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Review

The role of interventional radiology in complications associated with liver transplantation

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The evolution of liver transplantation (LT) from an unusual procedure to a practical therapeutic option for patients with life-threatening liver diseases has brought with it several unique challenges. Although the patient survival rates have been steadily improving, with more complex surgeries being performed and increasing duration of graft survival, the overall post LT complication rate continues to stay high. They include inflow complications related to portal vein (PV) or hepatic artery, outflow complications related to hepatic vein or inferior vena cava, biliary leaks or strictures, postoperative collections or abscesses, graft rejection or post-transplant malignancy. These post-transplant complications provide a fertile ground for interventional radiology (IR) to flourish as it can contribute towards the management of each of these, and on most occasions, except for in graft rejection, it can circumvent a major surgery or even re-transplantation. The minimally invasive nature and lower morbidity associated with IR procedures make them preferable to similar surgical procedures. In post-transplant biliary complications, IR and therapeutic endoscopy have almost completely replaced surgery as the first-line treatments. The same can be said regarding the important role that IR plays in the management of most non-acute vascular complications. Meanwhile, more evidence and experience needs to be accumulated in the endovascular treatment of acute vascular complications encountered in the early post-operative period. This review primarily focuses on the various IR strategies in the management of the LT-related vascular and biliary complications with illustrative cases.

Introduction

The first liver transplant (LT) recipient (in 1963) died on the operating table and the first successful LT recipient (in 1967) survived for just over a year; however, due to multidisciplinary efforts, transplant centres now boast of graft survival rates of 84% at 1 year, 77% at 3 years, and 71% at 5 years.[1–3] Although the role of diagnostic radiology in LT proceedings is well established, over the last decade interventional radiology (IR) has also emerged as an essential service for a successful LT programme.[4,5] LT is a major undertaking with a high rate (25–27%) of complications.[6,7] IR can contribute towards the management of most of these

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and often can circumvent major surgery or even re-transplantation. This review will focus on the IR strategies in managing LT-related vascular and biliary complications. Image-guided liver biopsies, percutaneous drainage procedures, locoregional treatment of malignancies, transjugular intrahepatic portosystemic shunts (TIPSS), etc., which are not unique to post-LT status have not been included in the present review.

Vascular complications

The reported incidence of post-LT vascular complications is 7–15%; but it can be higher, up to 30.8%, with more complex surgeries such as split liver transplants and living donor LT (LDLT).[8–12] Early postoperative thrombosis of the inflow (arterial or portal) is the most dreaded vascular complication as it leads to early allograft loss, long-term dysfunction, or death. Arterial complications are usually more common than venous complications, frequently present in the early postoperative period in contrast to latter, and are associated with high rates of graft loss and mortality.[8]

Post-transplant vascular complications are usually diagnosed at imaging as clinical and biochemical findings are often non-specific. Doppler ultrasound is a robust first line imaging technique that can be performed at the bedside or intra-operatively.[13] Contrast-enhanced ultrasound can improve the sensitivity for detecting vascular flow[14]; however, contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI) has an overall better (almost comparable to catheter angiography) sensitivity and specificity than ultrasound in detecting post-transplant vascular complications.[5]

Arterial complications

Arterial complications include hepatic artery thrombosis (HAT), hepatic artery stenosis (HAS) and hepatic artery pseudoaneurysm (HAP) with incidence of 0.8–9.3%, 1.9–16.6%, and 0–3%, respectively.[8,15]

Hepatic artery thrombosis

HAT is associated with acute rejection, positive cytomegalovirus serology in the donor, multiple transfusions, use of aortic conduits, variant arterial anatomy, donor and recipient vessel calibre difference, LDLT, prolonged cold ischaemia, previous transcatheter arterial chemoembolisation (TACE) in the recipient, and prolonged surgery.[16–19] Depending on the time interval between the LT and HAT, it is classified into “early” or “late”. Although there is no clear consensus on the definition, HAT within 1 or 2 months of LT has been variably deemed as “early”.[16] Late HAT is usually due to ischaemic or immunological injuries and up to 50% of patients may be asymptomatic with mild biochemical abnormalities[18]; however, it can lead to recurrent cholangitis, liver abscess and biliary leakage or stricture.[17] In early HAT, there is a significant risk of death and graft loss if prompt revascularisation/retransplantation is not performed, whereas late HAT may have better prognosis due to formation of collaterals.[11,20] The re-transplantation rate in HAT that has not been revascularised is between 25–83% compared to 25–35% when revascularised and mortality is as high as 80% when retransplantation or revascularisation is not performed as an emergency.[21–23] Most cases of HAT can be diagnosed at duplex ultrasound (DUS).[24]

The ideal treatment for early HAT is retransplantation, but donor liver is a rare commodity.[17] The next best option is revascularisation. High graft survival rates (up to 81%) can be achieved with urgent revascularisation in early HAT, whereas late revascularisation is mostly a wasted effort.[25] Traditionally, revascularisation has been surgical, but endovascular interventions (catheter-directed thrombolysis, mechanical thrombectomy, angioplasty, and stenting) have shown reasonable success rates.[8,26–30] The current practices of endovascular treatment are based on several small case series. In a systematic review of several such series, Singhal *et al.*[15] reported intra-arterial thrombolysis to be successful in 68% (47/68 patients). Although catheter-directed thrombolysis is feasible and the associated risk acceptable, there is no consensus on a standardised regime for this treatment. Different thrombolytic agents (streptokinase, urokinase, and recombinant tissue plasminogen activator [rtPA]), in different doses and over variable periods of time have been used as both intra-arterial bolus and infusion. Thrombolytic therapy could be safer and more effective if the infusion catheter is placed within the thrombus.[31] Thrombolysis has been used as early as within 4 hours of a transplant.[32] The thrombolytic infusion is usually titrated to maintain plasma fibrinogen levels above 100 mg%. Prothrombin time and activated partial thromboplastic time (aPTT) are also monitored. Simultaneous administration of conservative dose of heparin infusion is a common practice. Bleeding is the most common complication affecting a quarter of patients receiving this treatment. The managing team must be prepared to handle a haemorrhagic complication by stopping the thrombolytic therapy and administering blood products, as well as consider immediate endovascular (balloon tamponade or stent) or surgical haemostasis.[15]

As HAT is usually the outcome of an underlying stenotic lesion or kink in the artery, definitive treatment with percutaneous transluminal angioplasty (PTA) and/or stenting is often required. To avoid the risk of rupture during PTA (especially in early postoperative patients), primary stenting has been advocated.[29] Successful stenting has been done in HAT as early as 7 days following LT.[29] After endovascular treatment, antiplatelet agents given for at least the first 3 months seems to have some protective effect from further ischaemic events.[15]

In summary, the role of endovascular treatment in HAT is still evolving. In the authors’ institution, surgical revascularisation is the preferred management. In certain situations, endovascular treatment may be combined with surgery; for example, in patients with extensive intrahepatic arterial thrombosis, intra-arterial thrombolysis serves as an ideal complement to surgery.[15,21] The safety of