Put your thinking HAT on....

Pulsed-Wave Doppler Ultrasound Characteristics of a Hepatic Artery Thrombosis

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INTRODUCTION

OLT (Orthotopic Liver Transplantation) is the only curative treatment for patients with End-Stage Liver disease. There are two types of OLTs; a living donor transplantation (partial hepatectomy) or a cadaveric donor transplant. The surgeon transplants the donor liver to the recipient using four anastamoses. The common bile duct (CBD) is anastomosed to the donor CBD ('end to end'), preserving as much of the original duct as possible. The other three anastomoses are vascular. Doppler Ultrasound plays an important role in assessing the vascularity post-procedurally for the months and years following. Vascular complications can occur in all three anastamosed vessels in either the early or late recovery period (Figure 2.). Complications of the portal vein is uncommon, with a reported incidence of 7% (Harrow *et al.,* 2011) and complications of the hepatic artery are the most common and relate to the highest number of re-transplantations due to vascular complications (Sanyal *et al*., 2014)

Ultrasound is recommended as the initial investigative tool to establish a clinical baseline after transplantation and follow-up ultrasound investigate abnormal findings on a prior transplant ultrasound examination, assessment of the transplant in the setting of abnormal liver function tests and for yearly follow-ups. The biliary tree and the vascular patency must always be assessed (AIUM, 2014).

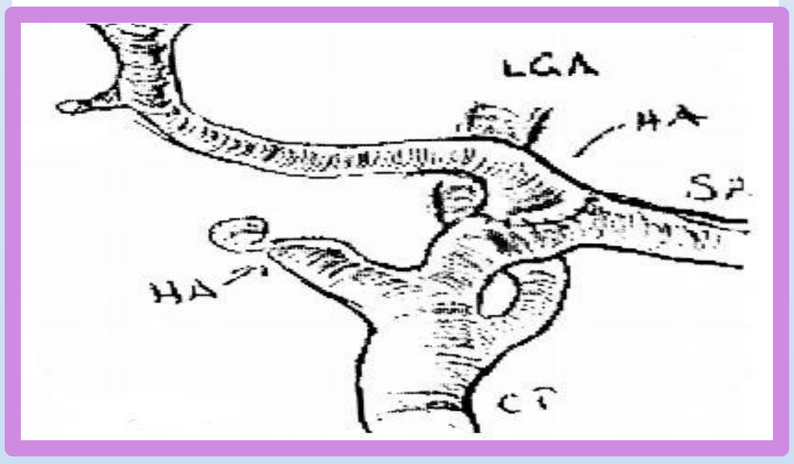

Figure 1.Sketch of the hepatic artery anasomotic site

CASE PRESENTATION

This case study describes the ultrasound imaging of a 54 year old female who underwent an OLT for decompensated advanced liver disease. The patient was referred for ultrasound by the hepatobiliary team having presented with abnormal liver enzymes. The patient was eight weeks post-OLT with an uneventful post operative period. The immediate post-procedural ultrasound did not show vascular complications or biliary complications. The patient was discharged three weeks post-procedure.

The arterial anastomosis (Figure 1.) was made to the splenic artery. This 'end-to-side' anastomosis is carried out to preserve the length of the donor hepatic artery. Surgical sketches that were included in the patient's notes, assisted the sonographer in identifying and imaging the hepatic artery. The portal vein was attached end-to-end and the hepatic veins were attached to the IVC using a 'Piggyback' technique.

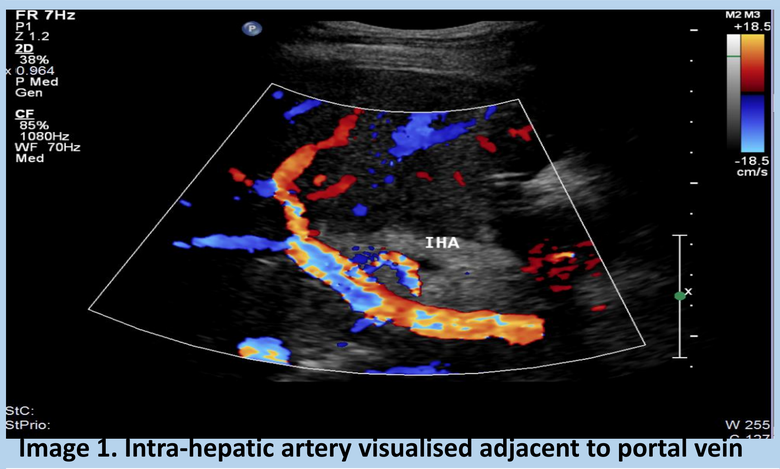

Image 1. Intra-hepatic artery visualised adjacent to portal vein

'DUCTS AND DOPPLER' US

The first post-operative ultrasound will demonstrate abnormal vessel waveforms. Surgically induced haemodynamic change, complex anastamotic sites and non-uniform donor-recipient vascularity leads to a sudden change of haemodynamic pressure. An abnormal high resistive index (RI) of the HA occurs due to decreased diastolic flow. This usually normalises within 7-15 days, when oedema has resolved (Horrow *et al*., 2007).

A decrease in HA RI is associated with HAT, however vascular 'kinks' due to vessel redundancy may led to inaccurate readings.

Correcting the angle of insonation corrects this.

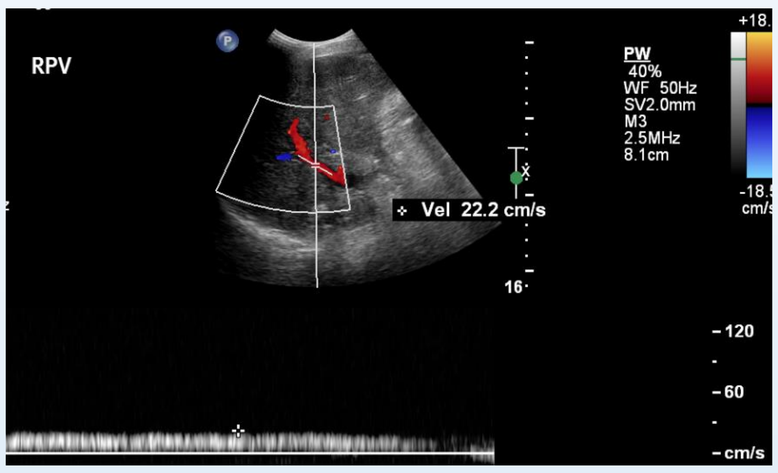

Image 2. Spectral Doppler of the RPV showing hepato-petal flow

ULTRASOUND TECHINQUE

Doppler Ultrasound is an excellent tool to visualise hepatic blood flow post-OLT. Information regarding velocity and patency can be acquired while scanning visualising the liver parenchyma in real-time. Patients who present 'day one' post-OLT are intensive care patients. Such patients are testing for the sonographer as arrested respiration and decubitus liver imaging are unattainable. Furthermore, the superficial surface is often extensively dressed. The sonographer must often utilise an intercostal approach. Post OLT patients who are presenting for follow-up or are experiencing symptoms months after surgery are often ambulant and follow instructions. In this case, a mixture of sub-costal and intercostal scanning can be used.

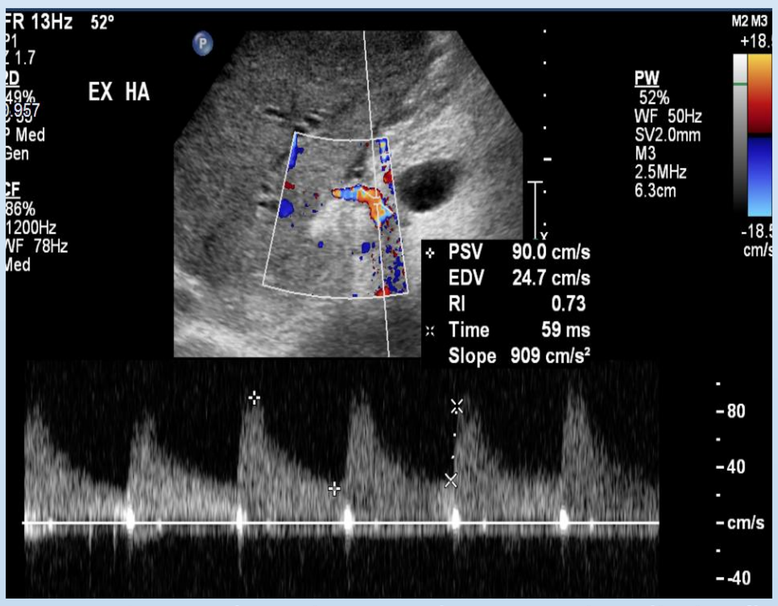

Image 3. Extra-hepatic artery demonstrating aliasing flow

The sonographer must pay careful attention to their technique when scanning an OLT patient. The colour Doppler must be less than 60 ◌̊ as colour detection will be poor if the vessel is perpendicular to the beam. A non- filling vessel has the image characteristics of occluded vessel and may lead the observer to an incorrect diagnosis.

Setting the correct PRF is imperative. The PRF should be set so that no aliasing is seen in a normal vessel (Sanyal *et al.*, 2014). A PRF set too low can result in a non-oculuding thrombus being overlooked due to bleed-out. A PRF set too high will not fill the lumen. By use of correct Doppler parameters, a diagnosis of an occlusive thrombus could be made in this case.

Spectral Doppler optimisation when visualising the hepatic artery involves using a small spectral sampling gate and angle correction so that the angle of insonation to the vessel is as close to 60◌̊ as achievable. The sample gate should be placed in the centre of the lumen. In this case the area of aliasing pre-thrombosis and small area of colour flow post-thrombosis were sampled. In the case of the LHA, no flow was identified. The spectral Doppler image parameters were optimised to detect slow flow (PRF reduced and removed wall-filter). Power Doppler was used.

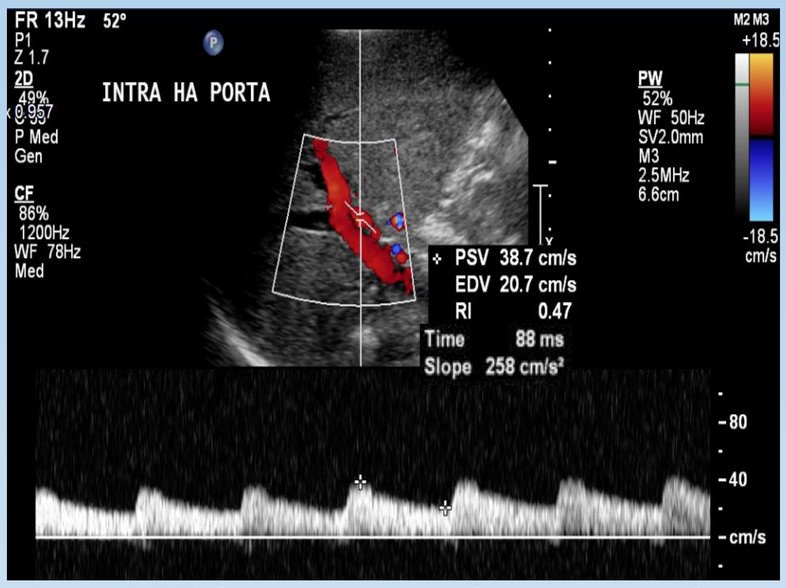

Image 4. IHA demonstating a tardus-parvus waveform

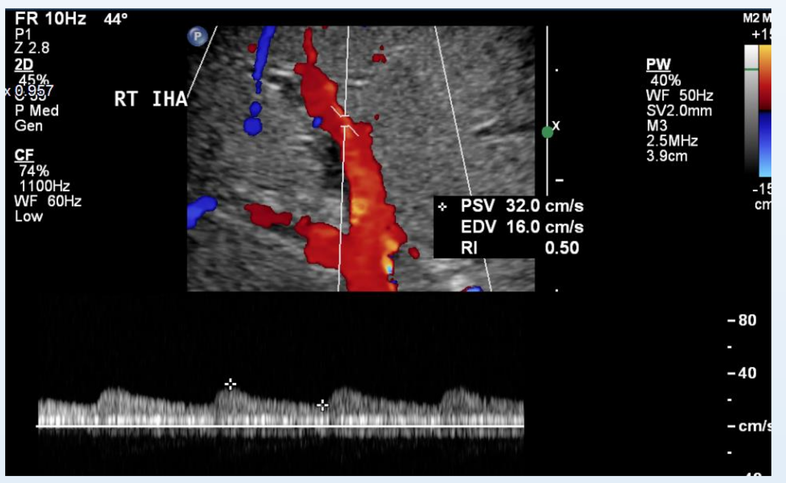

Image 5. Right IH artery demonstrating 'tardus-parvus'

US DIAGNOSIS OF HAT

A diagnosis of HAT is made by either the absence of flow in the hepatic arteries or demonstration of a tardus-parvus waveform on spectral Doppler at the site distal to the HAT thrombosis. The reported sensitivity and specificity of Doppler sonography for hepatic artery thrombosis range from 54% to 92% and from 64% to 88% (Horrow *et al*., 2011).

A tardus-parvus waveform does directly indicate a HAT but rather indicates thrombosis or stenosis at a proximal site to the thrombosis. Furthermore, obstruction the HA is rapidly compensated for by the opening of pre-existing intrahepatic or transcapsular collateral arteries, preventing ischemic damage. If periportal arterial collaterals are present, a tardus-parvus waveform is detected.

The EHA RI was 0.79 and dropped to 05 in the IHA. The SAT increased from 59ms to 88ms . Recommended spectral indices of the HA for the diagnosis of a thrombosis is an RI ≤0.5 and SAT >0.08s (Sanyal, 2014).

Recent literature suggest that the use of RI values and SAT values in isolation provide a high false-positive rate of HAT diagnoses from tardus-parvus waveforms of the MHA (Choi *et al*., 2013) . Thoroughly assessing the IHAs and EHAs is important for an accurate diagnosis; tardus-parvus waveforms demonstrated in both vessels have a high accuracy of a true diagnosis.

Image 6 a) Axial and b) Coronal CT angiogram demonstrating an occluding thrombus in the distal EHA (yellow circle)

Follow-Up

CT corroboration imaging showed a stable hepatic artery thrombosis with a small intra-hepatic arterial branch and collateral arterial supply to the RHA.A trans-jugular biopsy sample was positive for ischemic cholangiopathy. The patient went for MRCP and was put on the list for retransplantation.

Occasionally, cases of HAT are managed conservatively. In these instances, collateral hepatic arterial supply to the liver parenchyma are deemed sufficient for adequate perfusion.

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