Liver Transplant Imaging: A view from the other side

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Background: Ultrasound (US) is the prime imaging modality for early postoperative and long term follow up. Immediate postoperative Doppler US is challenging to interpret due to surgical technique and variable Doppler waveforms in a newly adjusting liver. The post surgical edema or hyperdynamic splanchnic circulation generally resolves in 7-10 days and thus resulting in normalization of Doppler findings.

Surgical Anatomy: In whole liver orthotopic transplant (OLT), the donor IVC is piggybacked to the recipient IVC. The intrahepatic donor IVC is included as a conduit for possible large draining veins (most importantly a large accessory right hepatic vein). Hepatic arteries are anastomosed end to end or between the donor celiac trunk and an aortic patch. Portal veins are anastomosed end to end. Bile duct is anastomosed end to end or as a choledochojejunal anastomosis.

Split Liver US: A cadaveric liver is divided such that an adult receives the right lobe and part of segment 4 and a child receives the left lateral segment and part of segment 4. This right lobe include the right and middle hepatic veins, generally the right and main portal vein, and the common hepatic duct.

Conclusion: Knowledge of transient variability in early postoperative phase on Doppler US can avoid aggressive management including re-exploration. Transient findings tends to improve in 48-72 hours.

Living donor liver transplantation (LDLT) - a portion of the right lobe from a living donor is removed from 1 cm to the right of the middle hepatic vein. The right lobe will include the right hepatic vein, right portal vein and the right common hepatic duct

Hepatic artery (HA): HA stenosis or occlusion usually occurs within 3 weeks after transplant and is usually related to technique. After a transplant, HA is the only blood supply to the bile ducts

HA waveform distal to anastomosis

Normal	Rapid systolic rise and non-elevated diastolic flow RI 0.55–0.80 normal, nearly 100% specificity in excluding significant stenosis
Abnormal but common post op; usually transient	Elevated diastolic flow: (RI < 0.55) Nearly 100% sensitive for severe stenosis. Transient early post op anastomotic edema vs stenosis
	Spectral narrowing: elevated parenchymal pressure due to edema; common immediate post op

The following findings indicates significant anastomotic stenosis

	Prolonged systolic rise (tardus parvus). SPECIFIC (90%) for severe stenosis. Low velocity (PSV ≤ 50 cm/s) increases specificity to 99% for severe stenosis
	Low velocity with normal and narrowed waveform: Low inflow or steal
	An anastomotic jet (PSV > 200 cm/s) and turbulence may be significant for stenosis even with normal post-anastomotic waveforms

If hepatic arterial stenosis or occlusion develops several years after transplant, sufficient collateralization may allow graft survival. Here is an example of delayed HA occlusion were ischemic biliary abscesses developed periodically that could be treated with drainage.

Axial CT images shows biliary abscess developed 2 years later at 6 month intervals.

HA Doppler showed abnormally high diastolic flow and tardus parvus waveforms. Angiography confirmed HA anastomotic thrombosis and reconstitution distally.

Portal vein (PV) - PV flow in the first week post transplant may be turbulent with high velocity due to high splanchnic flow into a now normal and adjusting liver with low portal resistance, or due to compression of PV by postoperative edema

Post op day 0 with increased velocity at the anastomosis and focal aliasing

Follow up imaging demonstrates decrease in velocity due to improvement in post operative edema

PV stenosis is rare given the relatively large size of the vein. Pediatric and LDLT are at risk due to small graft vein size. PV anastomotic to preanastomotic velocity gradient of ≥3 indicates PV stenosis.

Hepatic vein (HV)

	Phasic flow (RI > 0.5) excludes stenosis
	HV Vein RI = 0.5 (biphasic) normal. Excludes IVC stenosis
	Monophasic flow is commonly present in the early post operative period due to edema and usually resolves. If it persists or occurs after the postoperative period along with symptoms such as ascites, it is more likely to be due to stenosis requiring intervention.