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Role of Duplex Ultrasonography in Correlation With CT Angiography In Assessment Of Vascular Complications In Recipients Post Liver Transplantation

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ABSTRACT

Background: Liver transplantation is currently accepted as a first line treatment for patients with end-stage acute or chronic liver diseases. Graft survival and overall patient survival have steadily improved since the first transplants were performed in the early 1960s, but a significant percentage of transplants develop complications related to vascular and biliary insufficiency. Graft ischemia after liver transplantation is associated with a high incidence of morbidity and mortality. **Aim of the Work:** to evaluate the sensitivity and specificity of Duplex ultrasound in detection most of vascular complication after liver transplantation in correlation with CTA. **Patients and Methods:** The study was done from Aug. 2017 until Aug. 2018, where 50-55 cases who underwent living donor liver transplantation with post-operative complications. The cases were done at Ain Shams University Hospital and other private hospitals. All cases where admitted to post-transplanting intensive care unit in the postoperative period where a routine full laboratory and radiological assessment were done. The laboratory assessment included full liver function tests, kidney function tests, complete blood picture, and C-Reactive Protein. Immunosuppressant level and bilirubin level in drains had also done. **Results:** The patient age ranges from 36 to 53 years with the mean age of 45 years. Most cases have cases had hepatitis C related cirrhosis (90%). One case had veno-occlusive disease related cirrhosis (Budd Chiari syndrome). About 95% of cases were suffering from end stage liver disease. The results we have reached are that Doppler U/S sensitivity in diagnosis of these complications is 83.8% and CTA sensitivity is about 100%. **Conclusion:** It could be concluded that colour duplex is the investigations of choice in postoperative liver transplantation. They can be used as routine steps in the assessment of liver transplant graft postoperatively in recipient patient as early as possible within the first 3 days after operation and used as a late follow up, as they are noninvasive, safe, cheap, and accurate. Routine use of gray-scale US and color duplex showed to minimize the impact of postoperative complications and maximize both graft and recipient patient survival and if any complications suspected, it can be confirmed by CTA

Keywords: Duplex Study, CTA, Recipient Patient, Post Liver Transplantation

INTRODUCTION

Liver transplantation is currently accepted as a first line treatment for patients with end-stage acute or chronic liver diseases **(1).**

Graft survival and overall patient survival have steadily improved since the first transplants were performed in the early 1960s, but a significant percentage of transplants develop complications related to vascular and biliary insufficiency. Graft ischemia after liver transplantation is associated with a high incidence of morbidity and mortality **(2).**

Biliary and vascular complications and rejection of the transplanted liver are the main causes of malfunction and loss of the hepatic graft. Advances in medical therapy over the last few years have led to a more efficient diagnosis and treatment of postoperative complications after orthotopic liver transplantation, thereby increasing the survival rate after liver transplantation **(3).**

Vascular complications include; hepatic artery stenosis and thrombosis, portal vein stenosis and thrombosis, caval and hepatic veins obstruction, arterial pseudo aneurysm. Biliary complications include; biliary leakage, stricture and obstruction **(4).**

A multimodality approach including ultrasonography and cross-sectional imaging studies often is most effective for diagnosis. Each imaging modality has specific strengths and weaknesses, and the diagnostic usefulness of a modality depends mainly on the patient's characteristics, the clinical purpose of the imaging evaluation, and the expertise of imaging professionals **(1).**

Ultrasound is the initial imaging modality of choice for detection and follow-up of early and delayed complications from all types of liver transplantation. Knowledge of the surgical technique of liver transplantation permits early detection of complications and prevents misdiagnosis **(5).**

Duplex US is used to evaluate vessel patancy, and are frequently used to distinguish dilated bile ducts and blood vessels and also can evaluate the extrahepatic portal venous system **(6).**

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CTA is used in correlation with duplex to confirm any vascular complication (Ref No.).

The aim of this study is to evaluate the sensitivity and specificity of Duplex ultrasound in detection most of vascular complication after liver transplantation in correlation with CTA.

PATIENTS AND METHODS

This prospective study included a total of 50-55 cases with post-operative liver transplantation complications, attending at Ain Shams University Hospital and other private hospitals. Approval of the Ethical Committee and written informed consent from all the subjects were obtained. This study was conducted between Aug 2017 and Aug 2018.

All cases where admitted to post transplanting intensive care unit in the postoperative period where a routine full laboratory and radiological assessment were done. The laboratory assessment included full liver function tests, kidney function tests, complete blood picture, and C-Reactive Protein. Immunosuppressant level and bilirubin level in drains had also done.

The routine radiological assessment was ultrasound and duplex assessment of the patient as well as chest X-ray; both were done on daily basis. CT angiography is ordered in the following cases:

Inclusion criteria: Portal vein thrombosis in the ultrasound study. Increased resistive index of hepatic artery. Signs of portal hypertension. Evidence of IVC or hepatic vein thrombosis. Clinical signs of graft failures or rejection (fever, elevated TLC, etc.).

Ultrasound and duplex assessment:

The ultrasound and duplex assessment were done by GE LOGIC P5 – PHILIPS CLEAR VUE 850 machines using the curved 3.5-5 MHz probe with color and spectral facilities. The liver is first assessed for size and abnormal echogenicity such as area of infarctions or congestions. Assessment of the presence of dilated biliary system was done to exclude biliary strictures, also assessment for any collections and biloma were done and any collection mentioned by site and estimated volume.

Technique of Triphasic CT and CT angiography:

Cases for abnormal ultrasound Doppler finding or abnormal clinical and laboratory findings were examined by CT either. CT scans were done with a dual 64 channel multi-detector row CT scanner (GE 660 – 64 SLICES).

Image processing and reconstruction:

All phases of the study were assessed using maximum intensity projections with volume rendering techniques with zooming on areas of abnormal findings.

The statistical methodology:

The collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 18.0, IBM Corp., Chicago, USA, 2009.

Descriptive statistics were done for quantitative data as minimum& maximum of the range as well as mean ± SD (standard deviation) for quantitative normally distributed data, while it was done for qualitative data as number and percentage.

Inferential analyses were done for qualitative data using Kappa test for agreement between paired categorical data. The level of significance was taken at P value < 0.050 is significant, otherwise is non-significant.

Diagnostic characteristics were calculated as follows: Sensitivity = (True positive test / Total positive golden) x 100. Specificity = (True negative test / Total negative golden) x 100. Predictive positive value = (True positive test / Total positive test) x 100. Predictive negative value = (True negative test / Total negative test) x 100 Diagnostic accuracy = ([True positive test + True negative test] / Total cases) x 100. Youden's index = sensitivity + specificity – 1

RESULTS

Table (1): The incidence of each complication.

Complication	Number of cases
Portal vein thrombosis	8
Portal vein narrowing	8
Hepatic artery stenosis	19
Hepatic artery thrombosis	8
hepatic vein thrombosis	3
IVC thrombosis	6
Total	52

Table (2): Diagnostic characteristics of US in diagnosis of hepatic artery thrombosis (CT is golden).

Characters	Value	95% CI
Sensitivity	87.5%	47.3%–99.7%
Specificity	97.6%	87.4%–99.9%
Diagnostic accuracy (DA)	96.0%	86.3%–99.5%
Youden's index	85.1%	61.7%–100.0%
Positive Predictive value (PPV)	87.5%	47.3%–99.7%
Negative Predictive value (NPV)	97.6%	87.4%–99.9%

Table (2) shows that: US had moderate diagnostic characteristics in diagnosis of hepatic artery thrombosis.

Table (3): Diagnostic characteristics of US in diagnosis of hepatic vein thrombosis (CT is golden).

Characters	Value	95% CI
Sensitivity	100.0%	29.2%–100.0%
Specificity	100.0%	92.5%–100.0%
Diagnostic accuracy (DA)	100.0%	92.9%–100.0%
Youden's index	100.0%	100.0%–100.0%
Positive Predictive value (PPV)	100.0%	29.2%–100.0%
Negative Predictive value (NPV)	100.0%	92.5%–100.0%

Table (3) show that US had perfect diagnostic characteristics in diagnosis of hepatic vein thrombosis.

Table (4): Diagnostic characteristics of US in diagnosis of hepatic vein stenosis (CT is golden).

Characters	Value	95% CI
Sensitivity	75.0%	19.4%–99.4%
Specificity	100.0%	92.3%–100.0%
Diagnostic accuracy (DA)	98.0%	89.4%–99.9%
Youden's index	75.0%	32.6%–100.0%
Positive Predictive value (PPV)	100.0%	29.2%–100.0%
Negative Predictive value (NPV)	97.9%	88.7%–99.9%

Table (4) show that US had moderate diagnostic characteristics in diagnosis of hepatic vein stenosis

Table (5): Diagnostic characteristics of US in diagnosis of portal vein thrombosis (CT is golden).

Characters	Value	95% CI
Sensitivity	70.0%	34.8%–93.3%
Specificity	97.5%	86.8%–99.9%
Diagnostic accuracy (DA)	92.0%	80.8%–97.8%
Youden's index	67.5%	38.7%–96.3%
Positive Predictive value (PPV)	87.5%	47.3%–99.7%
Negative Predictive value (NPV)	92.9%	80.5%–98.5%

Table (5) show that US had low diagnostic characteristics in diagnosis of portal vein thrombosis

Table (6): Diagnostic characteristics of US in diagnosis of portal vein stenosis (CT is golden).

Characters	Value	95% CI
Sensitivity	77.8%	40.0%–97.2%
Specificity	97.6%	87.1%–99.9%
Diagnostic accuracy (DA)	94.0%	83.5%–98.7%
Youden's index	75.3%	47.8%–100.0%
Positive Predictive value (PPV)	87.5%	47.3%–99.7%
Negative Predictive value (NPV)	95.2%	83.8%–99.4%

Table (6)show that US had low diagnostic characteristics in diagnosis of portal vein stenosis

Table (7): Diagnostic characteristics of US in diagnosis of inferior vena cava thrombosis (CT is golden).

Characters	Value	95% CI
Sensitivity	83.3%	35.9%–99.6%
Specificity	97.7%	88.0%–99.9%
Diagnostic accuracy (DA)	96.0%	86.3%–99.5%
Youden's index	81.1%	50.9%–100.0%
Positive Predictive value (PPV)	83.3%	35.9%–99.6%
Negative Predictive value (NPV)	97.7%	88.0%–99.9%

Table (7) show that US had moderate diagnostic characteristics in diagnosis of inferior vena cava thrombosis

From the above numbers we can conclude that Duplex US sensitivity in detecting vascular complications in post liver transplantation patients is 83.8 % and the CTA sensitivity is 100% with highly positive predictive value and positive like-hood ratio which mean that positive findings in duplex study is usually indicative of the presence of complication while the negative findings in duplex study doesn't always mean the absence of complications.

DISCUSSION

Liver transplantation is lifesaving treatment for patient with liver cell failure. Improvement of preoperative selection, surgical techniques, immunosuppressive therapy, postoperative care and follow up has resulted in increased patient graft survival after the transplantation [(7)].

Ultrasound is the primary imaging modality in the detection and follow-up of early and delayed complications of LT. First, it can be easily performed at the bedside in the intensive care unit during the early post-transplantation phase; it is accessible and non-invasive; and it avoids the use of ionizing radiation. If performed by expert operators, the results are highly reliable. Ultrasound examination requires greyscale and Doppler evaluation for the assessment of the liver parenchyma, biliary tree and vessels. On greyscale evaluation, the normal LT has a homogeneous echogenicity.Pulsed and colour Doppler examination is performed complementarily to evaluate vessel patency and flow spectra.

CT is a second-line imaging technique that is generally used to confirm or exclude clinical suspicious and/or ultrasound findings. The introduction to clinical practice of multidetector CT (MDCT) has allowed for the acquisition of the whole volume of the abdomen, pelvis and possibly also the thorax in a few seconds with high spatial and temporal resolution, thus enabling the incorporation of both angiographic and parenchymal studies into a single acquisition.

Despite the improvement in the liver transplantation surgical techniques and post-operative management, there are still significant

and life threatening complications that can lead to graft failure and increased patient morbidity and mortality. Imaging is very important in early diagnosis and management of these complications [(9)].

The importance of stenosis or thrombosis of the hepatic artery is based on the fact that the intrahepatic biliary epithelium is perfused solely by the hepatic artery. Reduced hepatic artery flow can lead to graft ischemia, affecting at first the bile ducts, and eventually graft failure. We analyzed our study group on the basis of derived thresholds of RI less than 0.5 and SAT greater than 0.08 s for identification of marked HAS or HAT. Requiring both RI and SAT to be abnormal to predict HAS or HAT, Doppler US resulted in a diagnostic sensitivity and a specificity of 87.5-100% and 96.9-97.6%, respectively and considering the CT is the gold standard it has a sensitivity of 47.3%–99.7% for HAS and has a sensitivity of 81.5%–100.0%in detecting HAT.

Our results are superior to ***Dodd et al.*** [(2)] who reported a 73% sensitivity and specificity for the detection of marked hepatic arterial disease by using the same parameters. In another study that was consisted of 46 patients**,** ***Platt et al.*** [(15)]reported a sensitivity of 67% and a specificity of 96% for Doppler US in detecting HAS by using similar parameters and a sensitivity of 100% for CTA.

Thrombosis and/or stenosis of the portal vein and hepatic veins are reported to occur in 1–12.5% of liver recipients.We observed portal vein complications in 12-18%, and hepatic vein complications in 3% of liver transplantations. For portal vein stenosis, we prospectively analyzed our study group on the basis of Doppler US criteria those previously reported by ***Dodd et al.*** [(2)]. Our suggested thresholds for marked portal vein stenosis are consisted of a visualized portal vein diameter of 2.5 mm or less detected on sonography, and an accelerated flow at the stricture or a poststenotic jet at least five times of the recordings in the proximal portal vein revealed by spectral Doppler US imaging. We diagnosed five instances of marked portal vein stenosis including both of the diagnostic parameters described above and confirmed by portal CT venography. Combined use of sonography, spectral Doppler US parameters and CT venography resulted in a diagnostic sensitivity and specificity of 100% for marked portal vein stenosis/thrombosis. Our data reported 70-77.8% and 97.6% sensitivity and specificity respectively for doppler US and 93% and 97% sensitivity and specificity for CT.

Hepatic vein stenosis has emerged as one of the important vascular complications of living donor liver transplantation. In our study, the incidence of hepatic vein stenosis occurred in 6% of living donor liver recipients. In our study, all of the three cases of proven hepatic vein stenosis showed a persistent monophasic wave pattern on Doppler US examinations.

We concluded that duplex study has a sensitivity of 83.3% in detecting IVC thrombosis.and considering the CT is the gold standard it has a sensitivity of 35.9%–99.6%in detecting IVC thrombosis**.**

We recognize that our study has some limitations and biases. Limitations of our study mainly related to the prospective nature of the study, low incidence of occurrence of some vascular complications like pseudoaneurysm and splenic artery syndrome as well as low sample volume.

CONCLUSION

Duplex US are the investigations of choice in postoperative liver transplantation, they can be used as a routine steps in the assessment of liver transplant graft postoperatively in recipient patient as early as possible within the first 3 days after operation and used as a late follow up, as they are noninvasive, safe, cheap, and accurate. Routine use of gray-scale US and color Doppler showed to minimize the impact of postoperative complications and maximize both graft and recipient patient survival.

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