Perioperative management of liver transplantation

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J.I. is a 66y.o. man with liver mass

- The patient presented to his PCP for an annual examination and routine follow-up.
- His PMH was significant for hepatitis B virus (HbsAg positive at time of presentation) and cirrhosis.
- Blood tests detected elevated levels of the tumor marker AFP (24.3 compared to a normal value between 0-7). This result raised concern that the patient had developed hepatocellular carcinoma (HCC), a common sequela of cirrhosis.
- The patient underwent ultrasound which demonstrated a 10cm mass in the right hepatic lobe.
This is a classic presentation for HCC.

- Chronic hepatitis B or C virus infection and cirrhosis are risk factors for the disease.
- Patients such as J.I. are asymptomatic until late in the course of the disease.
- Because of this fact, unless regular surveillance is performed, at time of presentation on 30% are surgically resectable.
- Symptoms in advanced disease may present as
  - Obstructive jaundice representing bile duct obstruction
  - Diarrhea representing malabsorption or paraneoplastic syndrome
  - Bone pain or dyspnea reflecting metastasis
  - Peritoneal bleed from tumor rupture
  - Paraneoplastic syndromes (hypoglycemia, erythrocytosis, hypercalcemia, watery diarrhea, cutaneous change).
Four main roles for imaging in this patient’s medical management

I. Identification and diagnosis of HCC
II. Staging and determination of therapeutic strategy
III. Identification of anatomical variants of import in surgical planning
IV. Post-operative surveillance and diagnosis of complications
Differential diagnosis of a liver mass

**Vascular lesions**
- Cavernous hemangioma
- Hemangioendothelioma
- Hepatocellular carcinoma
- Metastases
- Adenoma
- Hamartoma
- Hemangiosarcoma
- Focal nodular hyperplasia

**Avascular lesions**
- Cholangiocarcinoma
- Hepatocellular carcinoma
- Extrinsic mass
- Fatty infiltrate
- Hydatid cyst
- Liver abscess
- Metastases
- Regenerative nodular hyperplasia
- Polycystic disease
- Traumatic liver cyst
- Lymphoma
I. Identification and characterization of a liver mass

In context of cirrhosis, diagnosis is made by findings consistent with HCC (mass with irregular margins, heterogenous composition, hypervascularity) on two imaging modalities, one of which demonstrates hypervascularity.
Menu of tests to characterize a liver mass

- Ultrasound
- CT scan
- MRI
- Angiography (if other modalities fail to demonstrate hypervascularity)
- Nuclear medicine scan utilizing Tc99-labeled AFP (experimental)
- Histopathology under CT or ultrasound guidance (for small lesions)

Biopsy of the mass is avoided unless the mass is <2cm and is unable to be adequately evaluated by non-invasive measures. This prevents possible complications related to seeding along the biopsy needle track.
Ultrasound evaluation of a liver mass

• Advantages
  – Readily available, low cost
  – Can be used intra-operatively or for screening
  – Can be used to evaluate vessel patency
• Disadvantages
  – Difficult to determine identity of mass
• Ultrasound appearance of hepatocellular carcinoma
  – Hypo-, iso-, or hyperechoic mass
  – Irregular echoes or margins
US identification of hepatic mass

hepatic mass – note irregular margins, heterogenic echogenicity

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CT evaluation of a HCC

• Advantages
  – 90% sensitivity

• Disadvantages
  – Does not detect lesions which are isoattenuating on non-contrast and venous phase CT
  – Difficulty in differentiating carcinoma from cirrhotic nodules
  – Reduced availability compared to ultrasound

• CT appearance of hepatocellular carcinoma
  – Enhancing lesions observed in arterial phase of CT with contrast
CT evaluation of HCC

hepatic mass – note mass is readily apparent in arterial phase CT, but difficult to visualize in the venous phase

MR evaluation of a liver mass

• Advantages
  – Improved ability to differentiate hepatocellular carcinoma and cirrhotic nodules
  – No nephrotoxic agents

• Disadvantages
  – Decreased availability versus US and CT

• MR appearance of hepatocellular carcinoma
  – High density appearance on T2-weighted images, low density on T1-weighted images.
  – Cirrhotic nodules appear hypodense on both T1- and T2-weighted images.
MRI evaluation of HCC

T1-weighted

T2-weighted

hepatic mass
II. Staging and determination of therapeutic strategy

Imaging studies are essential for determination of tumor resectability and for appropriate use of hepatic transplantation.
Treatment of hepatocellular carcinoma

• Medical therapy
  – Systemic chemotherapy

• Minimally invasive therapy
  – Percutaneous ethanol injection
  – Radioablation therapy
  – Trans-arterial chemoembolization

• Surgical therapy
  – Resection
  – Consider transplantation if tumor is unresectable or patient has concurrent Child’s class C cirrhosis.
Resection is performed based on the Couinaud segments defined by branches of the portal vein.

Contraindications to resection of HCC

- Multifocal intrahepatic disease
- Extrahepatic extension (local invasion of adjacent organs or visceral peritoneum)
- Inadequate functional reserve (can resect less than 50% of the liver in patients with cirrhosis)
- Inability to obtain adequate margins (1cm)
- Involvement of confluence of hepatic/portal veins
- Nodal involvement
- Metastases

Resectability is confirmed by intraoperative ultrasound which may change management in many cases.
Contradictions for liver transplantation in treatment of HCC

- **General**
  - Active drug or alcohol abuse
  - Extrahepatic malignancy
  - Severe heart or lung disease

- **HCC-specific**
  - Size of tumor >5cm
  - Vascular invasion
  - Metastases (CT lung and abdomen, consider bone scan)
  - HCV infection is a relative contraindication
Liver transplantation for HCC

- Major benefit is concurrent treatment of HCC and cirrhosis therefore can be performed in patients with poor functional reserve.
- Comparable 5yr. survival when compared to non-malignant causes.
- Comparable outcomes as compared to resection in most studies.
- HCC patients are given extra points toward severity of need as compared to others awaiting transplant.
- Poor prognostic indicators include
  - High histologic grade
  - Tumor >5cm
  - Bilobar tumor
  - Lymph node involvement
  - Vascular invasion
Chemoembolization of HCC is sometimes used as a bridge to transplant

The protocol involves selective cannulation of the hepatic artery feeding a tumor and injection of chemotherapeutic agents (e.g., adriamycin), a contrast agent such as ethiodol, and Gelfoam which causes decrease in blood flow through the cannulated artery.
Chemoembolization of HCC

Ethiodol-enhanced hepatic lesion – note significant reduction in size of lesion over time

immediately post-chemoembolization

6 months post-chemoembolization
Liver transplantation procedure

III. Identification of anatomical variants of import in surgical planning

• Pre-transplant work-up should include assessment of vascular anatomy as variants may require vessel reconstruction at the time of surgery.
• Can generally be assessed by CTA or MRA
• Includes evaluation for
  – variant hepatic artery anatomy
  – celiac axis stenosis
  – absent IVC
  – thrombosis portal vein
  – splenic artery aneurysm
CTA of classic arterial supply to the liver

- right and left hepatic arteries
- common hepatic artery
- celiac trunk
- proper hepatic artery
Variations in the anatomy of the hepatic artery

IV. Post-operative surveillance and diagnosis of complications

Post-operative period
- Infection
- Post-operative bleeding
- Graft failure
- Acute rejection
- Biliary leak
- Vascular thrombosis

Late complications
- Hepatic artery stenosis
- Hepatic artery pseudoaneurysm
- Bile duct stenosis
- Recurrent disease
- Opportunistic infection
- New malignancy
- Chronic rejection

Post-operative screening performed with ultrasound at 24 to 48h after procedure and at least weekly until discharge.
Hepatic artery thrombosis and stenosis

- Clinical presentation of hepatic artery thrombosis and stenosis
  - Elevation in LFTs
  - Bile leaks or bile duct stricture
  - Hepatic necrosis
  - Relapsing septicemia

- Thrombosis
  - Results in graft ischemia and failure
  - Occurs in 3-12% of adult orthotopic liver transplantations
  - Most common cause of graft loss
  - Mortality greater than 50% if not retransplanted

- Stenosis
  - Occurs in first three months post-transplantation
  - 5% incidence
  - Sequelae similar to those of hepatic artery thrombosis
Hepatic artery Doppler

Resistive index = (peak systolic flow – end diastolic flow)/end diastolic flow
Normal value is >0.5 and <0.8

- In HA thrombosis, see absent blood flow
- In HA stenosis see prolonged upstroke with increased diastolic flow (parvis and tardus pulse)
CT findings in hepatic artery thrombosis

- Infarction (peripheral wedge or large periportal hypodensities)
- Bilioma
- Bile duct dilatation
- Abscesses

Hypodensity in the periportal region reflecting ischemia-related necroses and edema

Hypodense fluid collection

Angiogram evaluation of hepatic artery patency is gold standard for diagnosis.

Hepatic artery stenosis

Normal angiogram

Proper hepatic artery

Celiac trunk

Absent hepatic flow

Splenic artery

Right and left hepatic arteries
Treatment of hepatic artery stenosis or thrombosis

- Consider angioplasty or stent placement
- Thrombolysis
- Normally require retransplantation
Portal vein thrombosis/stenosis

- Incidence is 1-3% of orthotopic liver transplants
- Treat by
  - percutaneous angiography/stent placement
  - thromboembolectomy
  - venous graft placement
  - shunt placement
  - retransplant

- US seeks to define portal vein thrombosis or stenosis as manifest by absent blood flow through the vessel.
- Portal vein patency can also be visualized by CT.
Doppler of the portal vein

Normal ultrasound of the portal vein shows constant flow with minimal respiratory variation.

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Bile leak

- Most common complication of orthotopic liver transplantation
- Occurs at site of T-tube placement or bile duct anastamosis
- Can reflect hepatic ischemia so must evaluate for hepatic artery patency
- Hypoechoic fluid collection observed on ultrasound
- Diagnosis made definitively by cholangiography with contrast placed via T-tube or percutaneous route.
- Treat with observation, drainage, stent placement or surgical revision of the duct anastamosis.
Contrast extravasation at the site of anastomosis between the bile duct and the duodenal Roux loop in a hepatojejunalostomy reconstruction.

Bile duct stricture

- Often due to ischemia so must rule out hepatic artery stenosis.
- Other causes include
  - Recurrent sclerosing cholangitis
  - Sphincter of Oddi dysfunction
  - Biliary sludge/stones
- Diagnosis made by observation of stricture and dilation of the bile ducts seen by US or CT and then on ERCP or MRCP.
- Treat with balloon dilation or stent placement.
ERCP

Bile duct stricture

Balloon dilation

Bile duct post-procedure demonstrating improved patency

Conclusions: Role of imaging in the perioperative management of liver transplantation for HCC

I. Identification and diagnosis of tumor
II. Staging and determination of therapeutic strategy
III. Identification of anatomical variants of import in surgical planning
IV. Post-operative surveillance and diagnosis of complications
References


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