Liver

- The liver is typically more echogenic than the renal parenchyma
- **Hepatopetal**
  - Flowing toward the liver
- **Hepatofugal**
  - Flowing away from the liver

Normal hepatic circulation

The rule of three

- **Superior mesenteric vein 2/3 – Splenic vein 1/3**
- **Right liver 2/3 – Left liver 1/3**
- **Portal vein 2/3 – Hepatic artery 1/3**

Hepatic artery

Longitudinal oblique view of porta hepatis

Hepatic artery between main portal vein & CBD

Abraham D et al. Emergency medicine sonography: Pocket guide. Jones & Bartlett Publishers, Boston, MA, USA, 1st edition, 2010.

Anatomical variations of hepatic artery

10 anatomic variants of HA (dissection of 200 cadavers)*

- Right hepatic artery from SMA
- Common hepatic artery from SMA
- Common trunk for celiac axis & SMA
- Celiac trunk absent & its branches arise from aorta

* Michels NA. Am J Surg 1966 ; 112 : 337 – 47.
Myers KA & Clough A. Making sense of vascular ultrasound. Arnold, London, 2004.

Hepatic Artery

- Note the characteristic low resistance pattern with a sharp systolic upstroke and sustained flow through diastole

Interpretation of hepatic artery flow

Low resistance flow	Decreased diastolic flow	Reversed diastolic flow
		
Normal	ESLD	ESLD

ESLD: **E**nd **S**tage **L**iver **D**isease

Kok Th et al. Scand J Gastroenterol 1999 ; 34 (Suppl 230) : 82 – 88.

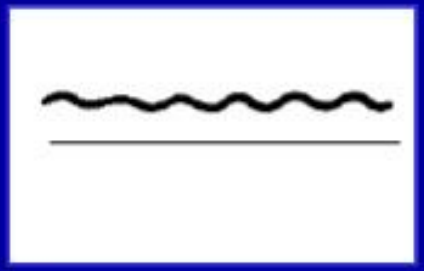
Normal portal vein

• **Diameter**	Upper limits of normal: **13 – 16 mm** > 20 – 30% increase with food & inspiration
• **Flow direction**	Towards liver (hepatopetal) Throughout entire cardiac cycle
• **Velocity**	Varies greatly (Max – Mean – Min – TAMV) Mean velocity: **15 – 18 cm/s** Varies with cardiac & respiration activity Undulating appearance of waveform

Goyal N et al. Clin Radiology 2009 ; 64 : 1056 – 1066.

Interpretation of portal vein flow

Normal flow



To and fro flow

Advanced PHT

Heart failure

Arterio-portal fistula

Reversed flow

Advanced PHT

SOS

Porto-systemic shunt

TIPS

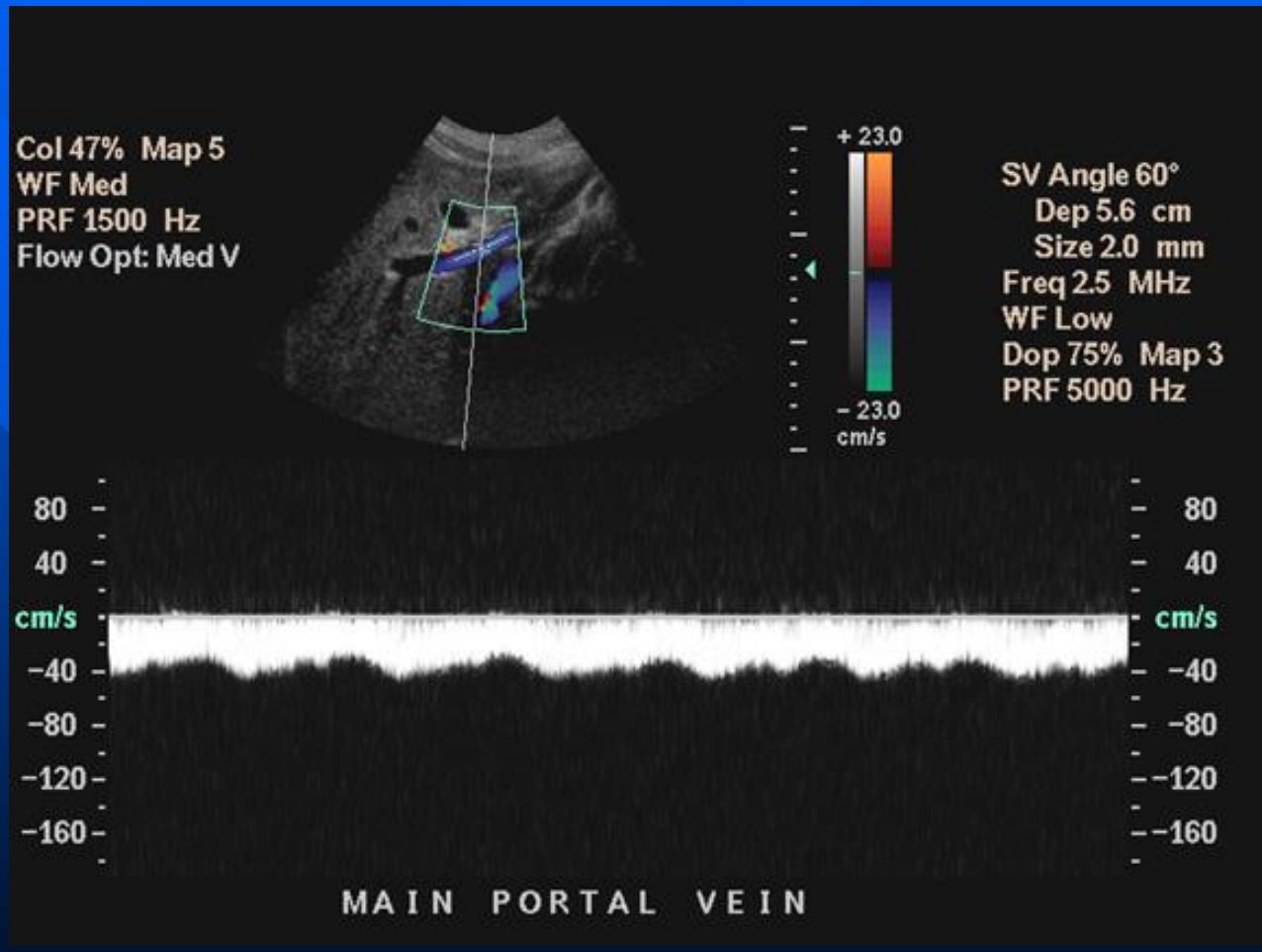
Kok Th et al. Scand J Gastroenterol 1999 ; 34 (Suppl 230) : 82 – 88.

Portal Vein

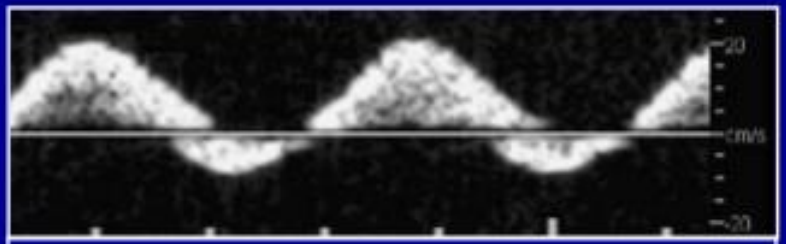
Note the antegrade flow and slight cyclical variation related to the cardiac cycle and also to respiration.

Vel = 13-23 cm/sec

Size < 13 mm



Increased pulsatility of portal vein



Exaggerated pulsatility

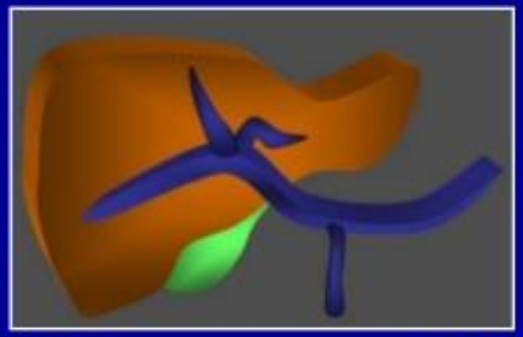
Minimum velocity below baseline

- **Portal hypertension**
- **Tricuspid regurgitation**
- **Right heart failure**
- **Arterio-portal vein fistula**

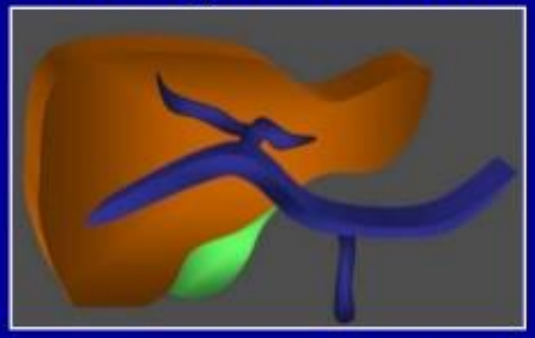
Robinson KA et al. Ultrasound Quarterly 2009 ; 25 : 3 – 13.

Anatomical variants of portal vein

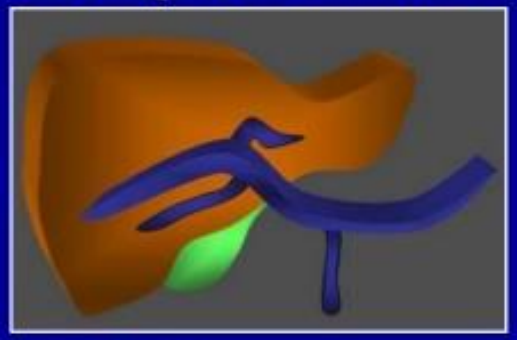
Trifurcation of PV



Right anterior branch arising from left PV



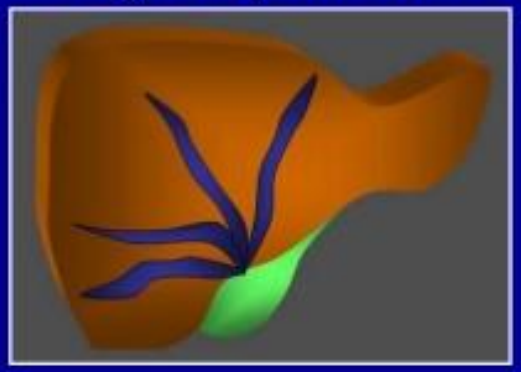
Right posterior branch arising from main PV



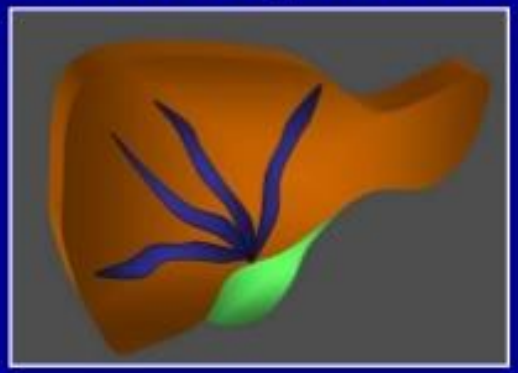
Battaglia S et al. J Ultrasound 2010 ; 13 : 49 – 56.

Hepatic vein variants

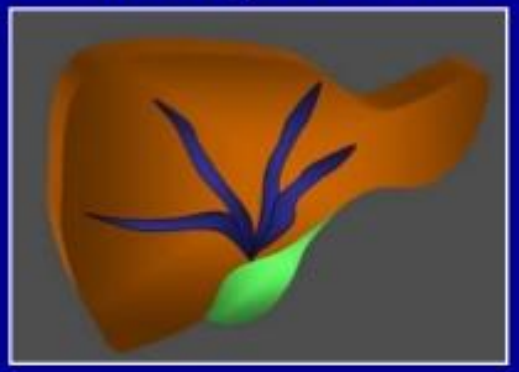
2 right hepatic veins



2 middle hepatic veins

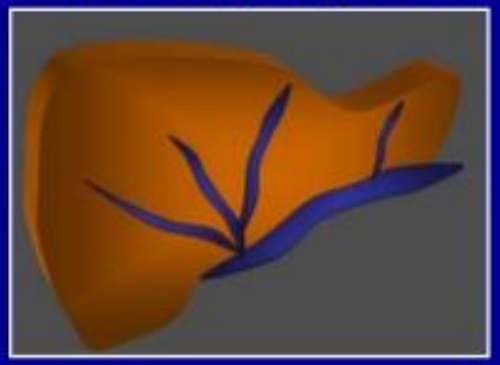


2 left hepatic veins



2 right & 2 left hepatic veins

Left accessory hepatic vein

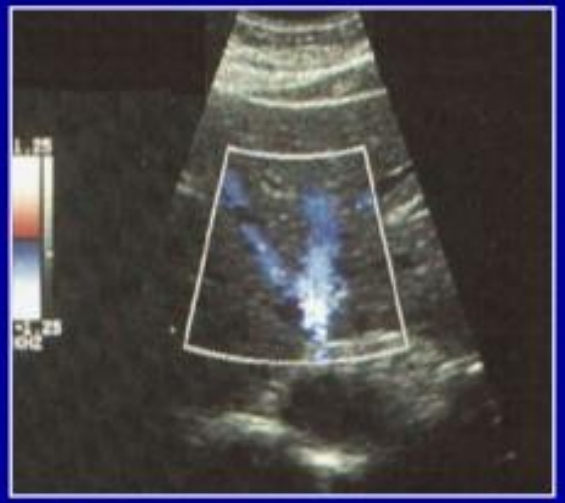


Battaglia S et al. J Ultrasound 2010 ; 13 : 49 – 56.

Color Doppler of normal hepatic veins

Atrial systole

Ventricular systole

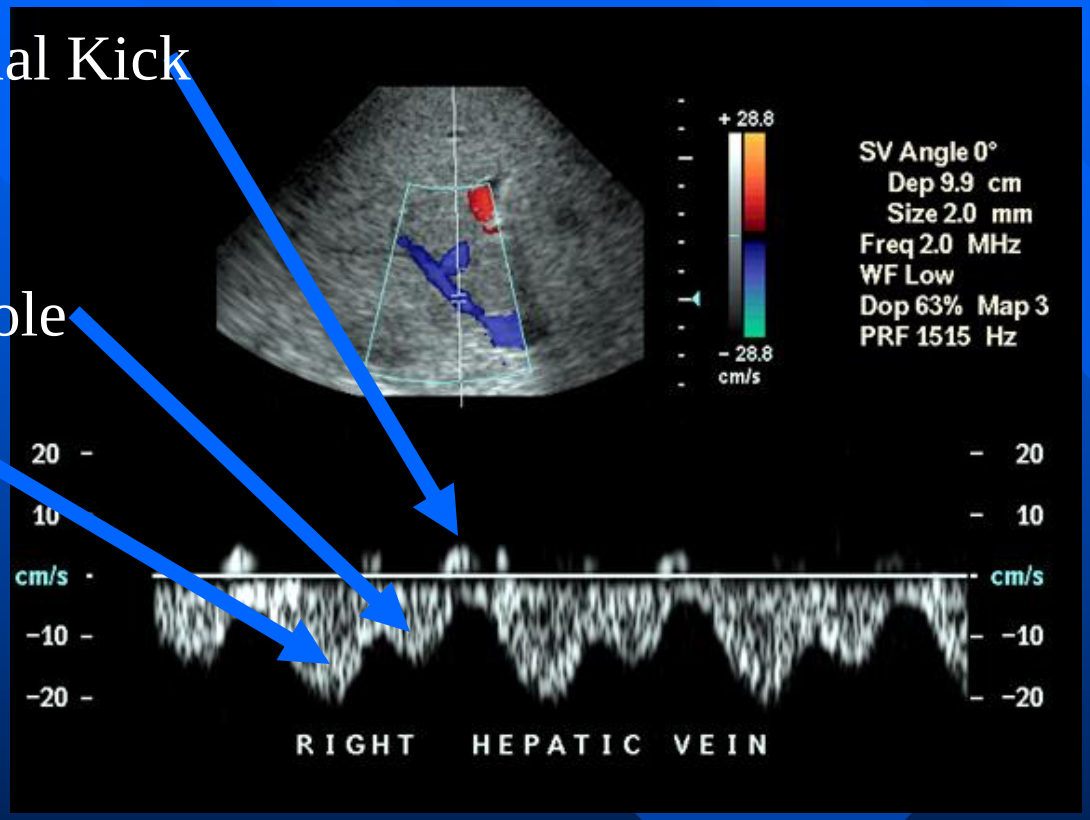


Normal diameter: < 10 mm

2 cm before entrance into IVC

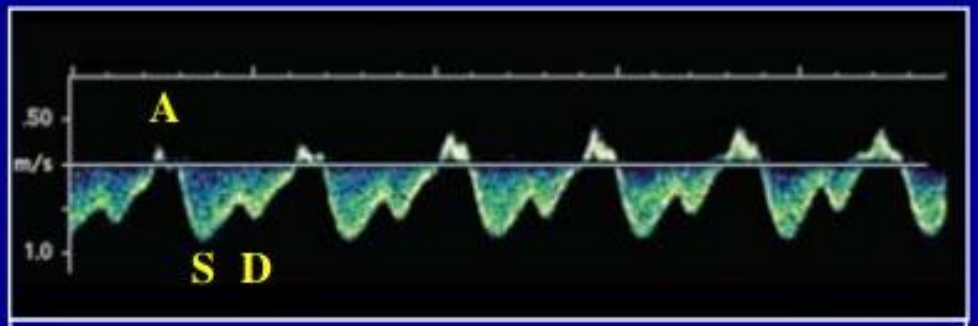
Buscarini E et al. Ultraschall Med 2004 ; 25 : 348 – 55.

Hepatic Vein



No valves. Note the characteristic biphasic or triphasic waveform, A-wave (reversal of flow is the atrial contraction

Normal hepatic vein waveform – 3 components



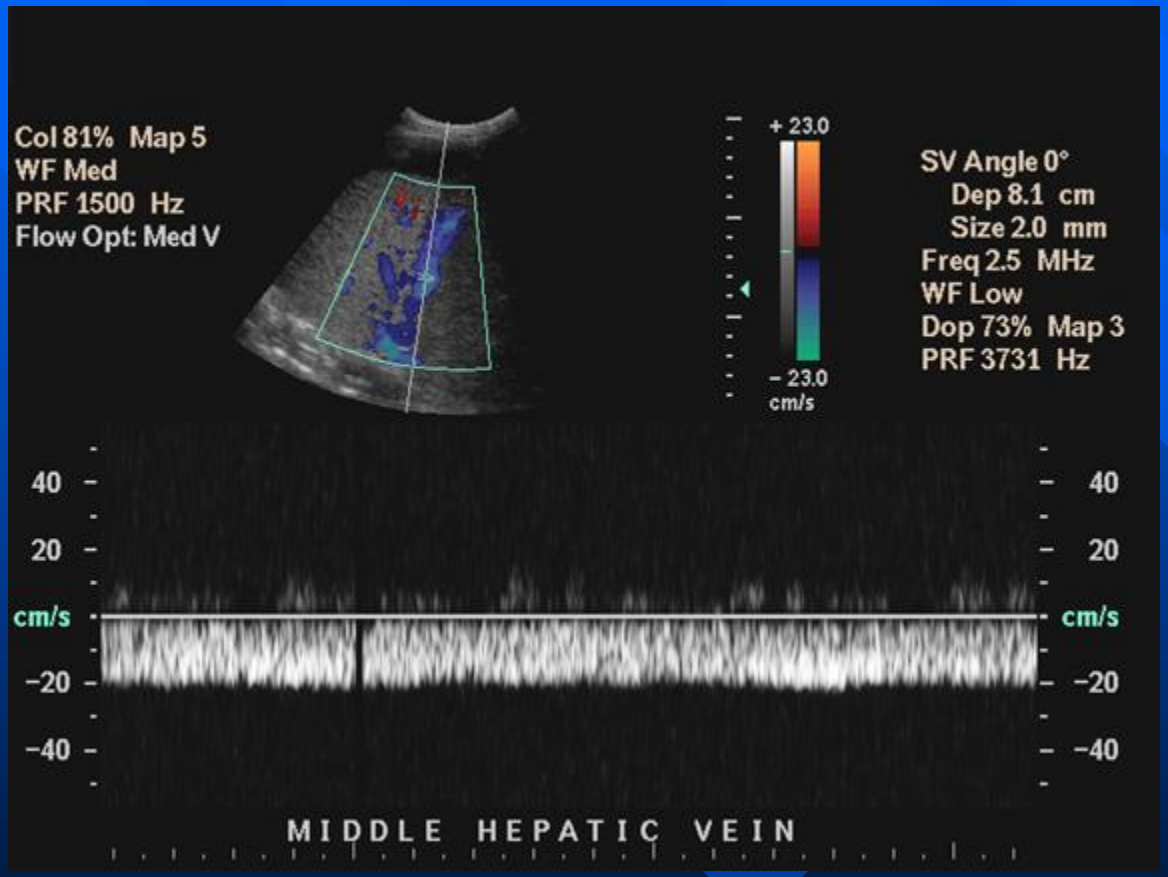
A	Atrial systole
S	Ventricular systole
D	Atrial diastole

S wave > D wave

Commonly described as triphasic

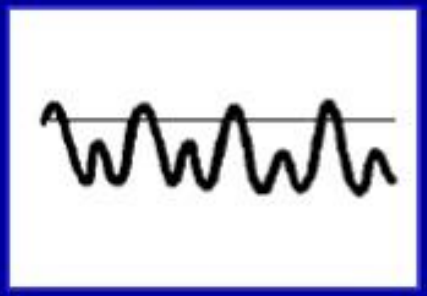
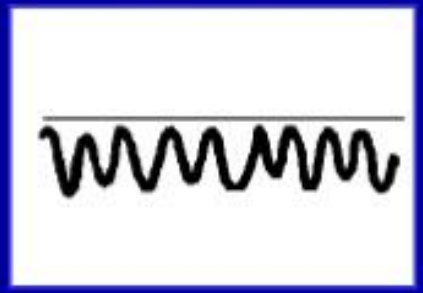
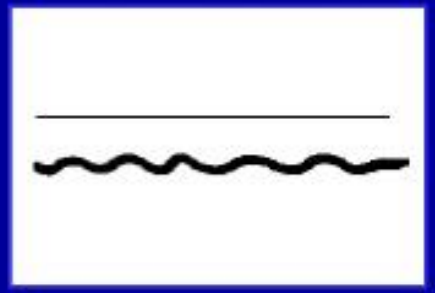
Kruskal JB et al. RadioGraphics 2004 ; 24 : 657 – 675.

Abnormal hepatic vein



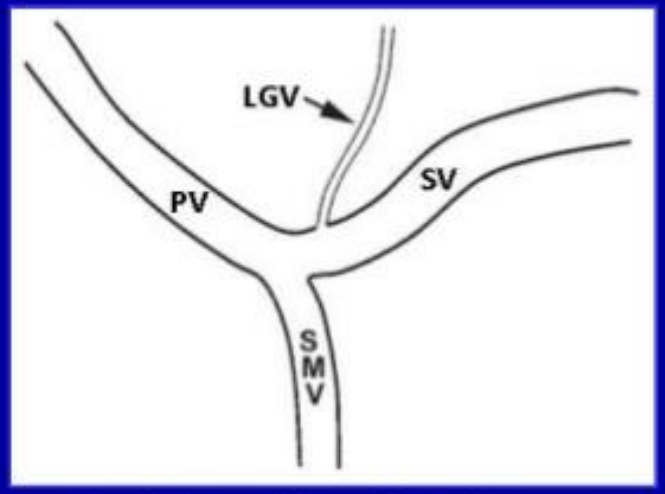
Abnormal hepatic vein waveform with loss of normal flow reversa

Interpretation of hepatic vein flow

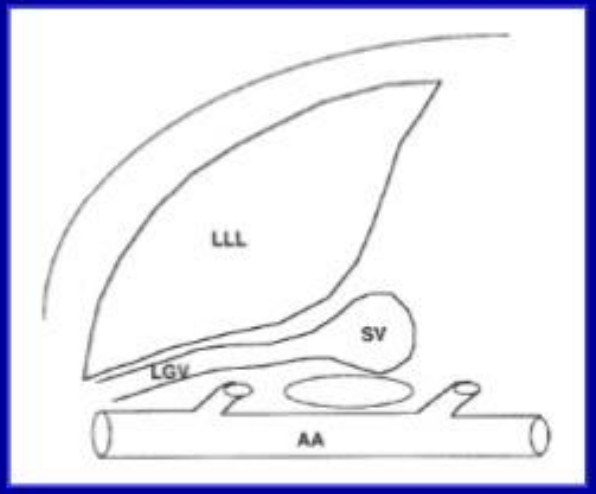
Triphasic	Biphasic	Monophasic
		
Normal	Cirrhosis Budd-Chiari syndrome Metastases Ascites Healthy subjects	Cirrhosis Budd-Chiari syndrome Metastases Ascites Healthy subjects

Kok Th et al. Scand J Gastroenterol 1999 ; 34 (Suppl 230) : 82 – 88.

Left gastric vein / Coronary vein



Relationship of LGV to SV, SMV, & PV



Sagittal left paramedian US of upper abdomen

Upper limit of normal: 5 – 6 mm

Robinson KA et al. Ultrasound Quarterly 2009 ; 25 : 3 – 13.