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Role of CT Portography in Detection of Portosystemic Collaterals in Patients with Portal Hypertension

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Abstract

Background: CT and CT portography become the tools of investigation of the liver and the portosystemic varices by drawing their course to avoid bleeding which could be life-threatening, and in major operations such as liver transplantation.

Aim of the Work: to draw portosystemic collaterals associated with portal hypertension by CT Portography imaging.

Patients and Methods: In this study, we have assessed 20 cases in 6 months at the Ain Shams university hospitals, where they subjected to full history sheeting, full clinical examination, MDCT portography and to the upper GI endoscopy.

Results: There is significant correlation between portal vein diameter and sites of collaterals, as the sites of collaterals increase when the diameter of the portal vein decreases. Regarding the CT findings and their comparison with the upper GI endoscopy findings was found that all the cases that were positive for gastro-esophageal collaterals in CT were also positive for gastro-esophageal collaterals in the upper GI endoscopy, which is meaning that the CT is very good excluded modality with 100% sensitivity. While the CT was upgrading for 2 cases from 20 cases in gastric varices (10%), 3 cases from 20 cases(15%) in esophageal varices, which is meaning that CT has 89 %, 82 % specificity in grading the gastric and esophageal collaterals respectively.

Conclusion: MDCT portography is an important imaging modality in the assessment of the portal vein, the resulting portosystemic collaterals. It is very good screening modality for any suspected varices as it has 100 % sensitivity.

Keywords: CT Portography, portosystemic collaterals, portal hypertension

Introduction

In portal hypertension, the hepatoportal blood flow is directed away from the liver through collateral pathways to low pressure systemic vessels. Among them, there are the esophageal varices, which are the most important clinically because they are frequent source of gastrointestinal bleeding. Information about other collateral pathways is considered relevant, especially if interventional procedures or surgery is contemplated because the probable disruption of these veins can cause significant bleeding [(1)].

Hepatic venous pressure gradient (HVPG) is currently considered as the "gold standard although, it is restricted technique because it is difficult and invasive while direct measurement of portal pressure (PP) is rarely performed due to significant invasiveness and potential complications [(2)].

Diagnostic angiographic procedures include both direct and indirect portography, indirect portography involves arterial injections into the superior mesenteric artery (SMA) or splenic artery and requires a prolonged arterial infusion of contrast material (CM) followed by delayed imaging. These techniques are also invasive and limited by flow dynamics [(3)].

Patients with cirrhosis should undergo screening for esophageal varices using upper gastrointestinal endoscopy because the bleeding from these varices is very life-threatening [(4)].

Up to 30% of patients screened by endoscopy found to have moderate to large varices (> or =5 mm diameter) which are at high risk of bleeding [(5)].

Many years ago angiography was considered the standard for the detection of varices. but with the possibilities and availability of cross-sectional imaging techniques, collateral vessels could be now well demonstrated in all parts of the abdomen and thorax without any risk of invasiveness [(1)].

Noninvasive techniques include the color Doppler ultrasound (US), which depicts the portal vein and provides good information

about the velocity and the flow direction, but it is operator dependent, while in patients with potential portosystemic shunt you need a procedure, that covers the whole portal venous system [(6)].

CT and CT angiography has become powerful procedures for examination of the liver. The addition of a portal-phase acquisition with 3D vascular reconstruction can augment the surgeon's perception of potentially problematic varices by detailing the course of these tortuous vessels. This is extremely important for many surgeries to avoid any possible disaster [(7)].

Aim of the Work

The purpose of our study is to deled portosystemic collaterals associated with portal hypertension by CT Portography imaging.

Patients and Methods

Our study includes assessment of 20 cases in 6 months, patients are referred to the internal medicine department at the Ain Shams university hospital, where they examined, thin referred to the radiology department, where they investigated.

The study included patients with evidence of portal hypertension (clinical and previous imaging) and evidence of liver cirrhosis.

- Patients with impaired renal function, pregnant patients, contrast hypersensitivity, vitally unstable and hepatic encephalopathy were excluded from the study.

The patients were subjected to the following: Full history sheet, full clinical and laboratory examination, CT portography and upper GI endoscopy, the history sheet included name, age, sex, history of viral hepatitis, past history of hematemesis or melena. The laboratory examination includes Liver enzymes (SGOT, SGPT), hepatitis markers (HBsAg, HCV Abs), renal function tests (creatinine level).

The technique of our CT examination

CT machine that is used:

- Toshiba –Aquillion, helical CT scanner 64 detectors in Ain shams university hospital. Patients were instructed to food fasting for 6 hours before the examination to avoid vomiting when the CM injected. Revision of all patients' personal and laboratory data was conducted to be sure that they are within normal range. Patients were informed about the CT scan and how to hold breath during the examination when it requested. Patients lied in the supine position on the CT table with head first and arms in resting position.
- A wide bore cannula is placed in the antecubital vein and to ensure the good function of the cannula 10 mm saline is injected first. The scout is determined in the coronal view and the scan is planed from the bifurcation of trachea to the symphysis pubis pre and post-contrast. The scan then proceeds with beam collimation 4×1 mm; table feed 5 mm per rotation (pitch 1.25); and rotation time 0.5 sec. Image reconstruction was performed with a slice thickness of 1.25 mm at an interval of 0.6 mm. with 120 kV,240-280 mA. 100-120 ml of the CM is injected at a rate of 4-5 ml/sec by a power injector and the scan proceeded in the following stations. Arterial phase: at 18-20 sec from injection, helical scanning is started from tracheal bifurcation to the symphysis pubis in craniocaudal direction with (1.25 collimation, 0.6 pitch, 120 kV, 240 -280 mA). Portal phase: 60 sec from injection (2.5 collimation, 0.6 pitch, 120 kV, 240 -280 mA), but the scan is done in the reverse direction. Delayed phase: at 200 sec from injection through the entire liver with (2.5 collimation, 0.6 pitch, 120 kV, 240 -280 mA).

Image processing:

All data were acquired and then analyzed with a standard algorithm, post-processed and reconstructed at the workstation that allows the generation of 3D images. The MIP was used for the 3D reconstruction images that are good in detection of the details of the veins. The images were reconstructed with 1.5 collimation.7 position increments.

Image interpretation:

All images were analyzed for Portal vein diameter and patency, CT evidence for portal hypertension as ascites or splenomegaly, complete analysis of the collaterals that were present, detection of all types of these collaterals, any hepatic focal lesions, and HCC.

Image display:

All images were sent to a work station that allows interactive analysis and also was copied on hard copies.

Statistical analysis:
Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 24. Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test. For comparing categorical data, Chi-square ***(χ2)*** test was performed. The exact test was used instead when the expected frequency is less than 5. Standard diagnostic indices including sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated. A P-value of less than 0.05 was considered as statistically significant.

Results

		Count (20 Pts)	**%**
PV dilatation	Yes	**9**	**45.0%**
	No	**11**	**55.0%**
PV thrombosis	Yes	**5**	**25.0%**
	No	**15**	**75.0%**

Table (1): Descriptive table showing the distribution of the studied patients regarding their PV patency and diameter.

	PV dilatation										
	Yes					**No**					**P-value**
	Mean	**SD**	**Median**	**Minimum**	**Maximum**	**Mean**	**SD**	**Median**	**Minimum**	**Maximum**	
Sites of collateral by CT	4.00	.87	4.00	3.00	5.00	6.00	1.05	6.00	4.00	8.00	.0009

Table (2): Correlation between PV diameter and sites of portosystemic collaterals in the studied patients**.**

There is a significant correlation between the PV diameter & sites of collaterals as P < 0.001. The increase in collateral sites is associated with decrease in PV diameter.

Findings	**Patients (20)**	
	Number	**%**
Cirrhosis	17	85%
HFL	2	10%
HCC	1	5%
Splenomegaly	14	70%
Ascites	18	90%
PV thrombosis	5	25%

Table (3): Distribution of all studied patients regarding other portal hypertension radiological criteria and common associations**.**

Type of detected collaterals	Frequency (n=20 Patients)	
	Number	**%**
Perisplenic	14	70%
Periumbilical	11	55%
Splenorenal	9	45%
Esophageal	8	40%
Anterior abdominal wall	8	40%
Perigastric	7	35%
Portahepatic	5	25%
Rectal	1	5%

Table (4) Distribution of the studied patients regarding frequency of the detected portosystemic collaterals.

	Portal vein dilatation	**Portal vein thrombosis**
Percentage of cases of collaterals	**80 %**	**20 %**
Frequent site of collaterals	**Perisplenic**	**Portahepatic**

Table (5): Distribution of the collaterals regarding the portal vein patency**.**

According to the above table, 4 cases from the 5 cases of portal vein thrombosis had also portosystemic collaterals with a percentage 80% and the main site for these collaterals was the porta hepatis.

	Count (20Pts)	**%**
I	13	65%
II	1	5%
III	3	15%
IV	3	15%

Table (6): Grading of the studied patients who have esophageal varices by CT**. Table (6):** Grading of the studied patients who have esophageal varices by CT**.**

	Count (20Pts)	**%**
I (Negative for varices)	13	65%
II	4	20%
III	1	5%
IV	2	10%

Table (7): Grading of the studied patients who have esophageal varices by endoscopy**.**

	Count (20Pts)	**%**
I	15	75%
II	1	5%
III	3	15%
IV	1	5%

Table (8): Grading of the studied patients who have gastric varices by CT.

	Count (20Pts)	**%**
I (Negative for varices)	15	75%
II	3	15%
III	1	5%
IV	1	5%

Table (9): Grading of the studied patients who have gastric varices by endoscopy.

The detected varices by CT could be graded according to Yu et al. (8) as:

with a 4-point confidence scale for the development of variceal bleeding according to their maximum diameter (scores 1–4): **(1)** definitely low or no -risk or no varices; **(2)** probably low-risk (1-2 mm in maximum diameter); **(3)** probably high-risk(2-3mm in maximum diameter); and **(4)** definitely high-risk(more than 3mm in maximum diameter).

Statistic	Value
Sensitivity	100.00%
Specificity	82 %

Table (10): CT sensitivity & specificity in esophageal varices compared to endoscopy.

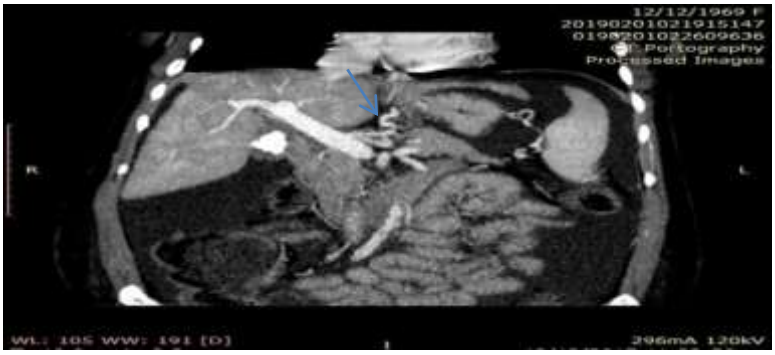
Statistic	Value
Sensitivity	100.00%
Specificity	89 %

Table (11) : CT sensitivity & specificity in gastric varices compared to endoscopy

According to the mentioned tables:

(1) CT portography has 100% sensitivity and 82% specificity in detection of the "high risk" esophageal varices compared to endoscopy **(Tables 6,7,10).**

(2) CT portography has 100% sensitivity and 89% specificity in detection of the "high risk" gastric varices compared to endoscopy.(**Table 8,9,11**).



(A)

(B)

Female patient 50 years old with a history of chronic liver disease complains of marked abdominal distension and lower limb edema.

The endoscopic findings: enlarged tortuous esophageal varices grade II

The MDCT findings: cirrhotic liver with ascites, dilated portal vein and porta hepatic collaterals grade III. (A) Triphasic CT (portal) coronal reconstruction image showing dilated porta hepatic collaterals (the blue arrow). (B) CT with 3D reconstruction showing dilated porta hepatic collaterals (the blue arrow)

Discussion

The portal system is the system that carries the blood from the digestive system to the liver, MDCT portal venography can depict the extent and location of the portosystemic collaterals in patients with portal hypertension **(9)**.

In patients with cirrhotic liver, portal hypertension could develop, so many collaterals could arise as alternative pathways called portosystemic collaterals, for many years the angiography was the standard for their detection **(10)**.

MDCT portal venography can display the portosystemic collaterals, as it has become a thin slice and better spatial resolution **(11)**.MDCT is also useful in diagnosis of other findings associated with portal hypertension such as ascites, liver cirrhosis, hepatic focal lesions, other collateral sites that can not be examined by the GI endoscopy **(11)**.

According to this study was found that the CT portography is very good technique for detecting the size and type of the collaterals with 100 % sensitivity with the upper GI endoscopy, but it shows less accuracy in grading of the high-risk varices compared to the upper GI endoscopy, as it shows 82% specificity in esophageal varices while 89% specificity in fundal or gastric varices.

Also in other studies like ***(El-Kammash et al,*** **(12)**, it was also found that the MDCT with MIP abilities is a reliable, noninvasive technique and able to depict the esophageal and other portosystemic collaterals.

In this study was found that 18 cases of 20 cases (90%) have hepatic causes of portal hypertension while 1 case due to periportal fibrosis and another due to Budd-Chiari syndrome. In agreement, the results of ***Agarwal et al,*** **(9)** found that the most common cause of portal hypertension has hepatic etiology with a percentage of 75%.

According to ***Kim et al.*** **(13)** who reported that the MDCT is a reliable, noninvasive modality for both portosystemic and hepatocellular carcinoma (HCC). Our study has also revealed the HCC in about 5% of the total number of the studied cases.

In our study the CT portography was able to classify the portosystemic collaterals according to the anatomical site and their grading, this data could be of benefit for the major operations such as liver transplantation, which is in agreement with ***Henseler et al.*** **(7)**, who reported that the variceal orientation and relationship to the adjacent organs are deceiving in this operation.

In this study were the prespleenic collaterals the most common type among the portosystemic collaterals which is in agreement with ***Antunez et al.*** **(14)**.

During the examination of the twenty patients, who have portal hypertension in this study for detection the portosystemic collaterals, that could arise, has revealed that

- The CT portography was able to detect early the esophageal varices that could arise as a complication to the high pressure in the portal vein with 100% sensitivity to the upper GI endoscopy.
- Also in the gastric varices was the CT portography able to early detection of these varices with the same sensitivity 100% to the upper GI endoscopy

This is meaning that the CT portography could be used as screening tool for early detection of the portosystemic collaterals and prevention of their life-threating complications, as the MDCT portography in comparison to the upper GI endoscopy less annoying and more comfortable than the upper GI endoscopy, in addition to it is reliable, available and noninvasive technique, this is in agreement with ***Hegab et al.*** **(15)**, who reported that the CT portography can replace or serve as alternative to the upper GI endoscopy in screening patients with portal hypertension.

In the grading of the detected portosystemic collaterals was the MDCT portography not in the same accuracy with the upper GI endoscopy, as it was upgraded for the esophageal varices in 3 cases from the 20 studied cases from the low-risk zone (grade II) to the high-risk zone (grad III, IV) with percentage of specificity reached up to 82%

While in the gastric varices was the CT portography upgrading in 2 cases from the 20 studied cases from the low-risk zone (grade II) to the high-risk zone (grad III,IV). This revealed that the CT portography has specificity 89% compared to the upper GI endoscopy. This is in agreement with ***Kim et***

al. **(13)** who reported that careful examination of these portosystemic collaterals could be possible to void performing the upper GI endoscopy.

Conclusion

Our study has found that:

- MDCT portography is an important imaging modality in assessment the portal vein, portal hypertension and the resulting portosystemic collaterals.
- The MDCT portography can provide all data necessary for major surgeries such as liver transplantation.
- CT portography is very good screening modality for any suspected varices as it has 100 % sensitivity.
- CT portography is considered less accurate than the upper GI endoscopy in variceal grading.
- CT portpgraphy can detect the portal vein thrombosis.

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