Vascular Imaging in the Pediatric Abdomen

Jonathan Swanson, MD
Goals and Objectives

- To understand the imaging approach, appearance, and clinical manifestations of the common pediatric abdominal vascular diseases.
Outline

- Hepatic Vascular Lesions
- Portal Hypertension Complications
- Liver Transplant Vascular Complications
- Renal Transplant Vascular Complications
Case #1: 2-day-old female with abnormal echocardiogram
Question #1:
What is the most likely diagnosis given these radiographic findings?

A. Ebstein’s anomaly
B. Tricuspid atresia
C. Hemangioendothelioma
D. Metastatic Neuroblastoma
2-day-old female with abnormal echocardiogram

**Findings:**
- Cardiomegaly
- Left upper quadrant soft tissue density with rightward displacement of the stomach and downward displacement of the bowel

**Diagnosis:**
- Hemangioendothelioma
Hemangioendothelioma

Cross-sectional imaging

Coronal T2
Hemangioendothelioma: Cross-sectional Imaging

Dynamic MRA in Arterial Phase, Coronal Plane
Hemangioendothelioma: Background

- **Definition**: Benign endothelial-lined vascular mass in liver

- **Demographics**
  - 85% in the first 6 months of life
  - 2:1 female-to-male ratio

- **Clinical Presentation**:
  - 50% have cutaneous hemangiomas
  - Can present in high-output cardiac failure, consumptive coagulopathy
Hemangioendothelioma

Imaging Characteristics

- Hypervascular and heterogeneous
- Most often large (1 – 20cm)
- Solitary or multiple
- Aorta caliber change below the level of the celiac artery
- Larger lesions often have central core of necrosis
DDX: Infantile hemangioma

Axial T2 Haste
Infantile Hemangioma

Dynamic MRA, arterial phase, coronal

Dynamic MRA, arterial phase, coronal
Hemangioendothelioma

Imaging Recommendations

- Ultrasound for initial imaging, confirms vascular hepatic lesion(s).

- MRI provides most flexible approach for multi-phase imaging.

- CT can avoid need for sedation, but multi-phase CT not recommended in the neonate population.
Case #2: 16 year old boy with long standing portal hypertension

Contrast-enhanced CT abdomen, venous phase.

Ultrasound of splenic hilum, greyscale and doppler.
Question #2:
What additional sequence could be used to determine the nature of the central vascular prominence?

A. Arterial Phase CECT
B. Delayed Phase CECT
C. Upper GI
D. Celiac Angiogram
Additional Imaging in patient with portal hypertension

Arterial Phase

Venous Phase

3-D Reconstruction of Arterial Phase CECT
Splenic Artery Aneurysm: Background

- **Epidemiology**: Occur in 1.6% of the population
- **Clinical Presentation**: Often asymptomatic
- **Risk Factors**:
  - Portal hypertension
  - Pregnancy
  - Vasculitis
  - Increasing age
Splenic Artery Aneurysm: Imaging

- **Findings:**
  - 75% are found in the distal third of the splenic artery
  - Can have rim calcification

- **Modality:**
  - Ultrasound – diagnostic challenge in setting of venous collaterals
  - CECT
    - Single phase or mixed arterial/venous phase CT can obscure the splenic artery
    - Dual-phase CT may be necessary to diagnose SAA
Case #3: 11-year-old girl status post liver transplant
Question #3: What is the most likely diagnosis?

A. Hepatic artery thrombosis
B. Hepatic artery stenosis
C. Normal arterial waveforms in immediate postoperative setting
D. Hepatic vein thrombosis
E. Expected findings in prolonged cold ischemia time of donor liver
Pediatric Liver Transplant: Background

- The number of cadaveric donor livers is not sufficient.

- Three options to meet the demand
  - Segmental liver transplantation with living donor
  - Reduced-size cadaveric
  - Split cadaveric allografts
    - Left lateral to small child
    - Right extended liver to large child or small adult
Pediatric Liver Transplant: Anastomosis

- Hepatic artery
- Bile duct
  - Standard vs. Biliary Atresia
- Portal vein
- Hepatic veins and IVC
Pediatric Liver Transplant: Imaging

- Imaging studies are critical for early diagnosis
  - Clinical signs are nonspecific with wide variation

- Imaging Options
  - US
  - CT
  - MR
  - Angiography
Pediatric Liver Transplant: Ultrasound Protocol

- Intraoperative
- Within 12 hours
- Every 24 hours while in ICU
Pediatric Liver Transplant: Normal hepatic arteries Doppler

- Normal hepatic arteries waveforms:
  - Rapid upstroke with continuous diastolic flow
  - Acceleration time from end diastole to first systolic peak less than 80 ms
  - Resistive indices 0.5-0.8
  - Peak systolic velocity >30 cm/s and < 250 cm/s
Pediatric Liver Transplant:
Immediate Postoperative Doppler

- Absent diastolic flow (RI = 1.0) to postoperative edema causing increased peripheral resistance.
- Differential would also include hepatic arterial thrombosis.
- Follow-up confirms resolving edema with lowered RI’s secondary to improved diastolic flow.
Pediatric Liver Transplant: Hepatic Artery Stenosis

Findings:

- HA flow present but with tardus parvus pattern
- Low resistive indices
Pediatric Liver Transplant: Imaging hepatic artery stenosis

- Hepatic artery stenosis occurs in up to 14% of pediatric liver transplants

- Doppler US imaging modality of choice
  - Sensitivity = 80-90%
  - Diagnosis usually made on Doppler US finding distal to narrowing
  - Tardus Parvus
    - Tardus parvus can be normal in first 72 hours due to edema at anastomotic site
  - Confirm with CT/MR angiography, treat with IR
Pediatric Liver Transplant: Hepatic Artery Thrombosis

Immediate post-op

24 hrs. post-op

Syndrome of Impending Thrombosis

48 hrs. post-op
Pediatric Liver Transplant: Imaging hepatic artery thrombosis

- Prevalence is 5-7%,
  - More common in split or living donor transplantations.

- Doppler US imaging modality of choice
  - Absence of proper and intrahepatic arterial flow
  - Syndrome of impending thrombosis
  - Both MR and CT can be used to confirm
Pediatric Liver Transplant: Imaging Portal Vein Stenosis
Pediatric Liver Transplant: Imaging Portal Vein Stenosis

- Uncommon complication occurring at anastomotic site.
  - Potential to lead to thrombosis
  - More likely in reduced-size liver transplantation

- Doppler US demonstrates $\geq 50\%$ reduction or 2.5mm or less vessel caliber
  - Aliasing at vascular anastomosis
  - Stenosis vs. Pseudostenosis
  - MR and IR can confirm portal vein stenosis
Case #4: 15-year-old female post-op renal transplant
Question #4: What is the diagnosis?

A. Renal vein thrombosis
B. Renal artery thrombosis
C. Expected post-operative waveform secondary to edema
D. Renal artery stenosis
Pediatric Renal Transplantation
Renal vein thrombosis

- Occurs in <5% of patients.
  - Presents in first postoperative week

- Clinical Presentation:
  - Anuria
  - Tenderness over graft

- Etiology
  - Hypovolemia, venous compression, slow flow secondary to rejection
Pediatric Renal Transplantation

Imaging renal vein thrombosis

- Gray-scale ultrasound
  - Enlarged kidney

- Doppler
  - Absent venous flow
  - Increased resistance on the arterial side
  - Reversed diastolic flow
    - Upside down “m” sign
Pediatric Renal Transplantation

Imaging Renal Artery Stenosis

- **Ultrasound**
  - Color Doppler demonstrates stenotic segments
  - Velocities greater than 2 m/sec
  - Marked distal disturbance

- **MR angiography**
  - MRA can confirm, but limited in patients with low GFR
Pediatric Renal Transplantation

Biopsy Induced Pseudoaneurysm

- Result of arterial laceration secondary to biopsy
- Gray-scale – hypo-echoic mass mimicking simple or complex renal cyst
- Intracystic color Doppler flow with classic swirling pattern
Conclusions

- MR angiography excellent tool for infantile hepatic vascular masses

- Multi-phase imaging improves detection of splenic artery aneurysms in the setting of portal hypertension

- Repetitive liver Doppler ultrasound is effective in following postoperative liver transplant patients

- Doppler ultrasound provides an effective method to evaluate for the immediate and delayed vascular complications of renal transplant