

Review

Comprehensive ultrasound assessment of complications post-liver transplantation

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ABSTRACT

Human liver transplantation for end-stage liver disease was first performed in 1963. Refinements in surgical technique and new immunosuppressive regimens have improved outcomes. Today, transplant patients have a 5-year survival rate of approximately 75%. Nevertheless, significant complications still occur. Ultrasonography (US), is the initial imaging modality of choice allowing bedside assessment for detection and follow-up of early and delayed graft complications, and facilitating interventional procedures. This review outlines the role of ultrasound in post-transplantation assessment.

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1. Introduction

Therapeutic human whole liver transplantation for end-stage liver disease was first performed in 1963. Refinements in surgical technique and new immunosuppressive regimens have improved outcomes, and it is now an accepted and successful therapy for end-stage liver failure [1]. Today, transplant patients have an improved 5-year survival rate of approximately 75% [2], nevertheless, significant complications still occur. The shortage of cadaveric livers, however, has led to more split liver transplantation and living donor liver transplantation, often with an increased incidence of complications. The time period associated with the highest risk of mortality is the first year after transplantation particularly in the first 3 months due to graft dysfunction, problems due to vascular and/or biliary complications and infection.

Ultrasonography (US), including Doppler analysis, is the initial imaging modality of choice for detection and follow-up of early and delayed graft complications, offering advantages over other modalities. Ultrasound is ideally suited to imaging the post-operative graft as it is widely accessible, cost-effective, radiation free and can be performed at the bedside if required. If performed by skilled operators the results are highly reproducible. Ultrasound is the primary imaging modality used to assess the patient both in the immediate post-transplant period, and may also facilitate interventional procedures. It is also important in

the subsequent follow-up assessment. Cross-sectional imaging with CT and MRI can be performed if the ultrasound study is unsatisfactory or to further characterise any abnormalities detected.

2. Normal appearances

Awareness of the normal ultrasound appearance of the transplanted liver aids detection of complications and prevents misdiagnosis. Routine study involves gray-scale assessment of the liver parenchyma and biliary tree and Doppler evaluation of the graft vasculature. The normal parenchyma has a homogenous pattern at gray-scale imaging. The intrahepatic biliary ducts should be of normal calibre and appearance. In the early post-operative period a small amount of fluid in the perihepatic space is normal. Vasculature assessment involves both gray-scale and Doppler evaluation. The normal hepatic arterial waveform shows a rapid systolic upstroke with a continuous diastolic flow [Fig. 1(a)]. The systolic acceleration time (SAT) should be less than 0.08 s. The resistive index should be between 0.5 and 0.7 [3]. The normal portal vein waveform is a continuous flow pattern toward the liver with mild velocity variations due to respiration [Fig. 1(b)]. The normal hepatic venous waveform is triphasic [Fig. 1(c)], reflecting the physiologic changes in the blood flow during the cardiac cycle.

3. Ultrasound examination protocol

Annually at our institution 35–40 cadaveric or living donor liver transplantations are performed and, approximately 1200 outpa-

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tient surveillance ultrasound examinations. Our post-transplant imaging protocol includes routine ultrasound, including Doppler assessment of the graft in the early post-operative period using 3.5 or 2.25 MHz transducers. Examination of the hepatic parenchymal, perigraft region and biliary system is made using gray-scale ultrasound. The following vessels are routinely examined, first with gray-scale, then with spectral Doppler imaging to obtain spectral waveforms and velocities: the right, left, and main hepatic arteries; right, left and main portal veins; right, left and middle hepatic veins; and the IVC [4]. Anastomoses are evaluated where possible and quantitative measurements of flow velocity, RIs, and SAT are routinely performed. Further ultrasound assessment is performed at regular intervals during the follow-up period; 1, 3 and 7 days following transplantation, 2 months later and 4 monthly intervals for the first year. Newer ultrasound contrast agents such as microbubbles can be used for the enhancement of Doppler signals. These may be useful in the setting of equivocal Doppler signals, however as further imaging is usually necessary in these patients, we do not routinely administer these agents in our assessments.

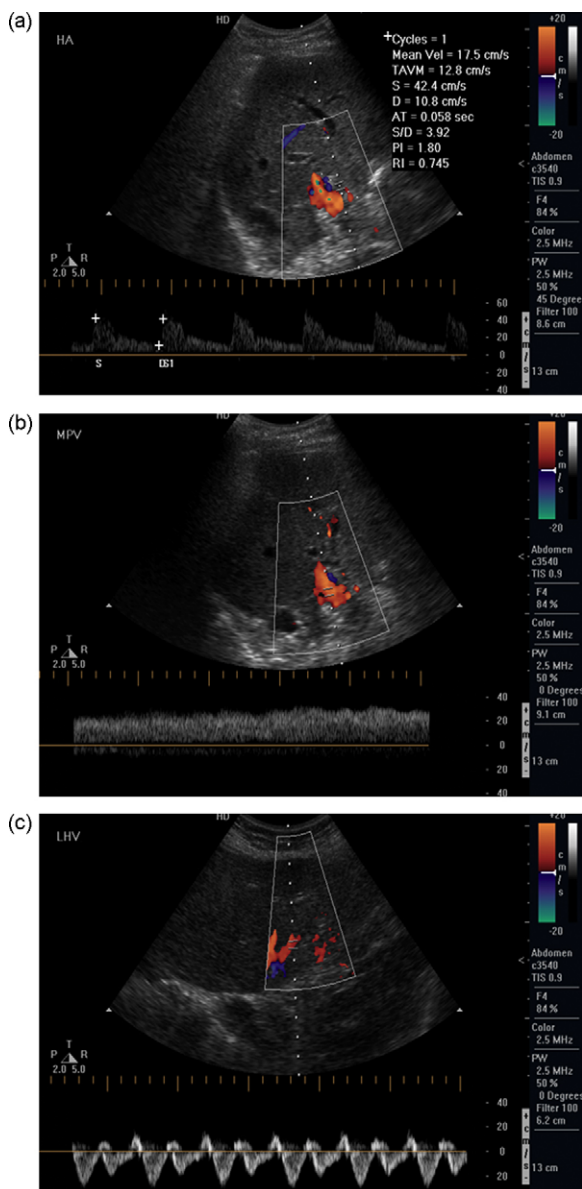


Fig. 1. (a) Normal hepatic artery waveform. (b) Normal portal venous waveform. (c) Normal hepatic venous waveform.

Additional imaging is performed as required based on patient symptomatology. If histological assessment of the graft is required, ultrasound-guided core biopsy is performed using an 18 G biopsy gun, usually via a right lateral intercostal approach.

4. Vascular complications

Vascular complications commonly occur early in the post-transplant period, although significant complications may be clinically silent. Duplex ultrasound is the primary screening modality and can determine vascular integrity without the need for more invasive and costly imaging. Angiography is the gold standard for diagnosing arterial complications, however CT or MR angiography are increasingly being used in these circumstances.

Hepatic artery thrombosis occurs in up to 8% of grafts, accounting for 60% of vascular complications [Fig. 2(a and b)]. Early thrombosis occurs in the first 15 days and risk factors include cold ischaemic time of the donor liver, donor/recipient vessel discrepancy, complex anastomoses and acute rejection. Early thrombosis is associated with a higher mortality than that occurring later in the post-operative period. Delayed thrombosis occurs years after transplantation, usually being associated with stenosis, chronic rejection or sepsis. Because the bile ducts in a transplant liver are perfused solely by the hepatic arterial supply, thrombosis leads to biliary ischaemia. This may present as biliary stricture, leak/biloma, or fulminant biliary necrosis which can lead to bacteraemia or hepatic failure. Urgent revascularization is required to salvage the graft and early detection is therefore essential, although re-transplantation may ultimately be required. Recently fibrinolytic therapy followed

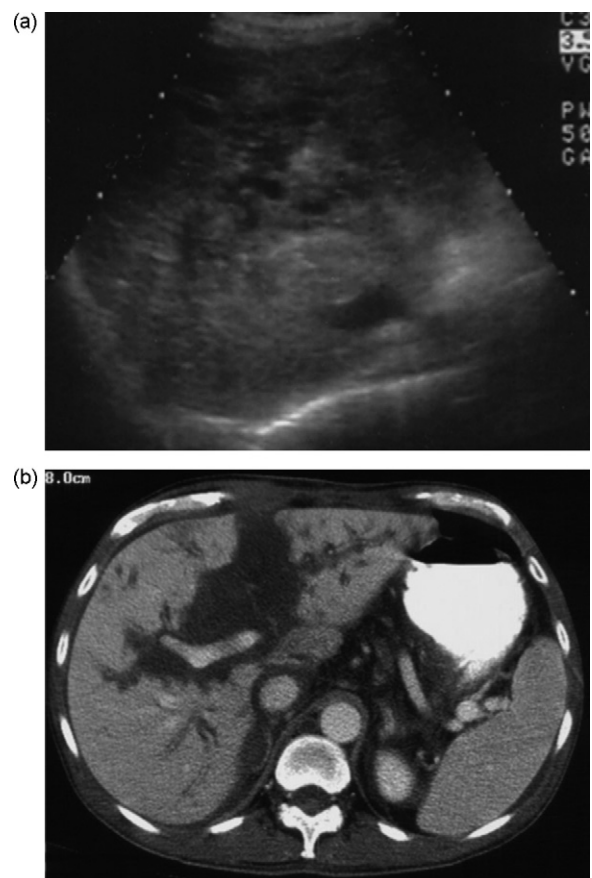


Fig. 2. Hepatic artery thrombosis: (a) US demonstrates diffuse heterogeneous mixed echogenic change. (b) CT showing widespread periportal low attenuation change.

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