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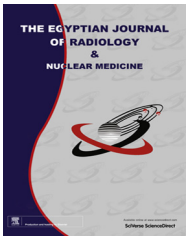

ORIGINAL ARTICLE

Multi-slice computed tomography imaging of the post transplant complications in the recipients after living donor liver transplantation

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KEYWORDS

LDLT;
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Abstract *Aim:* To evaluate the clinical utility of MSCT in the detection and proper management of the different post-transplant complications in the recipients after LDLT.
Patients and methods: 33 patients (28 males & 5 females) who underwent LDLT were referred to the Radiology department (CT unit) for evaluation of vascular, biliary, and parenchymal complications after LDLT using MSCT.
Results: Vascular complications were found in 16 cases (48.5%) [hepatic artery thrombosis (8 cases), hepatic artery stenosis (1 case), portal vein thrombosis (3 cases), portal vein stenosis (2 cases), hepatic veins stenosis (2 cases)]. Biliary complications were found in 9 cases (27.3%) [biloma (6 cases) 18.2%, biliary stricture (3 cases) 9.1%]. Hepatic abscess was found in 2 cases (6%), acute rejection was found in 2 cases (6%), recurrent HCC was found in 3 cases (9.1%). Neoplastic lympho-proliferative disorder was found in 1 case (3%).
Conclusion: MSCT is a non-invasive and accurate examination to detect complications after LDLT, it provides synchronous evaluation of the hepatic vasculature, biliary tract, liver parenchyma and the other abdominal organs in a single examination. MSCTA is the best option for confirming the US suspicion of vascular complications, with DSA reserved if therapeutic intervention is contemplated.

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1. Introduction

Liver transplantation is currently the treatment of choice for patients with severe acute or advanced chronic liver failure for which no other therapy is available.

The most common post-hepatic transplantation complications include vascular and biliary complications. Bowel obstruction, post-operative collections, infection and

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malignant recurrence are also commonly seen in the post-hepatic transplantation patients (1).

Postoperative complications have a significant impact on the morbidity and mortality of liver transplant recipients. Different imaging modalities are used to optimize the follow-up of these patients (2).

Multi-Slice CT (MSCT) is recently accepted as a practical noninvasive diagnostic method in assessment of various complications following liver transplantation. The excellent spatial and temporal resolution combined with post-processing of the imaging data using a variety of three-dimensional reformatting techniques such as maximum intensity projection (MIP), shaded surface display, and volume rendering (VR) allows MSCT to depict both hepatic anatomy and pathology efficiently and accurately (3).

In the present study we prospectively evaluated the clinical utility of MSCT and MSCTA in the early detection and proper management of different post transplant complications in the recipients after Living Donor Liver Transplantation (LDLT).

2. Patients and methods

2.1. Patients

This prospective study was conducted on 33 adult recipients who underwent LDLT. Patients were referred from different transplantation units to the Radiology Department (CT unit) from November 2009 to June 2012 for further evaluation of vascular, biliary, parenchymal and abdominal complications using MSCT. The study population comprised 28 males and 5 females ranging in age from 38 to 63 years with a mean age of 49.8 years ± 5.9. The indication for transplantation was liver cirrhosis secondary to HCV in all cases with five cases having hepatocellular carcinoma on top of cirrhosis.

This study was performed after the approval of the scientific and ethics committee of the hospital.

2.2. Methods

All the 33 patients underwent MSCT of the abdomen using a 64-detector multislice CT scanner (SOMATOM Definition, Siemens, Forchheim, Germany). Scanning the upper abdomen was performed before the use of IV contrast material, followed by triphasic CT and CT angiography of the hepatic vasculature.

Low osmolar nonionic contrast material (Omnipaque 300–350; Nycomed Amersham, Princeton, NJ) was injected intravenously via a power injector, the dose of contrast material was 2 ml/kg of patient's weight with a maximum of 150 ml, injection flow rate was set to 5.5–6 mL/s.

Using the bolus triggering technique, the region of interest (ROI) was set within the abdominal aorta at the level of the celiac artery as a baseline. The arterial phase of acquisition was started when the density of contrast material in the aorta reached the 100 HU (the triggering threshold), then after a delay of 20 s the portal phase was performed. The third phase (venous phase) was started after a delay of 35–40 s from the start of the contrast injection.

The CT acquisition was designed to cover the entire craniocaudal extent of the liver and vascular anastomoses during the precontrast scan, hepatic arterial phase and portal venous phase. Third-phase scanning included the whole abdomen to detect an abnormality outside the liver.

The CT parameters were: 120 kV, 280–300 mA, 2.5 mm nominal section thickness, a slice pitch of 6, a gantry rotation period 0.6 s, a table speed of 15 mm per rotation and 2.5 mm reconstruction thickness. Patients were requested to hold their breath during the precontrast phase and the three phases of acquisition for 8 s each and were allowed to breathe quietly after that.

All images were transferred to the workstation for post processing. Multiplanner reconstruction (MPR) and 3D maximum intensity projections (MIP), volume rendering (VR), curved planer reformations (CPR) were performed for all patients.

The final diagnosis used as reference was based on clinical findings, clinical course and constellation of findings of different imaging modalities (Conventional angiography, PTC, ERCP, MRCP) and surgery.

3. Results

This study enrolled 33 patients. The complications were categorized into vascular, biliary, parenchymal and abdominal. The distribution and percentage of patients according to type of complication are described in Table 1.

3.1. I-Vascular complications

Sixteen out of 33 cases (48.5%) were referred for assessment of vascular complications. Doppler ultrasonography examinations were either inconclusive or required further definite diagnosis by MSCTA. Hepatic artery thrombosis (HAT)

Table 1 Distribution of number and percentage of patients according to type of complication.

Type of complication	Number of cases	Percentage
Vascular	16	48.5
Hepatic artery:		
HA thrombosis	8	24.2
HA stenosis	1	3
Portal vein:		
PV thrombosis	3	9.1
PV stenosis	2	6
Hepatic veins:		
Hepatic vein stenosis	2	6
Biliary	9	27.3
Biloma	6	18.2
Biliary stricture	3	9.1
Parenchymal		
Hepatic abscess	2	6
Recurrent HCC	3	9.1
Rejection	2	6
Abdominal (lympho-proliferative disorder)	1	3

was detected in 8 cases (24.2%), hepatic artery stenosis (HAS) was detected in 1 case (3%), portal vein thrombosis (PVT) was detected in 3 cases (9.1%), whereas portal vein stenosis (PVS) was detected in 2 cases (6%), and hepatic veins stenosis (HVS) was detected in 2 cases (6%). The distribution of number and percentage of patients with vascular complications according to the type of complication are described in Table 2.

Table 2 Distribution of number and percentage of patients with vascular complications according to the type of complication.

Type of vascular complication	Number of cases	Percentage in relation to vascular complications
Hepatic artery thrombosis	8	50
Hepatic artery stenosis	1	6.3
Portal vein thrombosis	3	18.7
Portal vein stenosis	2	12.5
Hepatic veins stenosis	2	12.5

Six cases with HAT, 1 case with HAS, 1 case with PVS and 2 cases with HVS were sent for conventional angiography for further radiological intervention, whereas the rest of cases were referred for surgery (Figs. 1-3).

3.2. II-Biliary complications

MSCT depicted the presence of biloma in 6 (18.2%) cases. Drainage of these collections was performed under CT guidance, it was performed in one case via transhepatic approach (Fig. 4). Four cases were successfully drained, whereas the other 2 failed to resolve thus need further ERCP assessment, which confirmed the diagnosis of biliary leakage (Fig. 5).

MSCT showed intra-hepatic biliary radicles dilatation with suspected underlying biliary stricture in 3 (9.1%) cases. Subsequent MRCP examination confirmed the presence of biliary stricture at the anastomotic site. ERCP and Biliary stents were

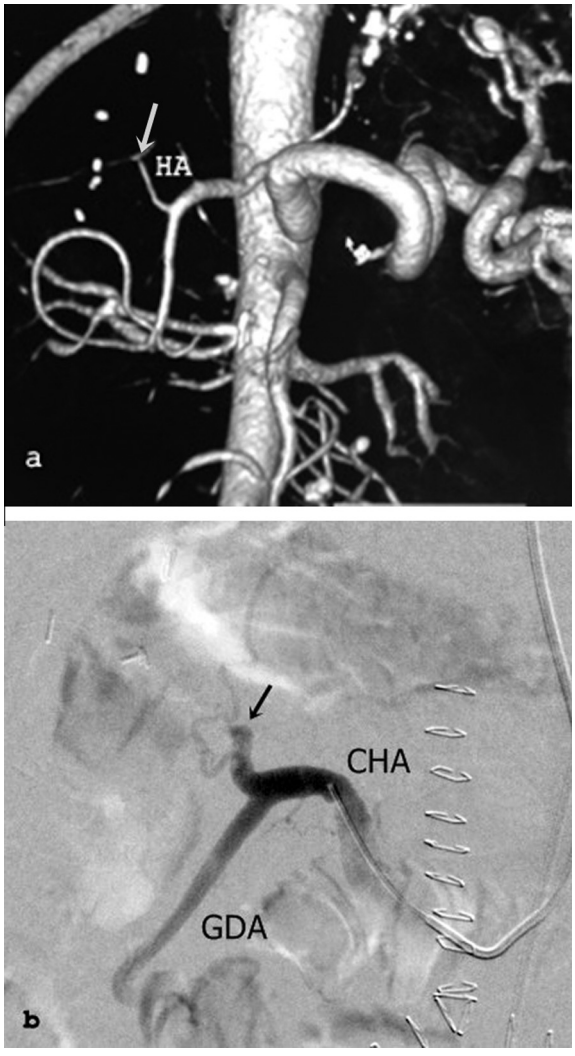

Fig. 1 Fifty-six year old male recipient 4th day post LDLT with stable liver enzymes and absent hepatic artery flow on Doppler US. (a) Coronal CT angiography VR image shows occluded HA proper just proximal to the anastomosis (white arrow). (b) Selective hepatic arteriogram image confirmed HAT with absent intrahepatic flow.

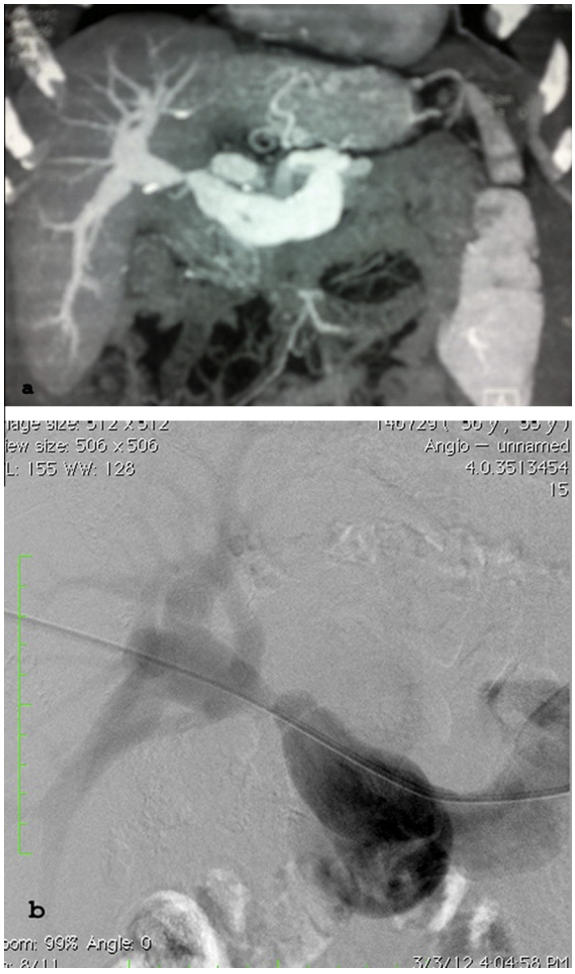

Fig. 2 Forty year old female recipient 1-month post LDLT, with clinical signs of portal hypertension. (a) Coronal CT angiography MIP image showing tight stricture at the portal vein anastomosis (b) Percutaneous transhepatic portography showed dilated splenic and portal vein with tight anastomotic stricture and size mismatch between the recipient and donor portal veins.

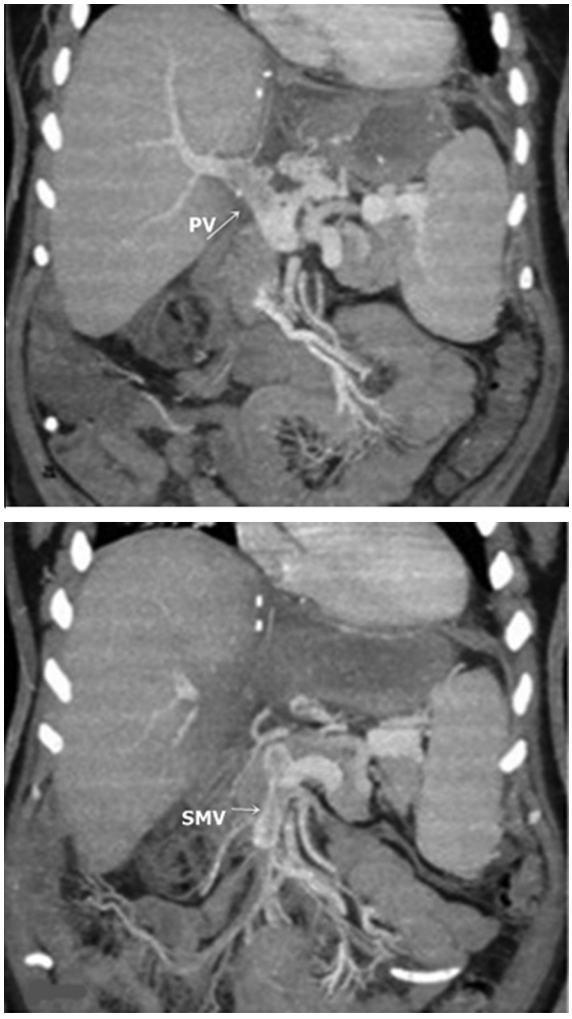

Fig. 3 Fifty-one year old male recipient 2 weeks post LDLT, with suspected PVT on Doppler US. (a & b) coronal CT angiography MIP images showed partial portal and superior mesentric vein thrombosis.

done in the three cases with successful relief of biliary obstruction (Fig. 6).

3.3. III-Parenchymal complications

3.3.1. Hepatic abscesses

MSCT examination confirmed the presence of abscesses in 2 cases (6%). US-guided drainage was performed.

3.3.2. Acute rejection

Acute rejection was suspected by MSCT in 2 cases (6%), it showed non-uniform liver parenchymal and periportal collar sign (Fig. 7), whereas the definite diagnosis was confirmed by biopsy.

3.3.3. Recurrence of hepatocellular carcinoma (HCC)

Recurrent HCC in the transplanted liver was detected in 3 cases (9%) ranging from 6–12 months post transplantation. The three patients died within the first year after transplantation (Fig. 8).

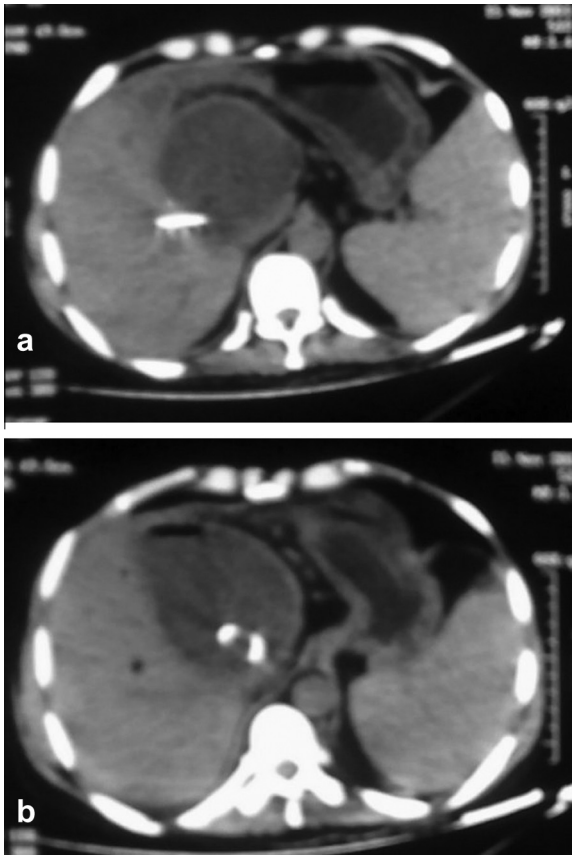

Fig. 4 Fifty year old male recipient 2 months post LDLT, complained of persistent abdominal pain and fever. (a & b) Axial CT image showing a large biloma. It was not accessible via anterior approach due to adjacent bowel. CT guided placement of 8 F Pig tail drainage catheter was performed via transhepatic approach.

3.4. IV-Abdominal complications

One case (3%) developed Non-Hodgkin lymphoma one-year post transplantation, the patient complained of abdominal pain, US was not conclusive, and MSCT was requested for further evaluation. Diffuse mural thickening of the small bowel loops was detected by MSCT (Fig. 9).

4. Discussion

Despite great technological and immunological advances in the field of liver transplantation, there are still significant complications (1,3–5).

In the post-transplant period, the goal of imaging is to identify vascular and biliary complications. The long-term follow-up also allows clinicians to identify recurrence of the primary disease and/or detect disease related to long-term immunosuppression (6).

In this study we presented our experience with the application MSCT in the follow-up examinations of liver transplant recipients.

The risk of vascular complications is relatively higher in LDLT compared to deceased donor liver transplantation

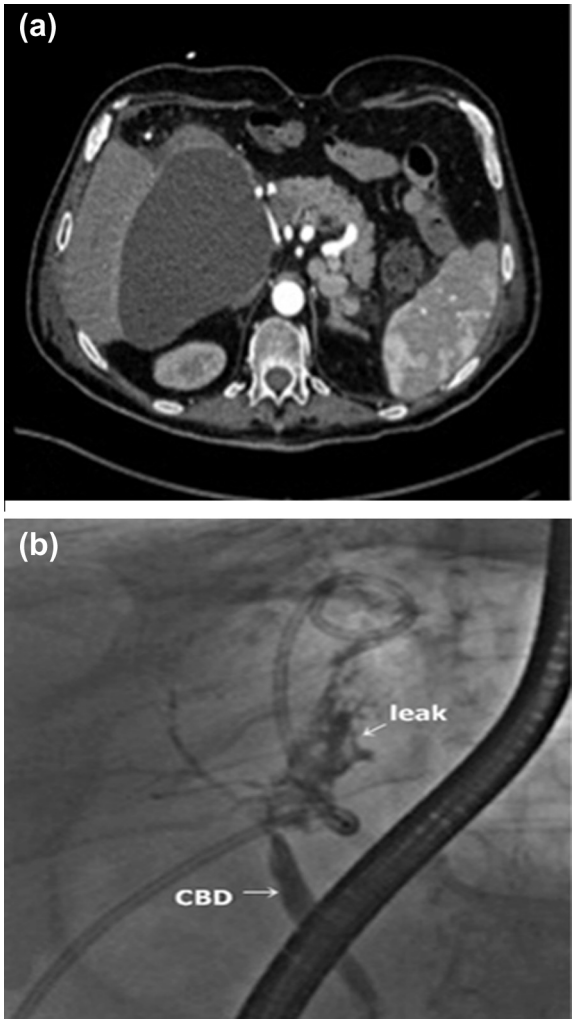

Fig. 5 Fifty-seven year old male recipient complaining of jaundice and elevated liver enzymes. (a) Axial CT image showing a large biloma at graft cut surface (b) ERCP image showing anastomotic leakage and minimally dilated intrahepatic bile ducts.

(DDLT) especially in pediatric recipients. Reported rates can be as high as 25%, 16% and 11% for HAT, PVT and HAS respectively, HVT is an unusual complication. These complications can lead to increased morbidity, graft loss and even death (7).

Even though Doppler Ultrasonography (DUS) accuracy depends on a technically experienced operator and the condition of the patient, it is the routine method in the clinical algorithm for the follow-up of vascular complications because it is portable, inexpensive, and noninvasive (8). Conventional angiography is the gold standard for diagnosing this problem, but it is not ideal for screening because of its high cost, invasive nature, associated risks, and potential complications (8). The excellent spatial resolution and fast scan times with multislice scanner allow CT angiography to depict small vessels. MIP and volume rendered images improve diagnostic accuracy (9).

In this study, vascular complications were detected in 16 cases (48.5%). MSCTA accurately detected the exact location and the extent of the stenotic or thrombotic segment of the HA, PV, and HV in all cases. The diagnostic accuracy, sensitivity, specificity of MSCTA for the detection of various vascular complications was 100% each. Earlier studies by Cheng et al., and Brancatelli et al. had shown the usefulness of MSCTA for the evaluation of vascular complications with reported sensitivity and specificity ranging between 87 and 90% (10,11).

Ulu et al. (9) investigated the accuracy of MSCTA for the detection of HA complications after liver transplantation. All patients with HA complications were correctly diagnosed by MSCTA apart from one patient with an overestimation of stenosis. False positive diagnosis of HAT had been reported for cases with splenic artery steal phenomenon in which MSCTA showed non opacified HA due to slow flow whereas DSA revealed a patent artery with splenic artery steal (12).

Diagnosis of the vascular complications is intensely important because early radiological or operative intervention may allow graft salvage. MSCTA is noninvasive modality to select patients who must be treated with angiographic intervention or surgery. In this study 6 cases with HAT, 1 case with HAS, 1 case of PVS and 2 cases with HVS were sent for conventional angiography for radiological intervention, the rest of cases were managed surgically.

Biliary complications occur more frequently after LDLT versus DDLT, and they remain the most common and intractable problems after LDLT (13,14). They included bile duct stricture, anastomotic stenosis, bile leak, biloma, biliary necrosis cholangitis and sludge formation (15). US and T-tube cholangiography are the imaging methods most often used to evaluate the biliary tree in the first months after liver transplantation. After removal of the biliary catheters, other imaging modalities may be used (16).

Bilomas contain bile leaks that may be caused by anastomotic dehiscence secondary to ischemia (8,17). Percutaneous catheter placement in the collection is sometimes needed, especially when it becomes infected (1,5,18). Six cases (18.2%) of fluid collection were detected in this study and diagnosed as bilomas. The main role of CT was to pinpoint the amount and location of the fluid collection, detect the extension and accessibility for drainage. CT guided catheter placement was done in all cases.

Our results displayed the inherent weakness of MSCT to identify and characterize biliary stricture. Biliary dilatation and suspected stricture was detected in 3 cases (9%), which needed further evaluation by MRCP examinations to confirm the diagnosis. Although MRCP did not provide a method of therapeutic intervention, it allowed accurate visualization of the surgically altered biliary anatomy, in addition it helped in planning further therapeutic option by PTD, ERCP or surgery. This was in agreement with Elrakhawy et al. and Bismpa et al. who reported that MSCT was less sensitive for assessment of post transplant biliary complications especially biliary stricture and recommended the use of MRCP as a modality of choice (19,20).

Rejection is the most common cause of graft failure, clinical, laboratory and radiological findings are non-specific (16). In this study rejection was suspected in two cases based on laboratory and US findings. MSCT showed heterogeneity of the liver parenchyma and central periportal collar sign. In addition it was used to rule out other complications that have similar clinical signs and symptoms to acute rejection. The definite diagnosis was achieved only after liver biopsy.

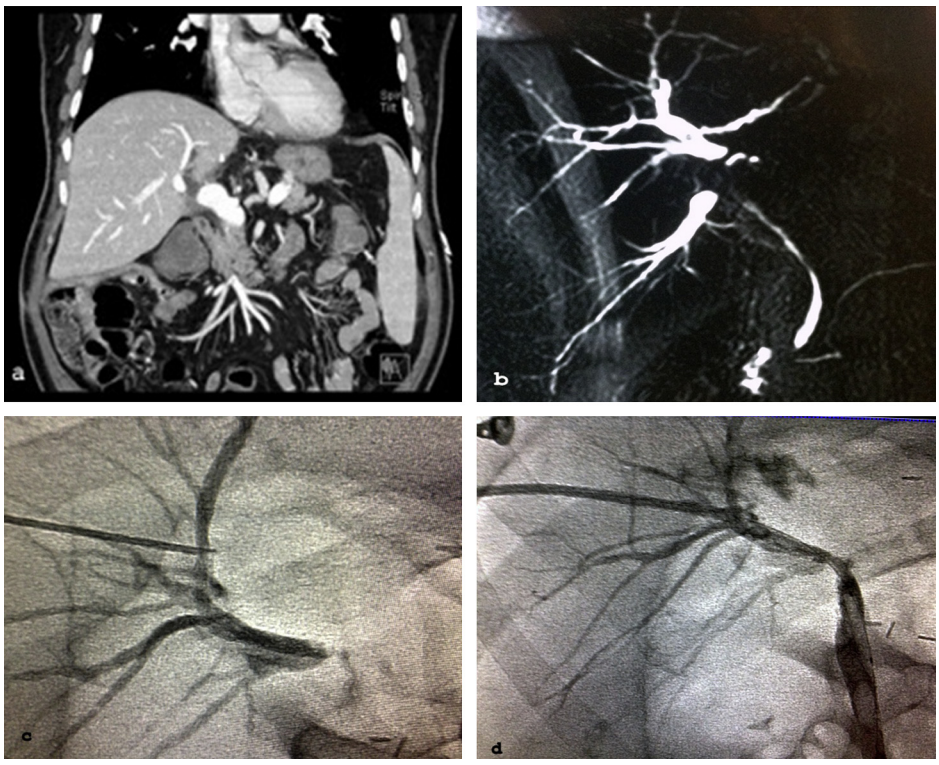

Fig. 6 Sixty-one year old male patient complaining of jaundice and elevated liver enzymes. US showed intra-hepatic biliary radicles dilatation. (a) Coronal CT image showing dilated anterior bile duct. (b) MRCP image showing anastomostic stricture at the confluence of the anterior and posterior hepatic ducts. (c & d) PTD was done after failure of ERCP to bypass the stricture, with ballon dilatation and stent placement.

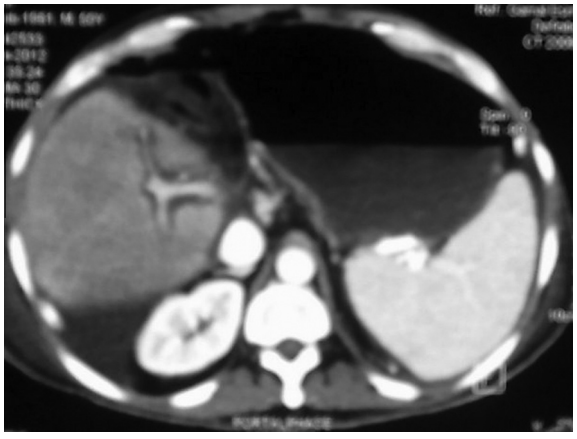

Fig. 7 Sixty-three year old male recipient 3 weeks post LDLT, with elevated liver enzymes. Axial CT image showing non uniform liver parenchyma and central periportal collar sign, which is a non specific finding seen in rejection, cholangitis and hepatic congestion. Rejection was confirmed by liver biopsy.

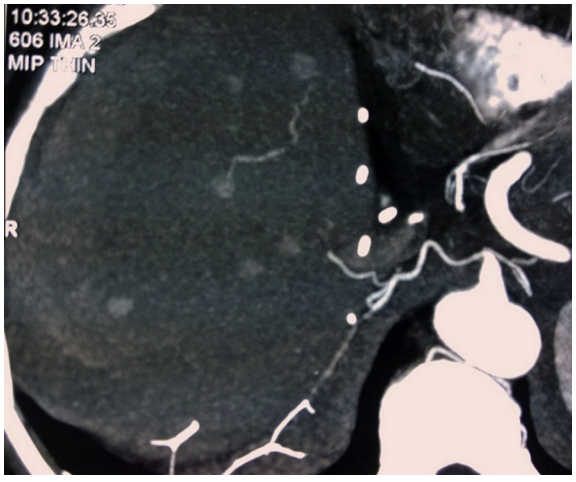

Fig. 8 Sixty-one year old male recipient 1 year after LDLT for liver cirrhosis and HCC. Axial CT image showing multiple enhancing recurrent HCC lesions.

Intrahepatic abscess is often secondary to liver infarction. Predisposing factors include biliary stricture, arterial insufficiency, and immunosuppressive medications (15). In this study we had 2 (6%) cases that developed hepatic abscesses. They were initially diagnosed by US study and were referred for further confirmation by MSCT. The presence of a complex fluid collection and air-fluid level confirmed the diagnosis of an abscess. They were treated by US guided catheter drainage.

Posttransplantation lymhoproliferative disorder affects 2–8.4% of adult recipients, is a consequence of prolonged immunosuppression (21). Lymphomatous involvement of the liver may be intra or extra hepatic. Other organs that may be

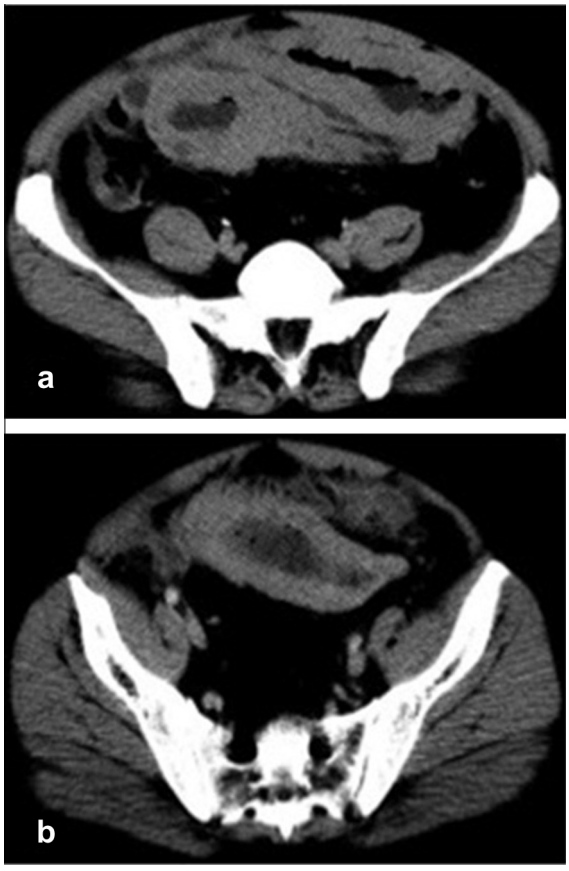

Fig. 9 Forty three year old male recipient one year post LDLT complained of repeated vomiting, fever and continuous abdominal pain. (a & b) Axial CT images of the pelvis showing diffuse mural thickening of the small bowel loops. Non-Hodgkin lymphoma was proved by biopsy and pathology.

involved include the lymph nodes, spleen, small intestine, stomach, kidneys, mesentery and adrenal glands (22). In this study one case had post-transplantation intestinal lymphoma. MSCT was valuable to detected bowel wall thickening and exclude the presence of associated nodal enlargement. The patient was treated with discontinuation of immunosuppressive therapy, in addition to chemotherapy and he died in the second year after transplantation.

Another complication following liver transplantation is tumor recurrence of HCC. The most common site or recurrence of HCC is the lung and the second most common site is the liver (23). In general, recurrence of hepatocellular carcinoma after liver transplantation is considered to result from undetected extrahepatic metastasis before surgery or the release of tumor cells during surgical manipulation (24,25).

In this study 3 out of 5 cases that had hepatocellular carcinoma on top of cirrhosis before transplantation developed hepatic recurrent HCC. Recurrence was detected early during the first year after transplantation. Treatment was palliative and the recurrence was managed with TACE, however the prognosis was bad as the patients died.

This was supported by the previous findings of Ecstrain et al., who stated that early recurrences of HCC during the first year after liver transplantation showed short survivals; with no treatment could be offered to these patients (25).

In conclusion MSCT is a non-invasive and accurate examination to detect complications after LDLT, it provides synchronous evaluation of the hepatic vasculature, biliary tract, liver parenchyma and the other abdominal organs in a single examination. MSCTA is the best option for confirming the US suspicion of vascular complications, with DSA reserved if therapeutic intervention is contemplated.

Conflict of interest

The authors have no conflict of interest to declare.

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