Abdominal Doppler US

- Duplex, Color, Power Doppler US
- Image abdominal vessels
- Characterize blood flow dynamics
- Assess hemodynamic disturbances in various pathologic states

Vascular Ultrasound in Liver Disease

Objectives:
- Normal Vascular Anatomy
- Portal Hypertension/Cirrhosis
- Portal Vein (PV) Thrombosis
- Cavernous Transformation of PV
- Budd - Chiari- Syndrome

Normal PV Flow
- Continuous hepatopetal
- Low velocity
- Non pulsatile
- Respiratory variation

Portal Vein (PV)

- Confluence of superior mesenteric vein (SMV) and splenic vein (SV)
- Supplies 70-75% of hepatic blood flow
- MPV divides into RPV and LPV
- Hepatopetal, monophasic blood flow
- Respiratory variation
- Helical flow- normal variant

Portal Vein

- Normal Diameter 13-16 mm
- Diameter varies:
  - Postprandial, deep inspiration
  - Fasting, post exercise
- Normal Velocity: 20-30 cm/sec
Pulsatile PV Flow

- Normal subject
- Congestive heart failure
- Hepatic to portal vein fistula
- Portocaval shunts

Pulsatile PV Flow - Congestive Heart Failure (CHF)

Hepatic Artery (HA)

- Originates from celiac axis
- Proper HA anteromedial to PV in hepatoduodenal ligament

Hepatic Artery (HA)

- Supplies 25-30% incoming blood
- Aberrant HA common (replaced right HA)
- Low impedance flow pattern on Doppler
- Sharp systolic upstroke
- Continuous forward flow in diastole

Normal HA

Hepatic Veins (HV)

- Triphasic hepatofugal flow: forward flow with right atrial filling (rapid & slow)
  transient flow reversal with right atrial contraction
- Characteristic pulsatile W wave in right heart failure and tricuspid regurgitation
- Dampened flow in cirrhosis and liver disease
Normal Hepatic Vein

Normal Hepatic Veins (HV)

Portal Hypertension

- Hemodynamic abnormalities associated with severe liver diseases
- Increased portosystemic gradient
- Increased resistance to portal venous flow
- PV pressures above 7-10 mmHg
- Portosystemic collaterals cause potentially lethal complications: GI bleed, encephalopathy...

Portal Hypertension (HTN)

- Prehepatic
  - Portal vein thrombosis
- Intrahepatic
  - Presinusoidal: schistosomiasis
  - Sinusoidal: ETOH, viral cirrhosis
- Posthepatic
  - Budd Chiari, VOD, IVC webs
- Hyperdynamic
  - Arteriovenous fistula- (AVF)

PV in Portal Hypertension

- Diameter of portal vein > 15mm
- Flow pattern in PV can be hepatopetal, hepatofugal, bidirectional, very slow
- False positive for PV thrombosis due to slow PV flow - may need confirmation by MRI
- Aneurysmal dilatation PV
  - "corkscrew" appearance

Portal Hypertension - other US Findings

- Liver cirrhosis
- Splenomegaly
- Ascites
- Varices
  - Recanalization of embryonic channels
  - Reversed flow in existing veins
Liver Cirrhosis

Portal HTN - Large PV (>15 mm)

Bidirectional PV Flow

Cirrhosis - Reversed PV, high HA

Portal HTN: Varices
- Gastroesophageal
- Short gastric veins
- Paraumbilical vein
- Splenorenal
- Retroperitoneal
- Hemorrhoidal

Patent Paraumbilical Vein
- Umbilical segment of left portal vein
- Within echogenic falciform ligament
- Flow towards liver capsule
- Along anterior abdominal wall into pelvis
Short Gastric Varices

Portal HTN-Splenic Varices

Pelvic-Retroperitoneal Varices

Liver Cirrhosis: US Findings
- Coarse echotexture
- Surface nodularity
  - Use linear high frequency transducer
  - Easily seen with ascites
- Volume redistribution
  - $\downarrow$ right lobe
  - $\uparrow$ caudate and med segment left lobe
- Focal nodules
  - regenerating nodules vs. HCC

Cirrhosis-

Nodular liver surface, $\uparrow$ caudate lobe, IVC compression

Cirrhosis- Hepatocellular Carcinoma
**PV Thrombosis - Etiologies**

- Cirrhosis
- Pylephlebitis, omphalitis
- Acute pancreatitis
- Hepatocellular or cholangiocarcinoma
- Hypercoagulable states
- Penetrating trauma, post surgical
- Endoscopic sclerotherapy
- Idiopathic

**PV Thrombosis - US Findings**

- Dilated PV with internal echoes
- Absence of PV flow - false + due to slow flow (pulsed Doppler, CTA or MRA)
- Echogenic thrombus in PV
- Inability to identify PV or its branches
- Partial thrombosis with flow around clot
- Enlarged hepatic artery

**Enlarged Hepatic Artery**

- Diffuse
  - Portal vein thrombosis (PVT)
  - Severe cirrhosis
  - Large hepatocellular carcinoma (HCC)
- Focal
  - Hepatic artery aneurysm and pseudoaneurysm

**Cirrhosis with PVT**

![PV with internal echoes, large HA]

**Malignant PVT**

- Non-occlusive thrombus
- Internal vascularity
- Arterial signal on Spectral Doppler US

**Portal Vein Thrombosis**

- False Positive
  - Very low portal velocities in severe cirrhosis
  - Optimize settings, confirm with spectral Doppler US, MRA/CTA
- False negative
  - Portal type flow detected in porta hepatitis from periportal collaterals
Cavernous Transformation of PV

- Occurs in 50% of patients with PVT
- Development of peri-portal and peri—gallbladder collaterals within heaptoduodenal ligament
- May occur as early as 6-20 days post PVT
- Commonly associated esophageal varices
- CDUS: tangle or cluster of irregular vessels in porta hepatitis or gallbladder wall
- Intra-hepatic collaterals or recanalized (paraumbilical) UV may be present

CDUS: vascular channels, PV not seen

Budd-Chiari Syndrome: Etiologies

- Cirrhosis
- Thrombosis
- Congenital webs/bands
- Neoplasms (HCC)
- Hypercoaguable states
- Trauma
- Pregnancy
- Polycythemia vera
- Oral contraceptives

Budd-Chiari Syndrome

- Venous outflow obstruction at level of hepatic venules, large HV’s or IVC
- Clinical presentation
  - Hepatomegaly
  - Abdominal Pain
  - Ascites
  - Lower extremity edema

Budd-Chiari: US Findings

- Portal vein
  - Post hepatic portal hypertension
  - PV flow hepatopetal or hepatofugal
  - PV thrombosis in 10% pts
  - Portosystemic collaterals
- Hepatic veins and IVC:
  - Narrowing, webs, occlusion
  - Focal calcifications

Budd - Chiari-Syndrome

Middle hepatic vein webs  Hypertrophic caudate lobe
**Budd Chiari-Syndrome**

- Absent flow MHV
- Echogenic thrombus in IVC

**Budd-Chiari-Syndrome: Therapeutic Measures**

- Thrombolytic therapy
- Shunts for decompression of hepatic vasculature
  - mesoatrial or mesocaval shunt
  - TIPS shunt
- Liver transplantation

**Conclusion: Doppler Liver US**

- Allows assessment of physiology and pathophysiology of liver vessels and associated conditions
- Normal appearance of liver vasculature
- Portal hypertension/ cirrhosis
- Portal vein thrombosis
- Cavernous transformation of portal vein
- Budd-Chiari-Syndrome

**THANK YOU !**

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