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EVALUATION OF HEPATIC ARTERIAL COMPLICATION AFTER DECEASED DONOR LIVER TRANSPLANTATION: A SINGLE CENTRE EXPERIENCE

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ABSTRACT

INTRODUCTION: Hepatic artery complications are one of the most frequent causes of morbidity and graft loss in the immediate post liver transplant period. Early detection of this complication is critical to treat them promptly and to reduce liver damage. The developments in diagnostic radiology have helped to diagnose these complications early and could be treated subsequently.

AIM OF STUDY: To determine the incidence of hepatic arterial complications after deceased donor transplantation and to discuss relative role of different imaging modalities in detection of post liver transplant hepatic arterial complication.

MATERIAL AND METHOD: This is a retrospective study of cohort of 281 adult deceased donor liver transplantation done over period of 9 years, between May 2009 to November 2018 in Institute of Kidney Disease and Research Centre. Each patient underwent Colour Doppler study for first 5 days after transplantation and as and when clinically or biochemically indicated. The Doppler study was performed on Cx-50 Ultrasound and Color Doppler machine from Philips. C1-5 transducer was used. Triphasic contrast enhanced CT Angiography of liver was performed to confirm the Doppler findings or when the Doppler study is suboptimal.

RESULTS : Hepatic artery complications were found in 7 patients post operatively. (Incidence 2.5%) We found hepatic artery thrombosis was the most common complication followed by hepatic artery stenosis and arterioportal fistula.

CONCLUSION: Routine Doppler sonography performed after liver transplantation allows early detection of hepatic artery complication. Further imaging study should be used as and when necessary.

KEYWORDS : Hepatic artery complication, liver transplantation, Colour Doppler

INTRODUCTION:

Normally, the liver allograft maintains a dual inflow blood supply: Portal and arterial. Hepatic artery (HA) plays a major physiological role, because it provides the blood supply for both the liver parenchyma and the billiary tree. The total incidence of HA complication was 4.34%[1]. Early detection of hepatic artery complication is critical to treat them promptly and to reduce liver damage. The developments in diagnostic radiology have helped to diagnose these complications early and could be treated subsequently.

AIM OF STUDY

To determine the incidence of vascular complications and to discuss relative role of different imaging modality in detection of post liver transplant hepatic arterial complication.

MATERIAL AND METHOD

This is a retrospective study of 281 adult deceased donor liver transplantation performed in patients with end stage liver disease over a 9 year period, between May 2009 to November 2018 in Institute of Kidney Disease and Research Centre. The data was retrieved from a prospectively maintained computerized database and imaging reports. End to end anastomosis of donor hepatic artery with recipient hepatic artery was done with continuous sutures in most of cases. In few cases interrupted suturing was done. In some cases pseudocarrel patch was formed from recipient right and left hepatic artery. 7-0 prolene was used. Each patient underwent Colour and Duplex Doppler study for first 5 days after transplantation and as and when clinically or biochemically indicated. The Doppler study was performed on Cx-50 Ultrasound and Color Doppler machine from Philips. C1-5 transducer was used. Colour and Duplex Doppler study of main, right and left hepatic artery was done. Hepatic artery peak velocity and Resistive index (RI) was recorded in all three arteries. Triphasic contrast enhanced computed tomography (CT) Angiography of liver was performed on Somatom sensation 64 CT scan from Siemens to confirm the Doppler findings or when the Doppler study is suboptimal. We found Colour and Duplex Doppler study 100% sensitive for diagnosis of hepatic arterial complication. Intra operative complications of hepatic artery and patients who lost follow up to institute are excluded from the study.

RESULTS :

Hepatic artery complications were found in 7 patients post operatively. (Incidence: 2.5%) Mean age of patients is 49 years (range: 42-64years). M: F ratio is 6:1. We found 5 patients with hepatic arterial thrombosis, (incidence: 1.8%) 1 patient with hepatic artery stenosis and 1 patient with arterio portal fistula as sequel to portal venous thrombosis. None of our patient developed hepatic arterial pseudoaneurysm, arterial steal syndrome or anastomotic leak. Mortality due to vascular complication in our study is 85.7%.

DISCUSSION

In the first few days after liver transplantation Color and Duplex Doppler is effective for the evaluation of hepatic arterial flow. Interpretation of Doppler findings may be difficult because the hepatic artery waveform also is commonly altered in the absence of complications. Moreover, the same Doppler findings can be observed in different situations. Normal HA has Peak systolic velocity ranges from 13.2–367 cm/sec on the 1st Post operative day

with a rapid upstroke , RI value is 0.55 to 0.80 and average flow of 400 ml/mi [2,3]. High velocity may be due to persistent preoperative high arterial inflow status and anastomotic edema. High velocity returns to normal within 3 days. In the first day, almost half of patients have a transient high RI in the hepatic artery which returns to normal in a few days if there are no complications.

According to the degree of resistance, the high RI has been classified by García-Criado et al.[4] into four types. Type I: RI >0.8 with continuous blood flow in the diastolic phase; Type II: RI = 1 complete absence of the diastolic signal and preserved systolic velocity. Type I & II pattern can be seen in cases of hepatic arterial spasm; (responds to vasodilator), increased portal flow which inhibits the release of arterial vasodilators, tissue edema, increased cold ischemia time and in older age in liver donors.

Type III pattern is absence of diastolic signal and diminished systolic velocity. This type is a further progression of the transient high-resistance flow, but these spectral waveforms are similar to the spectrum of arterial hypo perfusion secondary to some arterial complications. When type 3 pattern is found in the immediate postoperative period, daily Color Doppler is necessary and; If waveform does not become normal within 4 days further investigation should be done. If a patent artery is seen, a daily Doppler examination is mandatory until the flow becomes normal. Type IV is undetectable arterial flow in hepatic artery. This needs further investigation like contrast enhanced ultrasound, CT/Magnetic resonance /conventional angiography.

Hepatic artery thrombosis:

The incidence of hepatic artery thrombosis (HAT) is between 4 and 12% in adults [5]. Post transplant hepatic artery thrombosis can be divided into two groups depending upon the time of onset of thrombosis. Thrombosis occurring within 1 month of transplantation is classified as early HAT and thrombosis occurring after 1 month of transplantation is classified as late HAT. Etiological factors for early HAT includes technical cause, kinking, small donor or recipient vessels and several non surgical causes like acute rejection, sluggish flow through the hepatic artery, increased cold ischemia time of donor liver and ABO blood type incompatibility.[6,7,8]. Late HAT is associated with chronic rejection and sepsis. Evaluation of hepatic artery in case of liver transplantation starts with intra operative ultrasound. Some studies [9,10] demonstrated that measurement of hepatic arterial flow intra operatively help to predict early post transplant hepatic artery complication.

Post operatively, abnormal results on liver function tests are often its first manifestation. Patient may present with low grade fever, right upper quadrant pain to fulminant hepatic necrosis; billiary leakage; stricture formation and potential graft loss. In case of late HAT; patient may present with obstructive jaundice with elevated liver enzymes symptoms of cholangitis.

We found 5 patients with hepatic artery thrombosis : 3 patients with early thrombosis and 2 patients with late thrombosis. 3 patients had ischemic changes in liver parenchyma and one patient presented with symptoms of obstructive jaundice 6 months after transplantation. Mortality after hepatic artery thrombosis in our study is 100%.

Ultrasound and Colour Doppler is diagnostic in 92% of cases of HAT[11]. It shows absence of Doppler arterial signal at the hilum as well as in the intra hepatic arterial branches. A high-resistance flow (RI = 1) may be observed if The Doppler waveform is obtained in the main hepatic artery before the thrombus. Doppler US in the immediate postoperative period is limited by technical factors such as surgical dressing material, obesity, marked ascites, perigraft collection or hematoma. Occasionally, the arterial flow may be below the level of detection for the ultrasound probe because of hepatic edema, systemic hypotension, low cardiac output or proximal stenosis. Contrast-enhanced ultrasound can be useful. It improves the sensitivity and accuracy of Doppler ultrasound for hepatic artery flow detection. When contrast-enhanced ultrasound cannot be used, other noninvasive imaging techniques such as MRA or CTA can be performed after Doppler ultrasound and before arteriography. False negative findings may be seen in cases of late hepatic artery thrombosis, when periportal collateral arteries develop which shows a pattern with prolonged systolic acceleration time and low RI .This pattern is nonspecific of hepatic artery thrombosis and Differential diagnosis is hepatic artery stenosis.
In our study absent colour flow and arterial signal in hepatic artery was seen in 4 out of 5 cases. Tardus parvus pattern was seen in one case of late hepatic artery thrombosis due to development of periportal collateral vessels.

Hepatic artery stenosis

Hepatic artery stenosis has been reported to occur in 5%–11% of liver transplant recipients[12, 13,14]. It usually results from clamp injury; intimal trauma caused by perfusion catheters at the time of surgery, or disrupted vasa vasorum, leading to ischemia of the arterial ends. It can develop into billiary ischemia, causing hepatic dysfunction. Colour and Duplex Doppler examination shows focal peak velocity greater than 2 m/s in hepatic artery and intrahepatic Doppler waveform shows a prolonged systolic acceleration time (≥ 0.08 second) and a low RI (< 0.5). Causes of false positive tardus parvus pattern includes **e**arly postoperative period, celiac trunk stenosis and arterioportal fistula. When an increased focal peak systolic velocity is not detected along the course of the hepatic artery, the differential diagnosis must include hepatic artery thrombosis with the development of collateral vessels. In these cases, contrast-enhanced ultrasound examination is useful, although it does not obviate an angiographic study to establish the diagnosis.

The blood flow velocity must increase initially to maintain the continuity of volume flow, as the diameter of the stenotic vessel decreases. Once a critical stenosis is reached, any further decrease in stenotic diameter will rapidly reduce the blood flow velocity as well as the blood volume flow .For this reason, a low PSV at the hepatic artery distal to the anastomosis may suggest hepatic arterial stenosis.

Yang shin et al.[15] concluded that the combination of the tardus parvus pattern and an optimal PSV cutoff(≤48cm/sec) greatly improved the positive predictive value and reduced the false-positive rate in the diagnosis of hepatic arterial stenosis.

We found one patient with hepatic artery stenosis at anastomosis with tardus parvus pattern intrarenally and high peak systolic velocity at anastomosis.

The arterial steal syndrome

It is a cause of hepatic hypo perfusion after liver transplantation. These syndromes are characterized by low arterial flow toward the graft caused by a shift of flow into the splenic artery, called splenic artery steal syndrome, or into the gastro duodenal artery, called gastro duodenal artery steal syndrome. The diagnosis is defined by sluggish flow in the hepatic artery (subjective slow flow in the hepatic artery relative to the flow in the splenic artery) in the absence of significant (>50% arterial diameter reduction) arterial anatomical defects such as hepatic arterial stenosis, thrombosis, and/or kinking. An arterial steal syndrome must be suspected when a high arterial resistance flow does not normalize within a few days after liver transplantation. The criteria are the presence of an enlarged splenic artery (≥ 4 mm or 150% of the hepatic artery diameter) and high PSV in artery.

However, arterial flow in the hepatic artery is usually less impressive than in the splenic artery because the spleen is normally more vascular than the liver from an arterial/arteriography standpoint. This is because ~20 to 25% of the blood flow to the liver is arterial, and 100% of the blood flow to the spleen is arterial. Furthermore, liver transplant recipients are commonly cirrhotic patients with years of underlying portal hypertension, as a result, these patients have a high likelihood of having splenomegaly and enlarged SV at

baseline. Angiography is the gold standard for diagnosis of arterial steal syndrome. Angiography may demonstrate patent hepatic artery with delayed and reduced contrast filling rather than the other branches of the celiac axis; Reduction in the contrast filling of the peripheral liver parenchyma; the main part of blood flow through the splenic, left gastric, or gastro duodenal arteries and splenomegaly. Parenchymal vessels show delayed arterial filling that occurs in the portal phase of the angiographic run.

Hepatic artery pseudo aneurysm

It is an infrequent complication after liver transplantation, its potential for rupture and subsequent fatal hemorrhage makes early diagnosis important. Patient may present with upper GI bleeding, hemoperitoneum, hemobillia and bile duct fistula. It may rupture in to portal vein producing portal hypertension syndrome. Etiology is dissection or mycotic origin. Ultrasound shows cystic lesion at hilum which fills with color and presents as arterial Doppler waveform. We did not find hepatic pseudoaneurysm in our study patients.

Hepatic arterio portal fistula

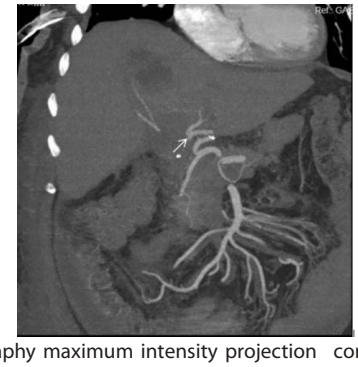
Arterio portal fistula (APF) refers to abnormal shunt or fistulous (organic or functional) connection between portal venous system and hepatic arterial system resulting in the redistribution of arterial flow into a focal region of the portal venous flow. Hemodynamically significant APFs in liver transplant recipients are rare, occurring in 0.2% of cases[16].We had one case of arterio portal fistula developed 3 years after transplantation as sequel to portal vein thrombosis. Doppler findings were portal vein thrombosis and hepatofugal flow in portal vein with high PSV (310 cm/sec) and low RI in hepatic artery. Arterio portal fistula was suspected and confirmed on Triphasic CT angiography.

CONCLUSION:

Routine Doppler sonography performed after liver transplantation may allow early detection of hepatic artery complication. It is now considered a standard of care. Further imaging study should be used as and when necessary.

Figure legends :

Figure 1:



CT angiography maximum intensity projection coronal image- showing normal contrast filling of anastomotic artery and left hepatic artery with acute cut off of right hepatic artery (arrow)just distal to bifurcation and collateral filling of distal branches.

Figure 2:

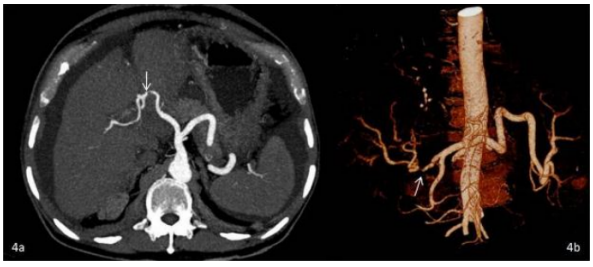
CT angiography maximum intensity projection coronal image - showing abrupt cut off of hepatic artery (arrow)at level of anastomosis.

Figure 3a: Axial image of CT scan in venous phase showing dilated IHBR in both lobes of liver

Figure 3b:

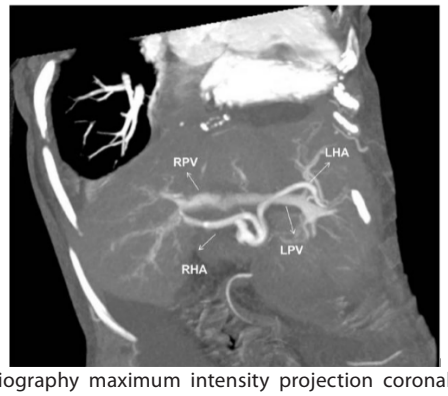
CT angiography maximum intensity projection axial image - Non filling of main hepatic artery with collateral filling of right hepatic artery (I arrows) suggest late hepatic artery thrombosis.

Figure 4:



Axial CT angiography image (4a) and volume rendered image (4b) showing narrowing of hepatic artery at anastomosis suggest 70-80-% stenosis.

Figure 5:



CT angiography maximum intensity projection coronal image showing contrast filling of right, left and main portal vein in arterial phase of imaging suggests multiple arterio portal fistulas

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