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Original Research Paper

Radio-Diagnosis

ROLE OF CT PORTOGRAPHY USING MDCT IN ADDITION TO COLOR DOPPLER ULTRASONOGRAPHY IN DETECTION OF PORTAL HYPERTENSION IN CIRRHOTIC PATIENTS-CROSS SECTIONAL STUDY.

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ABSTRACT

Aims And Objectives To compare multidetector computed tomography (MDCT) portography findings to that of grayscale and colour doppler ultrasound (CDUS) findings in evaluation of portal hypertension. To study the additional role of CT portography over ultrasound in detection of collateral circulation **Materials and Methods:** In our cross-sectional study, we studied 60 patients who were referred as a clinically diagnosed cases of liver cirrhosis, according to child pugh classification of liver cirrhosis. we took only class B and class C patients with a high clinical suspicion of liver cirrhosis. These patients then subjected to colour doppler ultrasound followed by contrast enhance CT portography to evaluate for signs of portal hypertension radiologically. Then the comparison between two modalities i.e ultrasonography and MDCT for evaluation of portal HTN was done with respect to epidemiological factors. Then we subjected this data for statistical analysis using Kappa statistics to find the agreement between the two modalities i.e., CDUS and MDCT. The value of kappa between 0.6-0.8 was considered as good agreement and the value 0.8 to 1.00 excellent agreement. **Results:** Out of 60 patients in study, 41(68.3%) patients were male and 19(31.6%) patients were females with highest etiological risk factor being chronic alcoholism in 40% patients followed by viral hepatitis in 16.7% then NASH in 15% patients. Morphological parameters of portal hypertension and cirrhosis like shrunken sized liver, liver surface irregularity, heterogenicity in echotexture, splenomegaly and ascites were found in both the modalities with kappa value between 0.7-1 showing good agreement between them. Morphologic parameters of portal vein and splenic vein like dilatation of PV & SV, presence of any thrombus or portal cavernomatous transformation were almost found equally with both modalities with good agreement of kappa statistics. However, hemodynamic parameters of PV like respiratory phasic variation in portal waveform, peak systolic velocity and direction of portal flow whether hepatopetal or hepatofugal can assessed only via CDUS and not with MDCT. We compared both the modalities for presence of portosystemic collaterals and found kappa value of 1 for left gastric/coronary collaterals, 0.9 for peri-splenic collaterals, 0.86 for peri-gall bladder, 0.07 for short gastric collaterals, 0.57 for para-umbilical collaterals, 0.13 for peri-esophageal collaterals and 0.25 for peri-rectal collaterals which means that MDCT portography was better in detecting these collaterals as compared to CDUS. Presence of early arterial enhancing hepatic nodule or mass in a cirrhotic patient is an indicator of hepatocellular carcinoma, we found mass lesion in 5 patients via MDCT and in 3 patients using USG with 60% agreement between USG and MDCT for presence of mass and 100% agreement for absence of mass with kappa value of 0.733. **Conclusion:** Though the morphologic and hemodynamic parameters of liver and portal circulation were better evaluated on CDUS and detailed anatomy of collateral circulation were better evaluated on MDCT portography. We concluded that when CDUS and MDCT portography when used in combination, provides more comprehensive information than either alone in the diagnosis and complications of portal hypertension in cirrhosis.

KEYWORDS : Portal hypertension, Liver cirrhosis, color doppler Ultrasonography, MDCT portography.

Abbreviations

HTN-hypertension; PHTN-portal hypertension, MDCT-multidetector computed tomography; CDUS- color doppler ultrasonography.

INTRODUCTION

Portal hypertension is a common medical problem in India. It may remain totally silent or may manifest as a dramatic life-threatening emergency. It is defined as a hepatic portal pressure gradient greater than 5 mm Hg and gradient of >10 mm Hg defines clinically significant PHTN. Amongst the many causes of portal hypertension, Cirrhosis of liver is the most common cause of portal hypertension, with 60% of patients with cirrhosis having clinically significant PHTN. PHTN is characterized by a pathological increase in portal pressure due to morphological changes at the level of hepatic parenchyma causes increased resistance and pressure in the portal venous system, which leads to portosystemic collateral circulation. The most direct consequence of portal hypertension is the development of gastroesophageal varices that may rupture and lead to the development of variceal hemorrhage which causes significant morbidity and mortality[1,2].

Because of significant morbidity and mortality in a patients with PHTN, there is a need to develop a non-invasive reliable imaging technique for diagnosing PHTN, assessing its complications and early interventions in life threatening variceal bleeding. Color Doppler ultrasound (CDUS) and multidetector computed tomography (MDCT) are widely used noninvasive methods. CDUS is valuable as it is dynamic and can accurately determine the direction of portal flow, velocity, Porto-systemic collaterals, liver echotexture, nodularity, splenomegaly [3,4]; however, MDCT provides comprehensive mapping of vascular compromise and collateral formation. MDCT is very important in detecting portosystemic collaterals, portal thrombosis. In some cases, MDCT portography cannot provide enough information, but it can reveal findings that CDUS is not able to display[5,6]. The purpose of our study is to compare CDUS and MDCT in evaluating findings related to PHT.

MATERIALS AND METHODS

1. Ethics:

Approval from Institutional Ethics Committee (IEC) was sought. Informed written consent in Subject's vernacular language was taken before enrolment for study.

2. Selection Of Patients:

All clinically suspected patients of liver cirrhosis who are fulfilling clinical criteria of liver cirrhosis according to child pugh score (in group B and C) are evaluated for portal

hypertension by using color doppler ultrasonography first and then MDCT portography.

3. Inclusion And Exclusion Criteria:

Inclusion Criteria:

All patients with all age group irrespective of gender referred for color doppler US and MDCT portography in a clinically suspected patients with liver cirrhosis (child pugh class B and C) for evaluation of portal hypertension.

Exclusion Criteria:

- Patient with deranged renal function who cannot undergo contrast CT examination.
- Hemodynamically unstable patients who could not remain stable while doing USG doppler study.
- All patients who do not consent to be a part of the study.

4. Method Of Collection Of Data:

All the clinically suspected patients of liver cirrhosis (**class B and class C patients of child Pugh scoring system)** who were referred to the department of Radiodiagnosis, were evaluated for portal hypertension using color doppler US and MDCT portography.

- We proceed the study after proper informed consent from guardians, explaining procedure in detail to the patient and obtaining clearance from ethical committee.
- On the day of Doppler ultrasound and MDCT appointment, complete history and clinical evaluation of the patient will be done.

5. Ultrasound Imaging Protocols:

A) Equipment:

Machine- PHILIPS GE LOGIQ S8.

Transducer- 3.5MHz curved array transducer and 7MHz linear probe.

B) Technique:

- After overnight fasting each patient was examined with longitudinal, oblique and transverse scans using transabdominal, intercostal and subcostal approaches in supine, right and left lateral decubitus positions.
- All areas of abdomen including the retroperitoneum and the pelvis were examined thoroughly.

C) Ultrasound Based Imaging Criteria:

i. Assessment of liver: Size, surface nodularity, echotexture, caudate to right lobe ratio and presence of mass lesion,
ii. Assessment of spleen: size
iii. Presence of ascites.
iv. The vascular evaluation comprised of evaluation of:

- Portal vein were evaluated in details for diameter, patency, PV thrombus, its respiratory phasic variation, direction of flow (whether hepatopetal, bidirectional or hepatofugal flow), PV velocity, wave form and presence of portal vein cavernous transformation.
- Splenic vein- patency, diameter.
- Presence or absence of Portosystemic collaterals in following region- Left gastric (coronary), Peri-splenic-splenorenal, Gall bladder wall, Short gastric, Paraumbilical, Periesophageal- at gastro-oesophageal junction, Rectal and perirectal-haemorrhoids.

6. Mdct Imaging Protocol And Techniques:

Equipment:

Machine Philips brilliant ICT 256 whole body spiral scanner. With proper patient preparation and positioning, patient were subjected to MDCT.

Surview:

CT imaging performed in the craniocaudal direction to examine the liver and vascular structures with FOV including from mid-thoracic area (to detect distal oesophageal varices) to the symphysis pubis with 1mm slice thickness.

Plain scan:

Pre-contrast scan should be obtained

Contrast scan:

Intravenous contrast: A bolus of 80-90cc intravenous non-ionic contrast material (300 mg/mL of Iohexol) is administered via pressure injector at rate of 3.5 mL/sec.

Phases of acquisition - TRIPHASIC

1. Arterial Phase: Post contrast delay is of 5 sec.
2. Portal phase: Post contrast delay is of 25 sec.
3. Venous phase: Post contrast delay is of 55 sec.

Delayed scans obtained as and when needed.

Following various MDCT parameters were considered:

We studied same morphologic and vascular parameters as in color doppler ultrasound.

Statistical Analysis-

- Collected data was entered into Microsoft Excel software and coded
- Charts and tables were prepared using Microsoft word and excel software.
- Descriptive data was presented in frequency and percentage.
- Kappa statistics was used to find the agreement between the two modalities i.e., ultrasound colour doppler and MDCT portography.
- The value of kappa between 0.6-0.8 was considered as good agreement and the value 0.8 to 1.00 excellent agreement.
- Statistical software SPSS 19.0v was used for data analysis.

RESULTS-

Epidemiological Distribution Of Cases:

Out of the total 60 patients included in our study, 41 (68.3%) patients were males and 19 (31.6%) patients were females. Male: Female ratio is our study is 2.1:1, our study had greater number of male patients this might be because we found chronic alcoholism 24/60 (40%) is important etiologic factor for development of liver cirrhosis in male patients. Out of 60 cirrhotic patients which are referred to us for evaluation of portal hypertension had multiple presenting complaints, highest being jaundice present in 48 patients (80%), hematemesis were present in 28 patients (46.7%), abdominal distension were present in 41 patients (68.3%), 19 patients (31.7%) brought by relatives with history of altered sensorium and 11 patients (18.3%) had associated skin changes like palmer erythema, spider nevi, pruritis.

Distribution Of Cases According To Comparison Between Cdus & Mdct Portography Findings For Various Parameters:

- When we compared CDUS and MDCT for detection of ascites, we found that 91.1% agreement present between 2 modalities for presence of ascites and 80% agreement present between absence of ascites with kappa value of 0.69. To conclude, there is **good agreement between two modalities for detection of ascites.**
- When we compared CDUS and MDCT for detection regularity of liver surface margins, we found that 80% agreement present between 2 modalities for regular liver margins and 100% agreement present between irregular liver margins. There were 19.5% such patients who had irregular margins on USG but regular liver margins on MDCT. Kappa value for this parameter is 0.72. To conclude, there is **good agreement between two modalities for detection of regularity of liver surface margins.**

- When we compared CDUS and MDCT for detection regularity of mass lesion, we found mass lesion in 5 patients via MDCT and in 3 patients using USG with 60% agreement between USG and MDCT for presence of mass and 100% agreement for absence of mass. Kappa value for this parameter is 0.733. To conclude, there is **good agreement between two modalities for detection of mass lesion in cirrhotic liver.**
- When we compared CDUS and MDCT for detection of spleen size, kappa value came as 0.89 that means **excellent agreement between two modalities for detection of spleen size.**
- When we compared CDUS and MDCT for detection of dilatation of portal vein, kappa value was 0.79 with 82.1% agreement between two modalities for dilatation of portal vein. To conclude, there is **good agreement between two modalities for detection of dilated portal vein.**
- When we compared CDUS and MDCT for detection of portal vein lumen for presence of thrombus or cavernoma formation, kappa value was 0.77 with 80.1% agreement between two modalities for cavernous venous transformation of portal vein, 66.6% agreement for presence of thrombus. To conclude, there is **good agreement between two modalities for detection of lumen of portal vein.**
- When we compared CDUS and MDCT for detection of splenic vein diameter, kappa value came as 0.83 that means **excellent agreement between two modalities for detection of splenic vein diameter.**
- When we compared CDUS and MDCT for detection of splenic vein lumen for presence of thrombus, kappa value was 0.77 with 75% agreement for presence of thrombus on two modalities. To conclude, there is **good agreement between two modalities for detection of lumen of splenic vein.**
- When we compared CDUS and MDCT for detection of increased caudate to right lobe ratio in 60 cirrhotic patients, kappa value was 0.8 with 97.5% agreement for normal ration and 80% agreement for increased ratio on two modalities. To conclude, there is **excellent agreement between two modalities for detection of increased caudate to right lobe ratio in cirrhotic patients.**
- When we compared CDUS and MDCT for detection of presence of left gastric (coronary) varices, kappa value came as 1 with 100% agreement between two modalities. To conclude, there was **perfect agreement between two modalities for detection of left gastric (coronary) varices.**
- When we compared CDUS and MDCT for detection of presence of peri-splenic collaterals, kappa value came as 0.9. To conclude, there was **good agreement between two modalities for detection of peri-splenic collaterals.**
- When we compared CDUS and MDCT for detection of presence of peri-gall bladder collaterals, kappa value came as 0.86 with 87.1% agreement for presence of peri-gb collaterals and 12.9% disagreement between two modalities. To conclude, there was **excellent agreement between two modalities for detection of peri-gall bladder collaterals.**
- When we compared CDUS and MDCT for detection of presence of short gastric collaterals, kappa value came as 0.075 with only 11.9% agreement and 88.1% disagreement between two modalities for presence of short gastric varices. To conclude, there was **NO agreement between two modalities for detection of short gastric collaterals.**
- When we compared CDUS and MDCT for detection of presence of peri-umbilical collaterals, kappa value came as 0.57. To conclude, there was **less agreement between two modalities for detection of peri-umbilical collaterals.**
- When we compared CDUS and MDCT for detection of presence of esophageal collaterals, kappa value came as 0.13 with only 13.3% agreement and 86.6% disagreement between two modalities for presence of esophageal varices. To conclude, there was **NO agreement between two modalities for detection of esophageal varices.**
- When we compared CDUS and MDCT for detection of presence of peri-rectal/hemorrhoidal collaterals, kappa value came as 0.25. To conclude, there was **No agreement between two modalities for detection of perirectal collaterals.**

DISCUSSION:

Portal hypertension is a common medical problem in patients with liver cirrhosis. It may remain totally silent or may manifest as a dramatic life-threatening emergency in the form of bleeding oesophageal varices and hence, assumes clinical significance. Diagnostic imaging modalities like CDUS and MDCT becoming popular for evaluation of portal hypertension because of its non-invasiveness. Aim of our study was to compare CDUS and MDCT portography technique for evaluation of different parameters in patients with portal hypertension like morphological changes in liver & spleen, hemodynamic parameters of PV & SV and evaluation of porto-systemic collateral circulation.

We have found that there is no significant difference between 2 modalities for detection of morphologic changes of liver like-surface nodularity, size, heterogenicity of liver, splenomegaly and presence of ascites with kappa value between ranging between 0.7-1, that means both modalities can used interchangeably. The hemodynamic parameters of PV and SV like respiratory phasic variation, direction of portal blood flow, velocity of portal flow, can only be assess by CDUS and not by MDCT. However, when we compared CDUS and MDCT for detailed evaluation of portosystemic collateral circulations, we found that MDCT portography was better in detection of collaterals and these 2 modalities can not be used interchangeably for detection of same. We compared our study with similar study done by **Agarwal SK and S Kumar [7]** and concluded whether the findings were corroborative or not.

CONCLUSION:

- There is good agreement between two modalities i.e. CDUS and MDCT portography for evaluation of morphological changes in liver, spleen, diameter and presence of thrombus or cavernomatous transformation in portal vein, splenic vein and detection of ascites in patients of portal hypertension.
- However, USG is superior to MDCT portography for evaluation of the liver parenchymal changes and hemodynamic parameters like portal vein flow direction, respiratory phasic variation of portal vein, peak systolic velocity of portal vein.
- CT demonstrated the presence of mass lesion in five patients as compared to three on CDUS, however, the difference is not statistically significant. Presence of an enhancing mass in liver on arterial phase imaging is strongly suggestive of hepatocellular carcinoma in a setting of liver cirrhosis.
- MDCT portography was superior to CDUS in demonstration of portosystemic collaterals. Short gastric, esophageal and hemorrhoidal collaterals could only be demonstrated on CT.
- CDUS and MDCT portography when used in combination, provide more accurate demonstration of signs of portal hypertension and its complications in cirrhotic patients.
- Doppler US is the first line investigative modality for the initial screening and regular follow up of the patients with portal hypertension. MDCT portography should be performed in all cases of portal hypertension to know to the detailed anatomy of porto-systemic collaterals and to assess future risk of life-threatening hematemesis and it will help clinicians in early management of portal hypertension.

- The combination of these two modalities provides more comprehensive information than either alone in the diagnosis and complications of portal hypertension in cirrhosis

TABLES AND FIGURES-

TABLE 1: Child-Pugh-Turcotte (CPT) classification.

Clinical and Lab Criteria	Points*		
	1	2	3
Encephalopathy	None	Mild to moderate (grade 1 or 2)	Severe (grade 3 or 4)
Ascites	None	Mild to moderate (diuretic responsive)	Severe (diuretic refractory)
Bilirubin (mg/dL)	< 2	2-3	>3
Albumin (g/dL)	> 3.5	2.8-3.5	<2.8
Prothrombin time			
Seconds prolonged	<4	4-6	>6
International normalized ratio	<1.7	1.7-2.3	>2.3
Child-Turcotte-Pugh Class obtained by adding score for each parameter (total points) Class A = 5 to 6 points (least severe liver disease) Class B = 7 to 9 points (moderately severe liver disease) Class C = 10 to 15 points (most severe liver disease)			

TABLE 2: Table showing comparison between CDUS and MDCT in assessment of morphological changes of liver, spleen and ascites in portal hypertension

		CDUS(No. of patients)	MDCT(No. of patients)	Kappa statistics
Parameters	Findings			
Liver				
Echotexture	Homogenous	14	NA	
	Heterogenous	46	NA	
Margins and surface nodularity	Regular	33	44	0.72
	Irregular nodular	27	19	
Mass lesion	Present	3	5	0.73
	Absent	57	55	
Caudate to right lobe ratio	Normal	43	40	0.8
	Increased	17	20	
Spleen				
Splenomegaly	Normal	12	12	0.9
	Increased	47	47	
Ascites		44	45	0.69

TABLE 3: Table showing comparison between CDUS and MDCT for assessment of PV and SV in portal hypertension.

		CDUS(No. of patients)	MDCT(No. of patients)	Kappa statistics
Parameters	Findings			
Portal vein				
Portal vein diameter	Normal	26		
	Increased	24		
Patency of PV	Normal	41	30	0.77
	Thrombus	9	12	
	Cavernoma (CVT)	10	10	
Splenic vein				
SV diameter	Normal	31	30	0.83
	Increased	28	29	
SV patency	Normal	52	51	0.77
	Thrombus	7	8	

TABLE 4: Table showing hemodynamic parameters of portal vein.

CDUS hemodynamic findings			
Parameters	Findings	No. of patients	% of patients
Portal flow direction	Hepatopetal	28	68.3
	Bidirectional	9	22
	Hepatofugal	4	9.8
PV respiratory phasic variation	Present (normal)	18	43.9
	Loss	23	56.1
PV peak systolic velocity	Normal (>=15cm/sec)	20	48.8
	Decreased (<15cm/sec)	21	51.2

TABLE 5: Table showing comparison between CDUS and MDCT for assessment of porto-systemic collateral circulation in portal hypertension.

	CDUS(No. of patients)	MDCT(No. of patients)	Kappa statistic
Left gastric (coronary)	49	49	1
Peri-splenic	45	47	0.9
Peri-gall bladder	27	31	0.86
Short gastric	5	42	0.07
Para-umbilical	6	13	0.57
Peri-esophageal	4	30	0.13
Peri-rectal	4	14	0.25

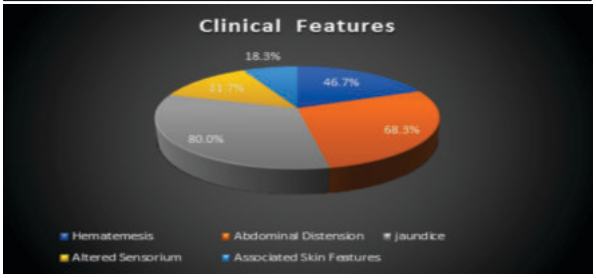

FIGURE 1: Distribution according to clinical history.

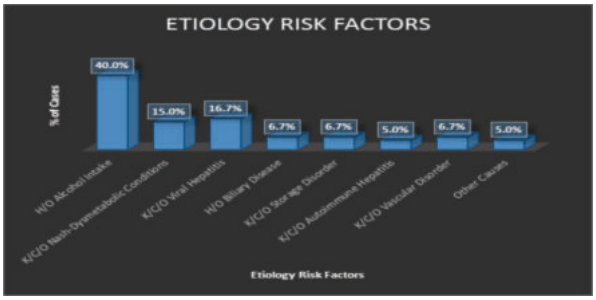

Figure 2 :Distribution according to etiological risk factors

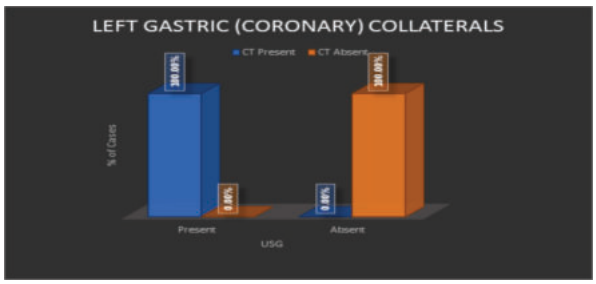

FIGURE 3: Comparison between USG and CT for detection of left gastric collaterals-

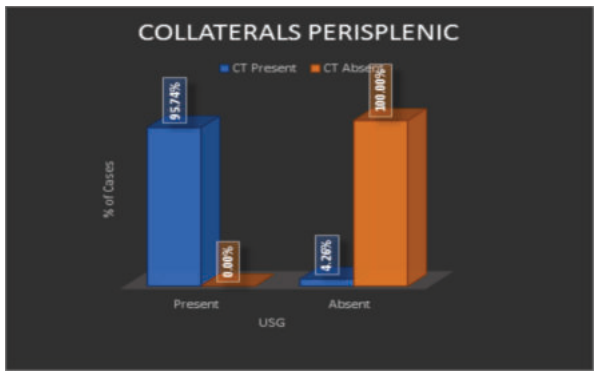

FIGURE 4: Comparison between USG and CT for detection of peri-splenic collaterals

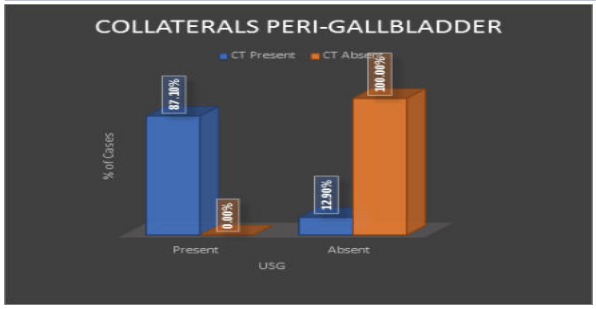

FIGURE 5: Comparison between USG and CT for detection of peri-gall bladder collaterals

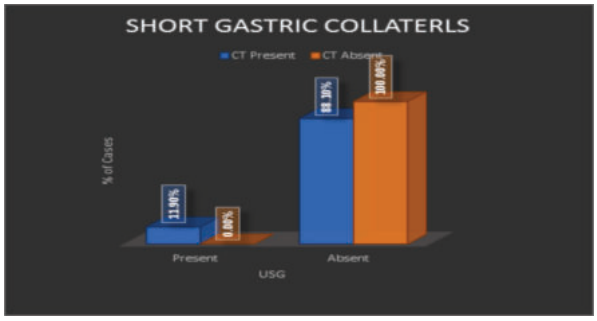

FIGURE 6: Comparison between USG and CT for detection of short gastric collaterals

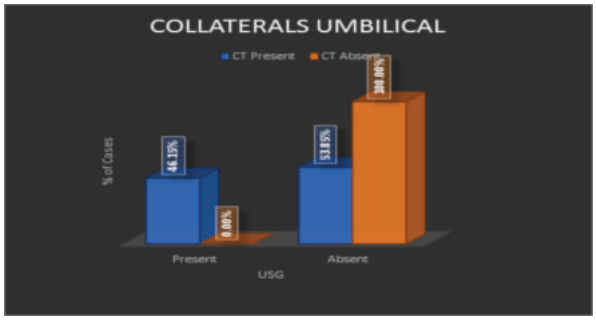

FIGURE 7: Comparison between USG and CT for detection of umbilical collaterals

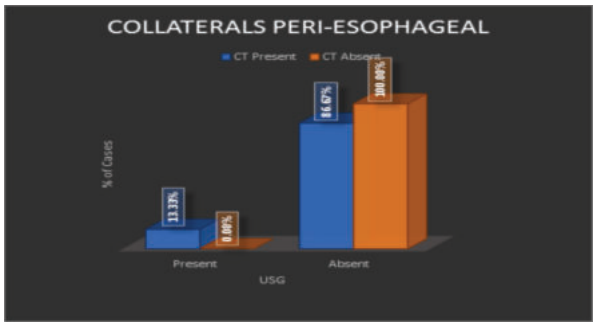

FIGURE 8: Comparison between USG and CT for detection of esophageal varices

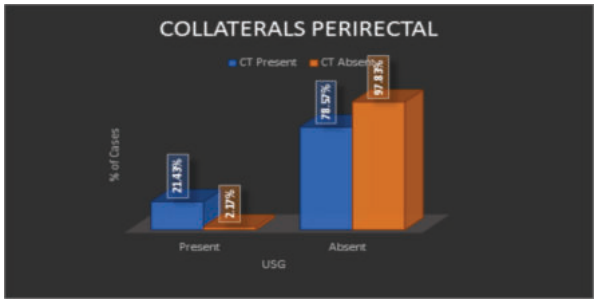

FIGURE 9: Comparison between USG and CT for detection of peri-rectal collaterals

Case

60 years old male patient with a history of chronic alcoholism, presented to casualty with C/O jaundice, hematemesis and altered sensorium. Patient then referred to radiology department as a case of cirrhosis for evaluation of portal hypertension.

Patient were first subjected to ultrasound colour doppler and then to contrast enhanced CT portography.

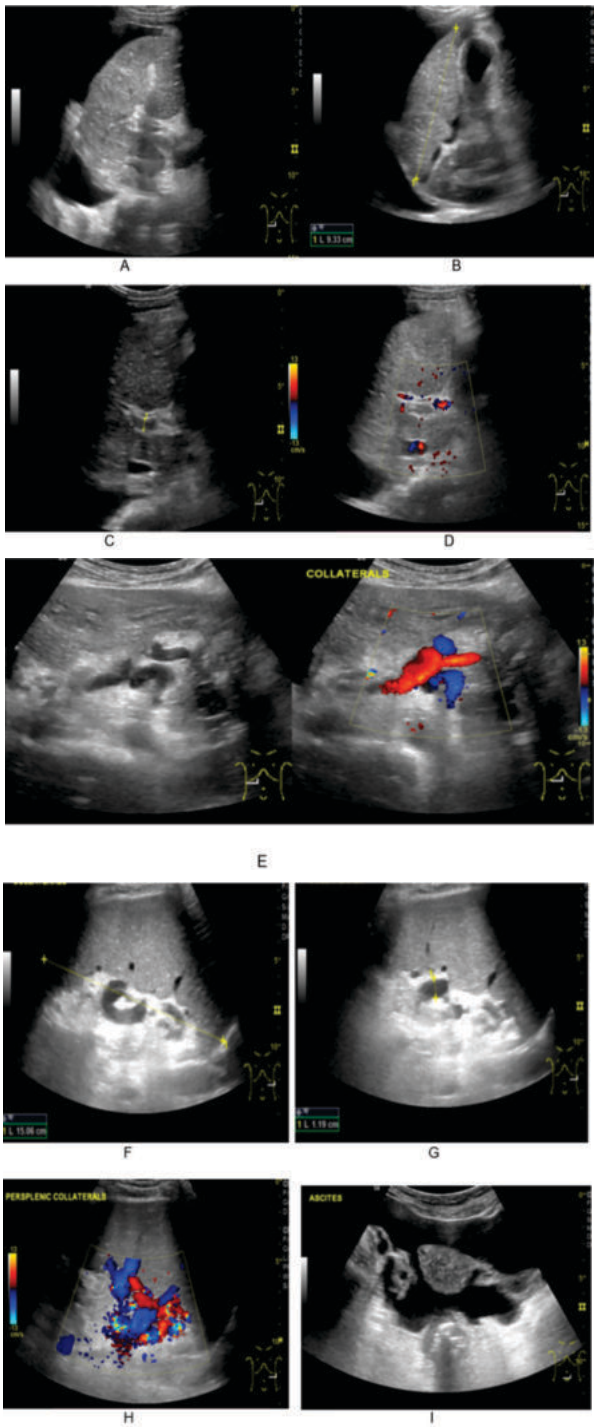

FIGURE 10 (A-I) showing ultrasound and doppler findings: A & B showing smaller, shrunken liver with irregular borders, C&D showing isoechoic thrombus in portal vein which is not showing colour flow on colour doppler, (E & H) showing multiple dilated tortuous collaterals in peripancreatic and peri-splenic region, (F&G) showing splenomegaly and dilated splenic vein, (I) showing gross ascites.

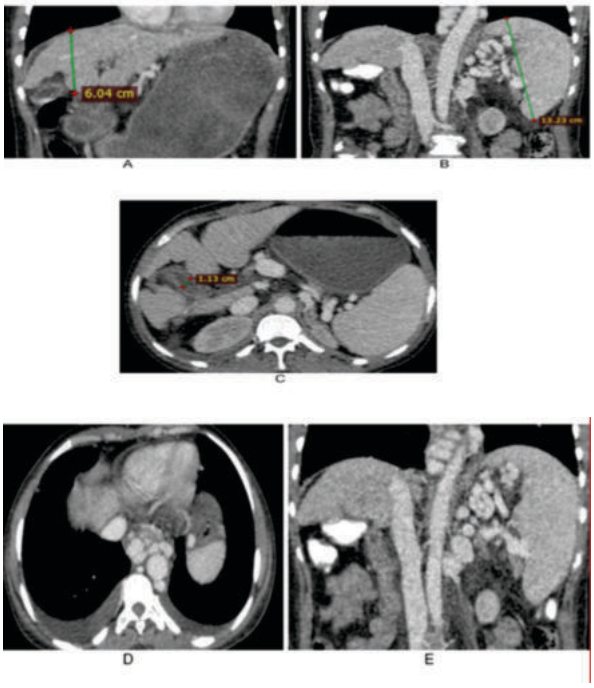

Figure 11 (A- E) showing MDCT portography findings in same case-

(A) showing small shrunken liver with caudate lobe and left lobe hypertrophy, (B) showing splenomegaly, (C) showing portal vein thrombus, (D &E) showing multiple oesophageal, paraesophageal, gastric and perisplenic varices.

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