Liver transplantation (LT) is a well established surgical treatment option for patients with end stage liver diseases, with high operative success rates and survival benefits in both deceased donor and living donor liver transplantation (LDLT). The QMH liver transplant programme is the largest of its kind in China and Southeast Asia. By the end of October 2008, a total of 659 liver transplants have been performed with a 1-year, 3-year and 5-year survival rates of 92%, 87% and 84% respectively. To ensure proper functioning of the liver graft, both arterial perfusion and venous drainage have to be sufficient and biliary ducts should not be obstructed. Vascular and biliary anastomosis must be patent without stenosis or leakage. Despite the success of liver transplantation in recent years based on improvements in surgical techniques and advances in immunosuppression, various complications still occur after liver transplantation1,2,3, resulting in significant patient mortality and morbidity. These complications may be categorised into vascular and biliary related groups. Radiology plays an important role in the diagnosis as well as in the therapeutic treatment of these complications4,5,6. This article describes how interventional radiology could be applied in the management of postoperative vascular and biliary complications in recipients after liver transplantation.

Management of Vascular Complications

Vascular complications following liver transplantation occur with an incidence of 5 to 25% and may involve the hepatic artery, portal vein, hepatic vein or inferior vena cava7. Colour Doppler ultrasound (US) is used as the main screening technique, while angiography is reserved for confirming US findings or when US findings are equivocal. Excellent results have been reported using multislice computed tomography angiography (CTA) in detecting vascular complications after liver transplantation8. Contrast magnetic resonance angiography (MRA) is another alternative non-invasive technique for this purpose9.

Hepatic Artery Thrombosis

Hepatic artery thrombosis is a serious and the most common vascular complication of liver transplantation. Early thrombosis is often catastrophic. Patients present with cholangitis, septic shock or fulminant liver failure. The diagnosis is established when colour Doppler US fails to identify both an arterial colour Doppler signal and waveform along the anticipated course of the hepatic artery. Preferred treatment is surgical thrombectomy with revision of the surgical anastomosis. However, most patients require retransplantation. Successful cases of transcatheter thrombolysis in early hepatic artery thrombosis (Fig. 1) have been reported but carry a high risk of intraabdominal haemorrhage during the very early post-operative period10. Chronic occlusion of the hepatic artery takes a more benign course and ends up with biliary complications such as biliary strictures, occlusions, and bilomas. Patients will require retransplantation if the biliary complications from chronic hepatic artery occlusion become too severe.

Hepatic Artery Stenosis

Patients with hepatic artery stenosis usually present with elevated liver function tests or a liver biopsy demonstrating ischaemic changes. Arterial stenosis is detected with colour Doppler US, with findings of peak systolic velocities greater than 200cm/sec or a focal increase in velocity of greater than three-fold suggesting a stenosis of greater than 50%. Balloon angioplasty is the accepted treatment for hepatic artery stenosis (Fig. 2). Stent placement is usually reserved for arterial dissections related to angioplasty or recurrent stenosis. The procedure is typically performed by placing a 6F- or 7F guide catheter into the coeliac artery and crossing the stenotic lesion using a 0.014- or 0.018-inch guide wire balloon stent system. The largest series by Oron and coworkers described angioplasty in 21 allografts and reported a technical success rate of 81%11. Percutaneous transluminal angioplasty has been reported to be an effective treatment of hepatic artery stenosis after LDLT,
with a success rate of 94% and a complication rate of 6%, with possible recurrence in 33% of patients 12.

**Portal Vein Stenosis**

Patients with portal vein stenosis present months to years after transplantation with symptoms of portal hypertension including variceal bleeding and ascites. Portal vein stenosis is diagnosed with US, CTA or MRA. If treatment is contemplated, further imaging using indirect arterial portography or direct portovenography can provide a better assessment of the stenotic lesion. Portal vein stenosis is treated from a percutaneous transhepatic approach with angioplasty and selective stent placement (Fig. 3). Success rates of over 70% have been reported 13.

**Hepatic Vein Stenosis**

Patients with hepatic vein stenosis present clinically with elevated liver enzymes, or Budd-Chiari Syndrome. Hepatic vein stenosis is most common in segmental liver transplants occurring in 4 to 7% of recipients 14. Diagnosis is usually with Doppler ultrasound, CTA or MRA; with hepatic venography reserved for selected cases. Treatment is typically from transjugular or transfemoral approach with balloon dilatation or stent placement (Fig. 4).

**Inferior Vena Cava Stenosis**

Patients with inferior vena cava stenosis typically present with lower extremity oedema or ascites. Early stenosis is usually due to technical factors at the surgical anastomosis, which may cause kinking or torsion of the inferior vena cava. Late stenosis is due to fibrosis or intimal hyperplasia at the anastomotic site. Diagnosis is with ultrasound, CTA or MRA. Treatment is from transjugular or transfemoral approach with balloon angioplasty and stent placement (Fig. 5). Weeks and coworkers published a large series of percutaneous angioplasty and stent insertion for IVC stenosis in 9 transplant recipients and found the procedure to be safe and effective in these patients 15.

In cases of venous outflow obstruction resulting from hepatic vein and/or IVC lesions after paediatric liver transplantation, percutaneous endovascular treatment after balloon dilatation or stent placement has been found to be a safe and effective alternative treatment that results in long term patency 16.

**Management of Biliary Complications**

Bile duct complications have been described in 15% to 25% of liver transplant patients 17 and include strictures, bile leaks, stone or sludge and dysfunction of sphincter of Oddi. Ductal dilatation due to biliary stricture is easily detected with ultrasound. Percutaneous transhepatic cholangiography or endoscopic retrograde cholangiography is used to diagnose biliary stricture and bile leak. Magnetic resonance cholangiography has been found to be a reliable technique for detecting post-orthotopic liver transplantation biliary complications 18. Bile duct stricture, either anastomotic or non-anastomotic, is the most common cause of biliary obstruction. Anastomotic strictures usually result from fibrosis or scarring, whereas non-anastomotic strictures may be related to cold ischaemia. Treatment is often by percutaneous transhepatic biliary drainage and balloon dilatation of the stricture (Fig. 6) or endoscopic dilatation with temporary stenting, while surgery is
reserved for recurrent strictures or those not responding to the less invasive measures. Long term patency of percutaneous bilioplasty in adult liver transplant recipients is reported to be about 50% at 5 year 19.

Image guided aspiration or drainage is often employed in the management of bile leakage occurring in liver transplant recipients. Bilomas can be aspirated under US guidance to confirm the diagnosis and to promote healing and preserve graft integrity. Should direct cholangiography demonstrates a bile leak then anastomotic stenting may be performed if the integrity of the hepatic artery has been established.

Conclusion

With advances in interventional radiological techniques, the interventional radiologist has become an essential member of the liver transplant team. Despite continuous improvements in surgical techniques resulting in a progressive decline in postoperative complications, vascular and biliary complications remain a significant cause of morbidity and mortality of the liver transplant patients. The judicious use of interventional radiological procedures is invaluable in the management of complications after liver transplantation.

References