Radiologic Evaluation of the Liver Transplant Candidate

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Welcome!!!

Before starting the presentation keep in mind that:
• Any writing in this color (blue) is narration
• The asterisk (*) at the bottom of a page is supplemental information to the main text.

Enjoy!!!
Objectives

• Indications for transplant
• Contraindications for transplant
• Role of imaging in transplant candidate selection
• Imaging modalities/Menu of Tests
• Implication of radiologic findings
To achieve the objectives a patient will serve as a case example of the steps taken to clear a patient radiologically for liver transplantation.

Most of the images will be from patient D.C., and any images that are from another patient will be labeled as companion 1, companion 2, etc.
Patient D.C.

**CC**: Abdominal enlargement and lower extremity edema

**HPI**: 49-year-old male presented with ascites and lower extremity edema was found to have cirrhosis secondary to hepatitis C.

- Referred for liver transplantation evaluation

Over the next 1½ years his signs and symptoms included:

- ascites
- fatigue
- gastric and esophageal varices
- hepatosplenomegaly
- hepatic encephalopathy
- jaundice
- hepatorenal syndrome
Patient D.C.

**PMH:** Urethral stricture, Nephrolithiasis

**SH:**
- Tobacco-15 pack year history
- Alcohol-Minimal
- Illicit drug use-IV drug use with needle sharing x2 (30 years ago)
- Tattoos-Multiple
- 100 sexual partners

**ROS:** Fatigue, anorexia, decreased libido, weakness, nausea

**Medications:**
- Protonix
- Nadolol
- Aldactone
- Lasix
- Lactulose
- Actigall
- Mycelex
- Calcium + Vit. D
- Magnesium oxide
Patient D.C.

**PE:**
- HEENT-scleral icterus
- Skin-spider nevi, palmar erythema
- Cardiac-RRR, no m/r/g
- Pulm-CTAB, gynecomastia
- GI-Hepatosplenomegaly, ascites
- Ext-2+ LE pitting edema

**Labs:**
- Cr: 1-5.3
- INR: 1.4-2.3
- TBili: 2.4-20
- CA 19-9: 81
- CEA: 17
- AFP: 16
- AST: 121 ALT: 147 ALP: 260
- HIV negative
Indications for Liver Transplantation

• Acute or chronic liver failure
  – Chronic Hepatitis
  – Alcoholic Liver Disease
  – Cholestatic Disease
  – Metabolic Diseases
  – Cryptogenic Cirrhosis
  – Acute Fulminant Hepatic Failure
  – Hepatocellular Carcinoma (HCC)

*Most of the above conditions will result in cirrhosis.
*80% of transplants are done for cirrhosis or cholestatic disease.
*5% of transplants are done for HCC.
Contraindications for Liver Transplantation

• Absolute
  – Extrahepatic malignancy
  – Advanced cardiopulmonary disease
  – Active alcohol or drug abuse
  – Infection outside the biliary tract

• Relative
  – Hepatoma (>5cm)
  – Mesenteric venous thrombosis
  – Advanced age
  – Cholangiocarcinoma

*Depending on transplant centers, relative contraindications can exclude a patient from transplantation.
Role of Imaging

• Candidate Selection
  – Search for intrahepatic and extrahepatic malignancy

• Prognostic Implications/Surgical Planning
  – HCC Staging
  – Assessment of vessel patency
    • Vascular invasion
  – Quantification of diseased liver volume
  – Vascular anatomy
  – Identification of cirrhosis and sequella of portal hypertension
    • Portocaval shunts

*HCC Staging is important because vascular invasion and bilobar distribution are associated with poor outcomes, often excluding patients from transplantation.

*5-year survival 60% without vascular invasion, 6% with macroscopic invasion.
*5-year survival 53% if unilobar, 15% if bilobar.
Chest X-Ray and Chest Computed Tomography

- Cardiopulmonary abnormalities
- Metastases
  - Identification
  - Staging
- Chest CT for further evaluation of any abnormality found
Chest X-Ray

Patient D.C.

Normal CXR

PACS,BIDMC
Ultrasound

- Screening tool
- Identification:
  - Liver masses
  - Malignant thrombosis
  - Vessel Patency
  - Direction of flow
    - Hepatopedal vs. Hepatofugal
  - Ascites

- US modalities
  - Gray Scale
    - Sensitivity 50-90%
    - Specificity 98%
  - Color Doppler
  - Duplex Doppler

*Sensitivity is closer to 50%, because heterogeneity of the liver complicates the identification of masses.*
Ultrasound Color Doppler

Ascites

Nodular Liver

Patient Portal Vein with flow into the liver

Pre-Transplant Portal Vein

Post-Transplant Portal Vein

PACS, BIDMC
Ultrasound

Liver Mass
HCC

*HCC can be hypo-, iso-, or hyperechoic
Ultrasound Duplex and Color Doppler

Pre-Transplant Hepatic Artery

Post-Transplant Portal Vein

*Duplex not important pre-transplant, more important post\textsuperscript{16}
Computed Tomography (CT)

- Further characterization of liver masses
  - Multiphasic contrast CT
- Vessel patency
- Global abdominal survey for extrahepatic malignancy
- Assessment of liver volume
- Identification of shunts

- Sensitivity
  - CT alone 67%
  - CT + US 75%
Portal Anatomy

Portal vein

Splenic Vein

IMV

SMV

Hepatic Anatomy

Multiphasic Contrast-enhanced CT

Patient D.C.

Hepatic Arterial Phase  Portal Venous Phase  Hepatic Venous Phase

*70-80% of liver blood supply is from the portal vein.  
*HCC blood supply is arterial, and therefore most masses will enhance early, during arterial phase.
Multiphasic Contrast-enhanced CT with HCC

Non-contrast

Portal Venous

Hepatic Arterial

Hepatic Venous

PACS,BIDMC
CT 3D Reconstruction

- Proper Hepatic Artery
- Common Hepatic Artery
- Celiac Artery
- Portal Vein
- Hepatic Vein

PACS, BIDMC
CT Portal Vein Thrombus

*Thrombus may be benign or malignant.
*If benign it will be bypassed during surgery, if malignant then patient has a worse prognosis.
*Donor livers 50% smaller or 20% larger are acceptable, but keep in mind that disparities in volume make surgery more difficult.
CT Splenorenal Shunt

Patient D.C.

*Identification of shunts is not critical pre-transplant, but does give the surgeons the option of ligating them to maximize flow to the transplanted liver.
Magnetic Resonance Imaging (MRI)

- Not commonly used
- Provides similar information as CT
- Used in some complicated cases

- Mass characterization
  - T1-weighted images
    - Anatomic detail
  - T2-weighted images
    - Non-neoplastic vs. neoplastic
  - Additional sequences if necessary
MRI

Companion 1

T1-weighted

Hemangioma

Subtraction

PACS, BIDMC
Biopsy

• **Indication**
  – Liver mass
  – Portal vein thrombus

• **Consideration**
  – Patient cooperation
  – Correction of underlying coagulopathy

• **Modalities**
  – Ultrasound
  – CT
  – Fluoroscopy
Ultrasound-guided Biopsy

*Ultrasound is a useful modality, because color doppler can identify vessels and real-time imaging is used.*
Celiac Axis Anatomy

- Celiac Artery
- Common Hepatic Artery
- Proper Hepatic Artery
- Left Hepatic Artery
- Right Hepatic Artery

Computed Tomography Angiography (CTA)

- Identification of thrombosed veins:
  - Portal
  - Mesenteric
  - Splenic

- Arterial abnormalities
  - Hepatic artery
  - Celiac axis
  - Splenic artery

*Bile ducts supplied by hepatic artery, therefore it is important to determine the anatomy and patency of the celiac axis.*
Patient D.C.

Impression:

Patient D.C. has no identifiable masses, the vessels are patent and there are no vascular anomalies.

Patient D.C. is radiologically cleared to undergo liver transplantation.

Patient D.C. had an orthotopic liver transplant in 02/04!!!
Summary

The Role of Radiology in Evaluating the Liver Transplant Candidate:

Candidate Selection
• Malignancy
  – CXR/Chest CT
  – Ultrasound
  – Abdominal CT
  – MRI
  – Biopsy

Prognostic Implications/
Surgical Planning
• Malignancy
• Vessel Patency/Shunts
  – Ultrasound
  – Abdominal CT
  – MRI
  – CTA

• Anatomy
  – CT
  – MRI
  – CTA
References

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