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·讲 座 Lecture·

Endovascular management in liver transplantation

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Liver transplantation was developed for the treatment of hepatic failure, and the first human liver transplantation was done in 1963. From the 1990 s, liver transplantation was generally accepted as a treatment modality for both end-stage liver disease and selected liver malignancies. Initially, liver transplantation was started with deceased donor whole-size liver transplantation (whole-size LT) as in other organ transplantation, but there is now a shortage of deceased liver donors has occurred. As a solution, deceased donor split liver transplantation (split LT) began in 1989 and living donor liver transplantation (LDLT) in the early 1990 s. Current liver transplantation techniques include whole-size LT, reduced-size liver transplantation (reduced-size LT), split LT and single or dual LDLT. Two donors give a part of their livers to one adult recipient simultaneously in dual LDLT.

Over 1,200 cases of liver transplantation has been performed at the Asan Medical Center (AMC) (Seoul, Korea) since 1992 and over 200 cases per year in 2004 and 2005. Some new liver transplantation techniques have been developed in AMC, such as the modified right lobe LDLT and dual LDLT. Over 90% of liver transplantations are adult-to-adult LDLT, and one quarter of them are dual LDLT. We retrospectively analyzed 613 patients (59.1%) who needed interventional procedures before, during and after liver transplantation among 1,037 LDLT patients. The most common interventional procedure was percutaneous drainage of fluid collection (34.5%) followed by percutaneous transhepatic biliary drainage for bile leak and biliary stricture dilatation (23.9%). The most common vascular interventional procedure was the embolization for hemorrhage (14.2%). Balloon dilatation and stenting for vascular stenosis or kinking were also performed at various sites including the hepatic vein (9.7%), portal vein (6.4%), hepatic artery (1.2%) and inferior vena cava (1.2%) (Table 1).

Table1 Interventional procedures in 1 037 LDLTs in AMC

	No.of patients	Incidence
Drainage of fluid collection*	358	34.5%
PTBD for bile leak or biliary stenosis	248	23.9%
Embolization for bleeding control	147	14.2%
For increase hepatic vein outflow Balloon angioplasty(13) Stent(88)	101	9.7%
For increase portal vein inflow Intraoperative stent(36) Balloon angioplasty(4) Percutaneous stent(26)	66	6.4%
For management of IVC stenosis and kinking	12	1.2%
For increase hepatic arterial flow Balloon angioplasty(8) Stent(4)	12	1.2%

*mainly drainage of pleural effusion, ()number of patients

The success rate of liver transplantation is 95% in AMC, and complications of liver transplantation are currently assessed first by interventional radiologists. In most cases, complications can be managed by interventional radiology, although in certain cases we have learnt that surgical treatment is better.

VASCULAR INTERVENTIONS BEFORE LIVER TRANSPLANTATION

Splenic artery aneurysm embolization

The incidence of splenic artery aneurysm (SAA) in patients with liver cirrhosis ranges from 7-17%, and SAA rupture after liver transplantation has

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resulted in a significantly higher morbidity and mortality. The preservation of the spleen is important due to its immunologic function. Therefore, even asymptomatic SAA or small sized SAA should be embolized prior to liver transplantation to prevent the growth and rupture of the SAA.

VASCULAR INTERVENTIONS DURING LIVER TRANSPLANTATION

Intraoperative portal venogram

Enough flow through the portal vein is essential for the hypertrophy of the graft after transplantation. Portal venogram is helpful for the evaluation of the direction of the portal vein flow before and after the ligation of varices.

Portal vein stenting

Stenting of the portal vein is usually done for the prevention of vascular kinking and for the dilatation of a small sized portal vein with or without partial thrombosis.

VASCULAR INTERVENTIONS AFTER TRANSPLANTATION

Hepatic artery stenosis and thrombosis

Stenosis or occlusion of the hepatic artery is mainly due to poor surgical technique or poor arterial status, and the reported incidence of hepatic arterial stenosis or occlusion is 12%.

Not all arterial stenoses seen on CT or Doppler ultrasonography require treatment, especially in many cases of mild degree of stenosis with normal liver function. However, symptomatic arterial stenoses do require treatment. Percutaneous transluminal balloon dilatation (PTA) and stent placement are alternative interventional techniques for arterial stenosis.

Hepatic arterial thromboses occur with or without arterial stenosis, and the reported incidence is 2 ~ 8% in adult liver transplantation. Hepatic arterial thrombosis occurred within several weeks has a high risk of graft failure, but it can be asymptomatic. The therapeutic options for hepatic arterial thrombosis include urgent retransplantation or under observation.

Hepatic artery pseudoaneurysm

Extrahepatic pseudoaneurysm is a rare complication and is usually encountered at the anastomotic site of the hepatic artery.

Surgical exploration and repair are usually required, but the embolization is an alternative therapeutic option.

The causes of intrahepatic pseudoaneurysm are iatrogenic such as liver biopsy, percutaneous transhepatic biliary drainage and transhepatic aspiration of peritoneal or intrahepatic fluid. All intrahepatic pseudoaneurysms must be treated because of a latent possible rupture, and no significant deterioration of liver function after the selective embolization of the pseudoaneuryms has been observed. Coil embolization from the distal to proximal portion of the pseudoaneurysm is the best method because it can preserve the distal hepatic artery through intrahepatic collaterals.

Hepatic vein stenosis and kinking

Stenosis or kinking of the hepatic vein is only a complication after reduced-size LT, split LT, and LDLT because end-to-end or end-to-side anastomosis to the IVC is done for hepatic vein reconstruction in whole-size LT. The hepatic veins are evaluated with CT and Doppler ultrasound, but clinical manifestations and laboratory findings should also be simultaneously considered. Decreased hepatic venous outflow due to stenosis or obstruction is typically presented as an inhomogeneous area of the graft on enhancing delayed phase CT. A pressure gradient greater than 10 mmHg across the anastomotic site and contrast stasis in the hepatic vein suggest a significant stenosis. Treatment should not be delayed in cases requiring management because it will progress to thrombophlebitis and graft loss. Prophylactic hepatic vein stenting just after transplantation if the surgeon had technical concerns during the transplantation might be a feasible method for graft saving.

Flow pattern of the hepatic vein on Doppler ultrasound changes immediately when a successful stenting is done, and the typical low density area of the liver on CT usually disappear within a week along with improvement of clinical manifestations and laboratory findings.

Inferior vena cava stenosis and kinking

Stenosis and kinking of the IVC is a problem of full-size LT. The reported incidence is less than 1%, and the clinical manifestations are depend on the location of stenosis. The clinical manifestations are similar to typical Budd-Chiari syndrome with ascites and hepatic dysfunction due to stenosis or obstruction of the suprahepatic IVC and lower extremity edema.

PTA and stent placement have been reported to be the treatment of choice for stenosis and kinking of the IVC.

Portal vein stenosis and thrombosis

These complications can be caused by the poor surgical technique for anastomosis with torsion, tension or venous redundancy induced by geometric relationship of graft to the recipient's portal vein. Impairment of portal flow induces worsening of liver function, poor hypertrophy or atrophy of the graft, and, finally, graft failure. The incidence of portal vein thrombosis is 1 ~ 3% .

Treatment options include surgery such as surgical revision with or without thrombectomy, venous bypass and retransplantation, and radiologic interventions.

Hemorrhage

Bleeding from liver transplantation is similar with bleeding from partial resection of the liver except bleeding from the arterial anastomotic site.

Surgical exploration is indicated for sudden massive bleeding, bleeding with a large amount of intraperitoneal hematoma, bleeding at cut surface of the graft, bleeding in the gallbladder fossa and at the hepatic artery anastomosis. Other sources of hemorrhage including the right inferior phrenic artery, inferior epigastric artery, superior epigastric artery, right renal capsular artery, intercostal arteries and small bowel bleeding caused by stress ulcers can be controlled by embolization.

Transjugular liver biopsy

Transjugular liver biopsy is a safe alternative technique to surgical and percutaneous biopsy; furthermore, it also can be performed in the acute post-transplant period. The advantage of this technique is to avoid an injury to the liver capsule.

Treatment in recurrent hepatocellular carcinoma

The most common malignant tumor of the liver is hepatocellular carcinoma (HCC) which usually develops in a cirrhotic liver. Liver transplantation is limited in HCC by the risk of tumor recurrence. Milan or University of California at San Francisco, criteria are applied for liver transplantation of HCC .

TACE and percutaneous transhepatic therapy including radiofrequency ablation are used for recurrent HCC, but no effective response has been observed in most patients probably due to simultaneously immunosuppressive therapy. Recurrent HCCs in a graft usually show rapid growth compaing to the non-transplanted liver.

Arterial embolization for splenic artery steal syndrome

Surgical splenectomy, splenic artery ligation, and reanastomosis of the graft hepatic artery with an interposed vascular graft from the aorta are more complicated surgical techniques whereas splenic artery embolization is a simple and preferred therapeutic method to treat 'splenic artery steal syndrome'.

TIPS

TIPS is indicated in chronic stage of liver transplantation for the control of portal hypertension with patent portal system.

VASCULAR INTERVENTIONS FOR DONOR

The greatest concern is the risk of death to the living donor. Mortality of the right lobe donor had been reported to be about 0.3%, and eight donor deaths had been reported worldwide.

Complications in the living donor are the same as with partial hepatic resection including pleural effusion, intraperitoneal fluid collection, bleeding, portal vein stenosis and kinking, and bile leak from the cut edge of the liver. The incidence of major complications was reported to be 5% in patient receiving hepatic resection, which is similar to liver donors.

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