Ultrasound – Liver Transplant Protocol

PURPOSE:

To evaluate the liver following liver transplantation; to interrogate the bile ducts; to evaluate for findings of portal hypertension; and to assess the hepatic vasculature.

SCOPE:

Applies to all ultrasound Liver Transplant evaluation studies performed at Imaging Services / Radiology

ORDERABLE:

- US Hepatic with Doppler

INDICATIONS:

- History of liver transplant; allograft dysfunction
- Pre-transplant evaluation
- Suspicion for portal or hepatic vein thrombosis; Budd-Chiari Syndrome
- Known hepatic artery stenosis; follow up to angioplasty and/or stent
- Signs or symptoms of liver dysfunction including elevated liver function tests (LFTs)
- Jaundice, elevated bilirubin, or other signs of biliary obstruction
- Suspicion for recurrent liver disease such as viral hepatitis (HBC; HCV; HIV), alcohol abuse, or fatty liver disease
- Findings of portal hypertension such as ascites, splenomegaly, varices
- Provided history of or screening for cirrhosis or hepatocellular carcinoma (HCC)
- Abnormal findings on other imaging studies suggesting recurrent chronic liver disease/cirrhosis

CONTRAINDICATIONS:

No absolute contraindications

EQUIPMENT:

- Curvilinear transducer, frequency range of approximately 2-9 MHz that allows for appropriate penetration and resolution depending on patient's body habitus.
- Linear array transducer, frequency range of 9-12 MHz, to evaluate the hepatic capsule.

PATIENT PREPARATION:

- Patient should be NPO according to the following Guidelines:

    - 0 - 6 months = 2 hours NPO
    - 7 months-3 years= 3hours NPO
    - 4 years -9 years= 5 hours NPO
    - 10+ years = 6-8 hours NPO

EXAMINATION:

GENERAL GUIDELINES:

A successful examination includes the evaluation of:

- Liver, including parenchymal architecture and capsular contour
- screening for focal lesions (eg. HCC)
- Bile ducts
- Abdominal cavity for ascites
- Spleen size
- Evaluation of the upper abdominal vasculature including hepatic arteries, portal veins, splenic vein, superior mesenteric vein, hepatic veins, inferior vena cava (IVC), and abdominal aorta.

EXAM INITIATION: (AIDET)

- Introduce yourself to the patient
- Verify patient identity using patient name and DOB
- Explain test
- Obtain patient history including symptoms. Enter and store data page
- Place patient in supine or left lateral decubitus (LLD) position with arm above head.

TECHNICAL CONSIDERATIONS:

- **Review any prior imaging, making note of associated abnormalities requiring evaluation.**
- Deep inspiration facilitates imaging of the liver dome and right hepatic lobe in the supine position via subcostal approach.
- In LLD position, the liver shift towards the midline, improving accessibility for scanning and facilitating intercostal scanning for the posterior liver.
- Liberal use of cine sweeps allows for better evaluation of focal or indeterminate findings.
- Assess the perihepatic area for fluid collections; if a fluid collection is visualized document and measure (evaluate with and without color).

- Doppler:
    - Optimize color Doppler setting to show optimal flow
- Adjust scale and gain to maximally fill the vessel of interest without artifact
- Use Power Doppler if suspect absent flow with color Doppler
    - Optimize spectral Doppler
- Place time-gate centrally within the vessel of interest
- Adjust scale to extend spectral waveform (amplitude adequate for interpretation)
- Reduce aliasing for high flow evaluation
    - As much as possible, utilize angle correction of ≤60^{o} to measure velocities
- Angle correction should always be parallel to the vessel wall
- For certain anatomy, you may need to try from different approaches to optimize angle
    - Evaluate proper, right and left hepatic arteries using angle correction. If anastomosis is seen (by focal turbulence; focal narrowing), measure velocities proximal to (within common hepatic artery), at, and distal to (PHA) the anastomosis.
    - Evaluate hepatic vein phasicity during suspended respiration or shallow breathing
- Deep inspiration may dampen hepatic venous flow
    - If a TIPS is present, survey the entire TIPS – see *US Liver TIPS* protocol

Liver

- Liver should be evaluated for focal and/or diffuse abnormalities. Liver echogenicity should be compared with that of the right kidney and pancreas.
- Cine sweeps, including as much hepatic parenchyma as possible, should be acquired in the transverse orientation for both lobes from dome to inferior most margin, and longitudinal sweeps of left lobe from midline to lateral tip.
- In the absence of ascites, nodular liver surface contour is best seen with a linear array transducer.
- Evaluate the parenchyma adjacent to the gallbladder fossa, fissure for the falciform ligament, and portal bifurcation for areas of focal fatty sparing.

Bile Ducts

- Intra/extrahepatic bile ducts should be evaluated for dilatation, wall thickening, and intraluminal findings.
- Color Doppler may be used to differentiate hepatic arteries and portal veins from dilated intrahepatic bile ducts
- Two types of biliary anastomoses are possible: duct-to-duct (choledochocholedochostomy), and duct-to-bowel (choledochojejunostomy). For duct-to-bowel anastomosis, the extra-hepatic bile duct may be difficult to visualize. If seen, common duct should be imaged longitudinally, adjacent to the main portal vein, distinguished from the hepatic artery by color Doppler.

- The duct should be measured from inner wall to inner wall at the porta hepatis near the crossing of the right hepatic artery. Remainder of the common duct should be evaluated as far distally as possible.

Spleen Size

- Deep inspiration facilitates imaging of the spleen.
- Longitudinal spleen measurement taken from inferior most tip to highest point along diaphragm, *crossing through the splenic hilum.*
- Transverse measurements: *oriented 90 degrees* relative to longitudinal measurement, calipers placed at greatest thickness and width at the same level.
- Evaluate for splenic vein varices with color Doppler evaluation of splenic hilum.

Collections and Ascites

- Assess the perihepatic area for fluid collections; if a fluid collection is visualized document and measure; evaluate with and without color
- Evaluate RUQ with attention to fluid peripheral to the liver and in the subhepatic space
- Evaluate LUQ with attention to fluid peripheral to the spleen
- Evaluate RLQ and LLQ for fluid in the paracolic gutters
- Evaluate midline pelvis for pelvic free fluid
- Document the extent and location of any fluid identified
- Provide stationary cine images to show mobility of debris, if present

DOCUMENTATION:

- **Liver**
  - Longitudinal images:
    - Left lobe left of midline
    - Left lobe at midline. Include proximal abdominal aorta, celiac artery, and SMA.
    - Left lobe with IVC. Include caudate lobe, MPV, and pancreatic head.
    - Left lobe with left portal vein
    - Right lobe with PHA at hilum of liver include color and spectral Doppler
    - Right lobe with spectral Doppler of the RHA and the anterior and posterior branch.
    - Right lobe with right kidney
    - Right lobe including right hemidiaphragm and adjacent pleural space
    - Right lobe far lateral
  - Transverse images:
    - Main portal vein bifurcation. Include color and spectral Doppler images

        - Dome with hepatic veins. Include entire right and left lobe (on separate images as needed)
        - Left lobe with left portal vein including both color and spectral Doppler.
        - Left lobe with spectral Doppler of the Left hepatic artery
        - Right lobe with right portal vein including both color and spectral Doppler
        - Right lobe with main portal vein including both color and spectral Doppler
        - Right lobe with anterior and posterior branch of the right portal vein includes color and spectral Doppler.
        - Right lobe
        - Right lobe with right kidney
        - Right lobe near liver tip

    - Cine sweeps, including as much hepatic parenchyma as possible:
        - Transverse orientation, left and right lobes, from dome to inferior most margin
        - Longitudinal orientation of left lobe from midline to lateral most tip
    - Liver Capsule (**not needed for immediate post-op**). With a linear 9 or 12MHz transducer, include high-resolution images of the left hepatic lobe capsule and underlying parenchyma for nodularity. Obtain both representative still images and a cine sweep of the left lobe.

- **Bile Ducts**
    - Common duct with largest diameter measurement at porta hepatis.
    - Images without and with color Doppler along the left and right portal veins for intra- hepatic ductal dilatation.

- **Spleen**
    - Longitudinal images:
        - Longitudinal spleen measurement, from inferior most tip to highest point along diaphragm, *crossing through the splenic hilum.*
        - Transverse images:
    - Transverse measurements: *oriented 90 degrees* relative to longitudinal measurement, calipers placed at greatest thickness. Width measured transverse to longitudinal measurements at same position.
    - Color Doppler evaluation at splenic hilum to document vessel patency, direction of flow; detect varices.

- **Pancreas**
    - Transverse view of the pancreas with color and spectral Doppler of the Portal splenic confluence (PSC) and splenic vein at the tail of the pancreas.

- **Aorta/IVC**

- Longitudinal gray scale and color images with spectral Doppler of the aorta and IVC. Include color and spectral Doppler of the Celiac Axis and the Common Hepatic Artery.

- **Ascites:**
  - Longitudinal or transverse images: RUQ; LUQ; RLQ; LLQ; Midline pelvis
  - Stationary cine images of mobile debris, if present

When pathologic processes are detected during the examination, extra images are necessary to characterize the abnormality. Sonographers are expected to apply their knowledge of pathophysiology to provide clear images of the abnormalities they encounter.

PROCESSING:

- Export all images to PACS
- Review examination images and data on PACS
- Document relevant history and impressions in primordial.
- Present images to Radiologist

REFERENCES:

Siegel, Marilyn, (2002). Pediatric Sonography. Philadelphia, PA: Lippincott Williams and Wilkins.

REVISION HISTORY:

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