 2013 Manual Version 9
Kaewalia AJR 2012;199:17-23
Recommendation

Who should we screen to identify at risk patients?

- Serum Cr *NOT* necessary in all patients
- eGFR is recommended for following patients
- Within 6 weeks of the MRI study
  - Patient > 60
  - History of renal disease including
    - Dialysis
    - Kidney transplant, kidney surgery
    - Single kidney
    - History of known cancer involving kidneys
  - History of HT requiring medical therapy
  - History of DM

MRI

- Indication
  - Biliary tract stone: MRCP
  - Tumor staging, treatment planning
  - Treatment follow-up
  - CT contrast media
  - ERCP
  - ERCP
MRI

- ✓ No radiation
- ✓ Multiplanar imaging
- ✓ Superior soft tissue contrast: better detection, characterization
- ✓ Safer contrast agent than CT: much lessor associated with nephrotoxicity and allergic reaction

- ✓ Expensive
- ✓ Not widely available
- ✓ Longer acquisition time
MR superior soft tissue contrast
MRI

- 
  - Cardiac pacemaker
  - Foreign body
  - Metallic clip: ferromagnetic aneurysm clip
  - Cochlear implant
  - Avoiding in first trimester pregnancy (teratogenic effect)
Outline

• Anatomy
• Imaging Techniques
• Common Diseases

  - Plain film radiograph
  - Ultrasonography
  - Computed tomography
  - Magnetic resonance imaging
  - **ERCP**
    *Endoscopic retrograde cholangiography*
ERCP
(Endoscopic retrograde cholangiopancreatography)

• Luminal endoscopy and fluoroscopic imaging

• Cholangiogram (CBD) + Pancreatogram (pancreatic duct)
ERCP
(Endoscopic retrograde cholangiopancreatography)

- Diagnose and treat conditions associated with pancreatobiliary system

- Indication
  - Inconclusive ultrasound, CT or MRI/ MRCP findings
  - Therapeutic procedure: stone removal, treatment bile duct stricture and biopsy

- Acute pancreatitis
Outline

• Anatomy
• Imaging Techniques
• Common Diseases
Common disease

✓ Hepatomegaly
✓ Liver cirrhosis and portal hypertension
✓ Liver abscess
✓ Gallstone and bile duct stone
✓ Biliary tract obstruction
✓ Acute cholecystitis
✓ Acute and chronic pancreatitis
Hepatomegaly

> 15.5 cm
Liver cirrhosis
Liver cirrhosis

• Irreversible remodeling of hepatic architecture with fibrosis and hepatic nodules

• Most are regenerative nodule (RN): localized proliferation of hepatocytes and supporting stroma in response to liver injury (stimuli, alter circulation)
Liver cirrhosis

• Role of imaging
  ➢ Evaluate liver size
  ➢ Evaluate portal hypertension
  ➢ Screening hepatocellular carcinoma (HCC)
Liver cirrhosis
Portal hypertension

• Increased portal flow
• Increase resistant to portal flow

Prehepatic portal hypertension
  ✓ Portal vein thrombosis
  ✓ Splenic vein, SMV, IMV thrombosis

Intrahepatic portal hypertension
  ✓ Liver cirrhosis
  ✓ Hepatic vein thrombosis

Posthepatic portal hypertension
  ✓ IVC thrombosis
  ✓ Cardiac disease: constrictive pericarditis
Portal hypertension
Portal hypertension
Portal hypertension

- Collateral circulation or portosystemic circulation
  - Coronary vein or gastric vein → esophageal vein
  - azygos/ hemiazygos vein → gastroesophageal varices
  - Recanalization of paraumbilical vein → caput medusae
  - Inferior mesenteric vein → hemorrhoidal venous plexus
    - internal iliac vein → internal hemorrhoid
Portal hypertension
Portal hypertension

• Plain film
  ➢ Ascites
  ➢ Splenomegaly
Portal hypertension

- Plain film
  - Ascites
    - Loss of definition of edge of liver/ spleen
    - Medial displacement of solid organ and bowel loops away from properitoneal fat stripe
    - Separation of bowel loops
    - Centrally located bowel loops
    - Bulging of the flank
    - Increased density of abdomen
    - Fluid accumulation in pelvis
  - Splenomegaly
Portal hypertension

• Plain film
  ➢ Ascites

➢ Splenomegaly
  ✓ Tip of spleen extends below rib 12th
  ✓ Displacement of splenic flexure of colon or displacement of stomach medially
Portal hypertension

- **US**
  - Enlargement portal vein > 13 mm
  - Hepatofugal blood flow
  - Ascites
  - Splenomegaly
  - Portosystemic circulation: varices

Normal: Hepatopedal
Portal hypertension

- CT
  - Liver cirrhosis
  - Ascites
  - Enlarged portal vein > 13 vein
  - Portosystemic circulation
Liver abscess

• Hepatic pyogenic abscess
  ➢ *Bacterial infection: E coli, K pneumoniae*

• Hepatic amebic abscess
  ➢ *Entamoeba histolytica*

• Hepatic fungal abscess
  ➢ *Candida albicans*
Pyogenic abscess

• 5 Routes:
  - Biliary route: Ascending cholangitis
  - Portal route: Intra-abdominal infection (diverticulitis, appendicitis)
  - Hepatic artery route: Septicemia from bacterial endocarditis
  - Direct extension from adjacent organ
  - Trauma: Blunt, penetrating injury
Pyogenic abscess

• Plain film
  ➢ Elevation of right hemidiaphragm
  ➢ Right pleural effusion
  ➢ Hepatomegaly
  ➢ Gas, air-fluid level
Pyogenic abscess

- US
  - Nonspecific
  - Cannot distinguish from other hepatic mass (HCC, metastasis)
Pyogenic abscess

• CT and MR
  - Hypodensity mass
  - Smooth rim enhancement
  - Cluster
  - Gas or air-fluid level
Hepatic amebic abscess

- Route: portal system
- Usually solitary
Fungal abscess

- Immunocompromised host
- Hematologic malignancy
- Candida, Aspergillus, Cryptococcus
Gallstone

- Cholesterol stones: Most common
  - Obesity, female > male

- Pigment or calcium bilirubinate stone
  - Excessive hemolysis, thalassemia

- Mixed stone

- Calcium carbonate stones

Calcium
Gallstone

• Plain film
• *Depend on calcium composition*
  - 80-85% miss gallstone
  - Pigment, mixed, calcium carbonate stones: *radio-opaque*
  - Cholesterol stone: *not visible*
Gallstone

- US
- *The best way to detect gallstone*
- *All stones appear similar on US, independent on stone composition.*
  - ✓ Mobile
  - ✓ Echogenic intraluminal structure
  - ✓ Posterior acoustic shadow
Gallstone
Gallstone

- CT
- *Density vary from heavily calcified to hypodense*
- *Depend on calcium composition*
  - ✔ Dense calcification: Sensitivity in detect calcification >>> plain film radiograph
    - Pigment
    - Mixed
    - Calcium carbonate
  - ✔ Hypodensity
    - pure cholesterol stone can be missed
Gallstone
Gallstone

- MRCP
- Similar ERCP

- All stones appear similar on US, independent on stone composition.
Porcelain gallbladder

- Calcification in GB wall
- Associated with chronic inflammation
- Increased risk of malignancy
Common bile duct stone

• Most located at distal CBD, near ampulla of Vater

• Plain film
  ➢ *Not useful*, very low sensitivity
Common bile duct stone

• US
  - Similar gallstone
  - Hyperechoic structure with posterior acoustic shadow
  - Proximal ductal dilation
  - > 25% may not be visualized distal CBD
Normal CBD in US

< 7 mm
CBD stones
CBD stones

- CT and MRI
  - Similar gallstone
  - Proximal ductal dilation
CBD stones
CBD stones
Biliary tract obstruction

- CBD stone
- Malignancy
  - Cholangiocarcinoma
  - Ampullary neoplasm
  - Pancreatic malignancy
  - Duodenal carcinoma
- Disorder of sphincter of Oddi
  - Ampullary stenosis
- Inflammatory strictures
  - Prior Sx
  - Prior choledocholithiasis
  - Prioriliary infection (ascending cholangitis)
Biliary tract obstruction

• Role of imaging
  • Confirm the presence of obstruction
  • Location of obstruction
  • Cause of obstruction
    - Stone
    - Stricture
    - Tumor

**US is a screening modality**

- IHD dilation
- EHD dilation
IHD dilation

- > 2 mm in diameter, parallel channel sign
- Lack of Doppler signal
- Irregular, tortuous wall
- Stellate configuration centrally
Normal IHD and CBD
IHD dilation

Normal CT

Normal MRI
IHD dilation
EHD dilation

• > 7 mm
EHD dilation

Transverse normal CBD

IVC A

L
EHD dilation
EHD dilation
EHD dilation
Biliary tract obstruction

• Investigation
  
  - US
  - CT or MRI with MRCP
  - ERCP
Acute cholecystitis

- Obstruction of GB by stone at neck or cystic duct

- Plain film
  - Not useful
  - may detect radio-opaque stone
Acute cholecystitis

• US
  - Gallstone
  - Gallbladder wall thickening
  - Distend gallbladder
  - Pericholecystic fluid
  - Tender at gallbladder; US Murphy’s sign positive
Normal gallbladder vs wall thickening

Normal GB wall < 3 mm

Wall thickening > 3 mm
Acute cholecystitis
Acute cholecystitis
Emphysematous cholecystitis

- Less common
- Vascular insufficiency of cystic artery
- Facilitating infection of gas-forming organisms (eg, *Clostridium* or *Escherichia coli*)
- Considered as surgical emergency
Emphysematous cholecystitis
Acute pancreatitis

- Activation of pancreatic enzymes within the pancreas leads to organ injury
- Autodigestion
- Parenchymal edema and peripancreatic fat necrosis
- Pancreatic necrosis, hemorrhage
Acute pancreatitis

• **Most common:**
  - Alcohol abuse
  - Gallstone

• **Less common:**
  - Trauma
  - Sepsis
  - Medication
  - Post ERCP
Acute pancreatitis

- Plain film
  - “Colon cutoff sign”
  - Abrupt termination of gas at splenic flexure
  - Inflammation extends to phrenicocolic ligament
  - Function spasm/ luminal narrowing
Acute pancreatitis
Acute pancreatitis

- **US**
  - Not be used for exclude the diagnosis
  - Enlarge, decreased echogenicity (compare with liver)
  - Peripancreatic fluid collection
  - Detect gallstone

![US normal pancreas](image-url)
Acute pancreatitis

CT normal pancreas
Chronic pancreatitis

• Permanent impairment of pancreatic function
• Permanent morphologic change as a result of persistent inflammation

• Findings:
  ✓ Pancreatic calcification
  ✓ Ductal dilation
  ✓ Parenchymal atrophy
Summary

• Acute abdominal pain
• Palpable mass
• Jaundice
• Abnormal liver function test
Summary

• **Acute abdominal pain**
  - Plain film
  - US
  - CT or MRI with MRCP

• Palpable mass

• Jaundice

• Abnormal liver function test
Summary

• Acute abdominal pain
• Palpable mass
  ➢ US
  ➢ CT or MRI
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Summary

• Acute abdominal pain
• Palpable mass
• **Jaundice**
  - US
  - CT or MRI with MRCP
• Abnormal liver function test
Summary

• Acute abdominal pain
• Palpable mass
• Jaundice
• Abnormal liver function test
  ➢ US
  ➢ CT or MRI
THANK YOU FOR YOUR ATTENTION