Introduction

Liver transplantation is now widely accepted as an effective therapeutic modality for a variety of irreversible acute and chronic liver diseases for wich there was formerly no other effective therapy. The first orthotopic liver transplantation was performed by Thomas Starzl in Denver in 1963. Long-term patient survival after liver transplantation was first reported also by Starzl in 1968. With advances in perioperative techniques, immunsupressive agents, postoperative care, and the greater understanding of the prognosis of many liver diseases, the results of liver transplantation have improved, with 1- and 5-year patient survival rates of approximately 70%-90% and 50%-70%. However, since the number of transplantation candidates exceeds the number of cadaveric organs available for transplantation, new techniques, such as split liver and living related donation have been developed.Viral hepatitis and alcoholic related liver diseases are the most commonest causes of end-stage liver disease worldwide

The organised liver transplantation programme of Hungary began in Semmelweis University, Transplantation and Surgical Clinic in 1995. It was a big challange not only for the clinicians but for the radiologist, as well.

A variety of radiological imaging modality are available fo the preoperative evaluation of the transplant candidate, and for the detection of early and late complications during follow-up.These include ultrasound, CT, MRI, and interventional procedures. New ultrasound, CT, and MRI techniques and the advent of new contrast agents have changed the diagnostic approach to the liver, helping to replace invasive diagnostic tools such as angiograpy.

3D CT angiography , as a non-invasive diagnostic modality,has emerged recently as a potencially useful diagnostic modality for evaluation in a number of abdominal vascular applications.This technique is more convenient and more tolerable examination for the patients, allows a reduction exposure to the patients and staff without making compromises in image quality or diagnostic accurancy, and saving in cost.

Purpose

I. Preoperative examinations

To assess the utility of 3D CT angiography as a replacement for invasive angiography in the evaluation of patients being considered for liver translantation.

Is 3D CT angiography as accurate as angiography in the assessment of hepatic arterial anatomy?

To compare the homogenicity of the basic types of hepatic arterial blood supply determined by 323 recipients examinations and the types found by Michels dissections of 200 cadavers.
How can we identify celiac stenosis, splenic artery aneurysms and lienalis steel syndrome?
To compare the utility of 3D CT angiography and colour Doppler ultrasound in the assess of portal vein system.

II. Postoperative examinations

Which were the indications of 3D CT angiography examinations?
To compare the results of 3D CT angiography and resistve index value calculated by colour Doppler ultrasound examinations.
What was the results of 3D CT angiography , when we did not found any arterial circulation in the liver?
To compare the results of 3D CT angiography and vascular complications found by colour Doppler ultrasound examination.
What was he indications, when the results of 3D CT angiography were negative?
What is the role of 3D CT angiography in the evaluation in patients after liver transplantation?

Patients and Method

I. Preoperaive examinations

3D CT angiography was performed on 352 (182 males, 170 females) liver transplantation candidates ranging in age 7 to 62 years.
The maging technique was the same in all patients. Oral contrast medium was not given to the patients. An 18-or 20-gauge intravenous line was inserted into antecubital vein through wich th bolus of contrast material was safely injected. When an antecubital vein was not accessible, a more periferialvenous was used. This technique should be performed extremely carefully to avoid extravasation from a small and fragile peripherial vein.Central venous access was available in some patients after liver transplantation. Because of the rapid administration of contrast material, care must be taken to adapt the rate of injection to the site of administration. The patency of the intravenous line was carefully checked with 10 mL hand-injected normal saline. A test bolus of contrast media was given (15mL, 5mL/sec) by power injector to determine the optimal timing for arterial enhancement. Fifteen 1 sec scans were obtained at the level of the Th11-12 interspace wih a 1 sec interscan delay, after a 2 to 8 sc delay from the

beginning of cntast media infusion. To find the peak aortic enhancement and optimal delay afterwards, 70-150 mL of inravenous contrast material was given at a rate of 4 to 5mL/sec.The delay was between 2-22 sec, determined by the test bolus. Two helical scan sets were obtained (ProSpeed Plus, GEMS), the first with a 3 mm collimation from the lower pole of the liver to the dome of the liver. The second scan set was performed with 5 mm collimation in the cephalocaudal direction to the lower pole of the liver, with pitch 1,7 in both aquisition. Axial images were reconstruted in every 1 mm. Data sets were transferred to a workstation (Adwantage Windows, GEMS), and 3D CT angiograms were obtained by using several techniques.

The recipient hepatic arterial anatomy was categorised by Michels classifications.

Angiography was performed also in 33 liver transplant candidates, and 147 of 352 patients underwent liver transplantation.

II. Postoperatíve examinations

87 three-dimensional CT angiography were performed on 65 (36 males, 29 females) patients after liver transplantation ranging in age from 6 to 55 years.

The imaging technique was the same, as in the recipients.

Results

I. preoperative examinations

323 (91,1%) of 352 examinations were diagnostic and successful. In 29 cases (8,9%) the examinations had technical failure.There was no marked differences between the two techniques used in 33 paients, who underwent angiography and 3D CT angiography, as well.

Surgical findings correlated with 3D CT angiograms in 143 from the 147 transplanted cases. In 3 cases, three small accessory arteries were found, wich were not important in terms of the major arteries supplying the liver.

There was a significant difference in the homogenicity the basic types of hepatic arterial blood supply determined by 323 recipients examinations and the types were found by Michels dissections of 200 cadavers.

In 31 patients (9,6%) we found lienalis steel syndrome.

Celiac stenosis was found in 14 recipients (4,3%), in 21 (5,9%) patients splenic artery aneurysm and in 39 candidates (16%) thrombosis of the portal vein system was detected.

II. Postoperative examinations

76 (87,4%) of 87 examinations were diagnostic and successful.

1. Indications of CT angiography

All indications was suggested by colour Doppler ultrasound examinations

Arterial complications: 61 cases (70,2%)

Venous complications: 8 cases (9,2%)

Other (without vascular complications): 18 cases (20,6%)

2. Results of 3D CT angiography: 76 (87,4%) were successful

Hepatic artery (common) thrombosis: 10 cases (13,18%)

Right hepatic artery thrombosis: 2 cases (2,63%)

Left hepatic artery thrombosis: 1 case (1,31%)

Hepatic artry stenosis: 21 cases (27,61%)

Lienalis steel syndrome: 6 cases (7,89%)

Kinking of the hepatic artery. 5 cases (6,58%)

Caliber discrepancy in the anastomosis of hepatic artery: 2 cases(2,63%)

Arterial blood supply by collateral vessels: 1 case (1,31%)

Splenic artery and celiac artery aneurym: 1 case (1,31%)

Portal vein thrombosis: 3 cases (3,94%)

Portal vein partial thrombosis: 1 case (1,31%)

Portal vein stenosis: 2 cases (2,6%)

Portal vein 7.segment thrombosis: 1 case (1,31%)

Thrombus in the inferior vena cava: 3 cases (3,93%)

Stenosis of the inferior vena cava: 1 case (1,31%)

Thrombosis of the middle and left hepatic vein:1 case (1,31%)

Thrombosisof the right hepatic vein: 1 case (1,31%)

Dilated bile ducts without vascular complication: 1 case (1,31%)

Negative results: 13 cases (17,10%)

Uncuccessful examination: 11 cases (12,64%)

3.CT-angiography results, when RI decreased

28 patients, 36 examinations, 32 successful examinations

Hepatic artery stenosis:18 cases (56,25%)

Kinking of the hepatic artery: 4 cases (12,5%)

Lienalis steel syndrome: 3 cases (9,37%)

Caliber discrepancy in the anastomosis of hepatic artery: 2 cases (6,25%)
Right hepatic artery thrombosis: 1 case (3.12%)
No arterial complication: 4 cases (12,5%), but 1 portal vein thrombosis, and 1 segmental portal vein thrombosis

4.CT-angiography results, when RI normal
21 patients, 21 successful examinations
Negative results: 13 cases (61,9%)
Questinable hepatic artery stenosis: 1 case (4,76%)
Kinking of the hepatic artery: 1 case (4,76%)
Thrombus in the inferior vena cava: 2 cases (9,52%)
Stenosis of the inferior vena cava: 1 case (4,76%)
Stenosis of the portal vein: 1 case (4,76%)
Thrombosis of the middle and left hepatic vein:1 case (4,76%)
Partial thrombosis of the portal vein: 1 case (4,76%)

5. CT-angiography results: US found venous complications: 8 examinations:
Portal vein thrombosis: 3 cases (37,5%)
Stenosis of portal vein:1 case (12,5%)
Portal vein 7.segment thrombosis: 1 case (12,5%)
Thrombus in the inferior vena cava: 1 case (12,5%)
Stenosis of the inferior vena cava: 1 case (12,5%9
Thrombosis of the middle and left hepatic vein: 1 case (12,5%)

6. US indications, when CT-angiography was negative
13 patients, 13 szccessful examinations
No arterial circulation: 4 cases (30,77%)
Inhomogenous liver parenchyma, RI normal : 3 cases (23,8%)
Suspected hepatic mass, RI normal: 1 case (7,69%)
Dilated bile ducts, RI normal: 2 cases (15,39%)
Abnormal laboratory data, RI normal: 1 case (7,69%)
Decreased RI: 1 case (7,69%)
Abormal corpulancy: 1 case (7,69%)

7. CT-angiography results: US found no arterial circulation

16 patients, 21 examinations, 19 successul examinations

Common hepatic artery thrombosis: 10 cases (47,62%)

Left hepatic artery thrombosis: 1 case (4,76%)

Right hepatic artery thrombosis: 1 case (4,76%)

Lienalis steel syndrome: 3 cases (14,29%)

Thrombosis of right hepatic vein: 1 case (4,76%)

Negative results: 3 cases (14,29%)

Summary

The 3D CT-angiography is an accurate and reliable method for assessing the recipients hepatic arterial anatomy, celiac stenosis, splenic artery anurysms, portal vein and the degree of portal hypertension.

A statistically sigificant difference was noted between the basic types of hepatic arterial blood supply determined by 323 resipients examinations and the types found by Michels dissection of 200 cadavers.

Technically successful 3D CT-angiography, as a non-invasive imaging modality can replace invasive digital angiography in patients being considered for liver transplantation.

The indications of 3D CT-angiography in liver transplanted patients always based on a colour Doppler ultrasound examination.

The diagnosis of the arterial complications was more accurate by 3D CT-angiography.

In the diagnosis of venous complications colour Doppler ultrasound was as accurate as 3D CT-angiography.

In patients with decreased RI values, the 87,5% of 3D CT-angiography was positive for arterial vascular complications.

In patients with normal RI values, the 61,9 % of 3D CT-angiography was normal.

3D CT-angiogram can be viewed from several projection having greater diagnostic possibilities in planning of interventional procedures.

3D CT-angiography is the next diagnostic modality in the detection of vascular complications in patients after liver transplantation following colour Doppler US examination.

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