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Hepatic Lesions Enhancement in Multiphasic Contrast-Enhanced Multi Detector Computed Tomography

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Abstract
Purpose: *To evaluate whether triphasic spiral Computerized Tomography (CT) enables characterization of a wide range of liver lesions.*
Materials And Methods: *50 patients with suspected liver disease underwent triphasic liver (CT) scan. After injection of contrast material, the liver was scanned in arterial, portal and equilibrium phases. Enhancement of each lesion in each phase was evaluated, and the lesions were tabulated according enhancement patterns.*
Results: *In all patients, liver lesions were detected. The nature of the lesions was characterized in all phases. Enhancement patterns of benign disease, malignant and metastases were also been analyzed. Arterial and venous phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions. Equilibrium phase images demonstrate benign focal liver lesions, such as hemangioma, cyst, of a hypo-/hypo-(cyst)/hypo- appearance. Hyper vascular rim of hyper-(rim)/ hypo-/hypo- lesions in patients with a hyper vascular primary tumor or chronic liver disease represented malignant disease. Hypo-/ hypo-/hypo- and hypo-/hypo-/hyper lesions need to be interpreted with caution.*
Conclusion: *Triphasic liver (CT) enables characterization of a wide range of liver lesions and characterized them significantly at p≤0.000*
Keywords– *Triphasic, Computerized Tomography, Hepatic Lesions*

I. Introduction

Multiphasic contrast-enhanced dynamic computed tomography (CT) of the whole liver has played an significant role in the examination for patients with liver disease. [1]Focal liver lesions can be distinct as any lesion in the liver other than the normal parenchyma with or without causing structural and functional abnormality of hepatobiliary system. Focal liver lesion is more likely to characterize a metastatic deposit than primary malignancy however; hepatocellular carcinoma (HCC) is the most frequent hepatic disorder. [2,3] In a patient without known cancer or history of chronic liver disease, these lesions typically can be evaluated with serial follow-up imaging examinations. In patients with cancer, resolving of the cause of such lesions may be essential for defining diagnosis. Small hepatic lesions were believed to be benign with a known underlying malignancy.[4] Most of the hepatic tumors have been reported to be benign in the general population.[5] Although classic HCCs are commonly hyper vascular and tend to be seen best during the arterial phase of contrast enhancement, some well-differentiated(HCCs) are relatively hypo vascular and often can be seen only on late phase images. [6]

One study reported the value of adding late phase imaging to dual phase helical (CT) for detection of (HCCs). [3] The degree of hepatic parenchyma enhancement depends on a variety of factors which have been well documented and acknowledged in previous studies .[7, 8, 9]It is often difficult to characterize hepatic lesions by imaging. While histopathology is the gold standard, biopsy is always not possible as it is an invasive procedure. Computed tomography (CT) is the imaging modality used to evaluate focal liver lesions, however, the complex blood supply of the liver annoy the application of contrast-enhanced (CT) protocol for the detection and characterization of focal hepatic lesions. Characterization of benign focal liver lesions including cysts, haemangiomas is essential. Therefore, the chosen liver (CT) technique should have a high sensitivity for lesion detection and characterization. To meet these requirements, a triphasic spiral (CT) technique was developed to image the entire liver in arterial, portal, and equilibrium phases.[10] In the current study, we evaluated a multiphasic contrast-enhanced spiral computed tomography technique for imaging of the entire liver. Our aim was to evaluate the hepatic enhancement and interaction in patients with liver disease.

II. Methodology

2.1 Patients And Methods

The study was simultaneously conducted in Department of Diagnostic Radiology in CT department in Alfaisal Specialized Hospital, Ibn Alhaitham Diagnostic Centre, Antalya Medical Centre and Royal Care International Hospital. Data were collected from April 2014 to February 2015. By a convenient sampling, 50

patients; ages ranged (10-95 years old) underwent CT triphaic scan were included in the study . The data that collected from Alfaisal Specialized Hospital, the CT machine was Toshiba 4 slice (Asteion) using 120 KVP, 200 MAS, also used triphasic protocol (sure start protocol)manually taken one slice cut above the liver and then begin the scan early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection flow rate is 4ml/sec,and using 18gague needle for injection .Patient position is supine position with feet first. The data that collected from Royal Care International Hospital, the CT machine was Toshiba 64 slice (Aquilion) using 120 KVP, 125 MAS, also used triphasic protocol begin the scan taken early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection using 70-100 ml omnipaque contrast media (CM) with flow rate is 3.5ml/sec. The scan begins immediately after injection and delayed phase are taken after 10 min from injection. Slice thickness 5mm/slice, patient position is supine position feet first, the oral (CM) 500ml in 3water bottle each one have 10ml of (CM).The data that collected from Ibn Alhaitham Diagnostic Centre, the CT machine was Toshiba 4 slice (Japan manufactures) using 120 KVP,187 MAS ,also used triphasic protocol begin the scan taken early arterial phase(20sec from injection), venous phase (40 sec) and delayed phase (5-10 min from injection) with automatic injection using 75 ml omnipaque contrast media (40-50 ml for child according to age and weight)for adult with flow rate is 3.5ml/sec. The scan begins immediately after injection and delayed phase are taken after 10 min from injection. Slice thickness 10mm/slice, the oral (CM) 500ml in 3water bottle each one have 10ml of (CM). The first slice are the scout (coronal section) then take plain film without (CM)then scan triphasic protocol with (CM). Patient position is supine position with feet first, from the sternal angle to symphysis pubis. In Antalya medical centre, the CT machine was bride speed 8 slice (American manufactures) using 120 KVP,165 MAS , the scout 120 KVP and 10 MAS also used triphasic protocol begin the scan taken arterial phase ,venous phase and delayed phase (3-6 min from injection) with automatic injection using 75 ml omnipaque contrast media for adult with flow rate is 3.5ml/sec. the scan begin immediately 5 mm /slice thickness then the reconstruction algorithm take 2.5mm.The first slice was the scout (coronal section)then take plain film without (CM)then scan triphasic protocol with (CM)

2.2 Statistical analyses

All data obtained in the study were documented and analyzed using SPSS program version16. Descriptive statistics, including frequency and percentages were obtained. ANOVA test was applied to test the significance of differences, p-value of less than 0.05 was considered to be statistically significant.

I. TABLES

Table 1: CT Findings (Diagnosis) In All Of The Examined Cases, Frequency And Percentages

CT (diagnosis)	Frequency	Percentages (%)
Cirrhosis +Liver Metastases	**1**	**2.0**
Calcified Granuloma +Liver Metastases	**1**	**2.0**
Calcified Granuloma+ Liver Abscess	**1**	**2.0**
Cirrhosis	**4**	**8.0**
Cirrhosis + Liver Tumor	**5**	**10.0**
Hemangioma	**8**	**16.0**
Hepatic Tumor	**2**	**4.0**
Hepatic Tumor + Liver Metastases	**1**	**2.0**
Hepatoma	**2**	**4.0**
Hepato-splenomegaly	**4**	**8.0**
Hepato-splenomegaly + Hepatitis	**1**	**2.0**
Hydatic Cyst	**2**	**4.0**
Liver Abscess	**1**	**2.0**
Liver Metastases	**9**	**18.0**
Lymphoma	**1**	**2.0**
Simple Cyst	**6**	**12.0**
Simple Cyst + Cirrhosis	**1**	**2.0**
Total	**50**	**100.0**

Table 2: Cross tabulation between the CT (diagnosis) and liver texture (Homogeneous and Heterogeneous)

		liver texture		Total
		Heterogeneous	Homogenous	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	.0%	10.0%
	Hemangioma	1	7	8
		2.0%	14.0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	1	1	2
		2.0%	2.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	1	0	1
		2.0%	.0%	2.0%
Total		27	23	50
		54.0%	46.0%	100.0%
Correlations		***P-value= 0.059***		

Table 3 :Cross tabulation between the CT (diagnosis) and lesion out line

		lesion Out Line		Total
		Irregular	Regular	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Heamangioma	0	8	8
		.0%	16.0%	16.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Hepatic Tumor	5	0	5
		10.0%	.0%	10.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1

		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		24	26	50
		48.0%	52.0%	100.0%
Correlations		***P-value= 0.000***		

Table 4 :Cross tabulation between the CT (diagnosis) and characterize of lesion (hyper attenuating, hypo attenuating)

		Characterize Of Lesion		**Total**
		Hyper attenuating	**Hypo attenuating**	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	1	3	4
		2.0%	6.0%	8.0%
	Cirrhosis + Liver Tumor	0	5	5
		.0%	10.0%	10.0%
	Hemangioma	0	8	8
		.0%	16.0%	16.0%
	Hepatic Tumor	0	2	2
		.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Liver Metastases	0	9	9
		.0%	18.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		2	48	50
		4.0%	96.0%	100.0%
Correlations		***P=0.001***		

Table 5: Cross tabulation between the CT (diagnosis) and enhancement of the lesion at arterial phase

		Enhancement Arterial Phase			Total
		Early Enhance	Enhance	No Enhance	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Cirrhosis	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	4	1	0	5
		8.0%	2.0%	.0%	10.0%
	Hemangioma	0	8	0	8
		.0%	16.0%	.0%	16.0%
	Hepatic Tumor	1	1	0	2
		2.0%	2.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Hepatoma	0	2	0	2
		.0%	4.0%	.0%	4.0%
	Hepato-splenomegaly	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hydatic Cyst	0	1	1	2
		.0%	2.0%	2.0%	4.0%
	Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Liver Metastases	6	3	0	9
		12.0%	6.0%	.0%	18.0%
	Lymphoma	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Simple Cyst	0	0	6	6
		.0%	.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	0	1	1
		.0%	.0%	2.0%	2.0%
Total		13	19	18	50
		26.0%	38.0%	36.0%	100.0%
Correlations		***P-Value= 0.001***			

Table 6 :Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Venous Phase

		Enhancement Venous Phase		Total
		Enhance	No Enhance	
CT report (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	.0%	10.0%
	Hemangioma	8	0	8
		16.0%	.0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	2	0	2

		4.0%	.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	1	1	2
		2.0%	2.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		30	20	50
		60.0%	40.0%	100.0%
Correlations		***P-Value= 0.001***		

Table 7 :Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Delay Phase

		Enhancement At Delay Phase		Total
		Enhance	**No Enhance**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	1	4	5
		2.0%	8.0%	10.0%
	Hemangioma	8	0	8
		16.0%	.0%	16.0%
	Hepatic Tumor	0	2	2
		.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Liver Metastases	0	9	9
		.0%	18.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		9	41	50
		18.0%	82.0%	100.0 %
Correlations		***P-Value= 0.000***		

Table 8: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at Arterial Phase

		Interaction At Arterial Phase				Total
		No Enhance	**Peripheral homogeneous Enhance**	**Peripheral And Central Enhance**	**Peripheral Heterogeneous Enhance**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	0	1	1
		.0%	.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	0	1
		.0%	.0%	.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	0	1
		.0%	2.0%	.0%	.0%	2.0%
	Cirrhosis	4	0	0	0	4
		8.0%	.0%	.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	0	1	0	4	5
		.0%	2.0%	.0%	8.0%	10.0%
	Cyst	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Hemangioma	0	5	0	3	8
		.0%	10.0%	.0%	6.0%	16.0%
	Hepatic Tumor	0	0	1	1	2
		.0%	.0%	2.0%	2.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	0	0	1
		.0%	2.0%	.0%	.0%	2.0%
	Hepatoma	0	2	0	0	2
		.0%	4.0%	.0%	.0%	4.0%
	Hepato-Splenomegaly	4	0	0	0	4
		8.0%	.0%	.0%	.0%	8.0%
	Hepato-Splenomegaly + Hepatitis	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Hydatic Cyst	1	1	0	0	2
		2.0%	2.0%	.0%	.0%	4.0%
	Liver Abscess	0	0	1	0	1
		.0%	.0%	2.0%	.0%	2.0%
	Liver Metastases	0	4	0	5	9
		.0%	8.0%	.0%	10.0%	18.0%
	Lymphoma	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Simple Cyst	5	0	0	0	5
		10.0%	.0%	.0%	.0%	10.0%
	Simple Cyst + Cirrhosis	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
Total		18	16	2	14	50
		36.0%	32.0%	4.0%	28.0%	100.0%
Correlations		***P-Value= 0.000***				

Table 9: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at venous Phase

		Interaction At Venous Phase			Total
		Late Enhance	**No Enhance**	**Rapid Washout**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Cirrhosis	0	4	0	4

		.0%	8.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	0	0	5	5
		.0%	.0%	10.0%	10.0%
	Hemangioma	8	0	0	8
		16.0%	.0%	.0%	16.0%
	Hepatic Tumor	0	0	2	2
		.0%	.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hepatoma	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepato-Splenomegaly	0	4	0	4
		.0%	8.0%	.0%	8.0%
	Hepato-Splenomegaly + Hepatitis	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Hydatic Cyst	0	2	0	2
		.0%	4.0%	.0%	4.0%
	Liver Abscess	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Liver Metastases	0	0	9	9
		.0%	.0%	18.0%	18.0%
	Lymphoma	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Simple Cyst	0	6	0	6
		.0%	12.0%	.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	0	1
		.0%	2.0%	.0%	2.0%
Total		10	21	19	50
		20.0%	42.0%	38.0%	100.0%
Correlations		***P-value= 0.000***			

Table 10: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at delay Phase

		Interaction Delay Phase			Total
		Empty	**Filling**	**No Enhance**	
CT report (diagnosis)	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Cirrhosis	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	0	5
		10.0%	.0%	.0%	10.0%
	Hemangioma	0	8	0	8
		.0%	16.0%	.0%	16.0%
	Hepatic Tumor	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Hepatoma	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepatosplenomegaly	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hydatic Cyst	1	0	1	2
		2.0%	.0%	2.0%	4.0%
	Liver Abscess	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Liver Metastases	9	0	0	9
		18.0%	.0%	.0%	18.0%
	Lymphoma	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Simple Cyst	0	0	6	6
		.0%	.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	0	1	1
		.0%	.0%	2.0%	2.0%

Total	22	8	20	50
	44.0%	16.0%	40.0%	100.0%
Correlations	***P-value= 0.000***			

II. Discussion

Because of the high frequency of diffused or focal liver lesions such as cysts, hemangiomas , lymphoma ,liver abscess, liver cirrhosis and metastases ;characterization of these lesions is essential. Table (1) shows the frequency of the presented cases. Cross tabulation between the CT (diagnosis) and liver texture (homogeneous and heterogeneous) was assessed , the scoring of the liver homogeneity was found to be high in our cases in the presence of either focal or diffused liver diseases as presented in table(2).Accordingly, the liver lesions were characterized, and the liver CT technique used was suitable for lesion detection and characterization, and in order to differentiate lesions ;a triphasic spiral CT technique was applied to image the entire liver in arterial, portal, and equilibrium phases. A contrast material protocol was used to achieve sufficient arterial opacification during the arterial phase, intense parenchyma opacification in the portal phase, and hyper attenuating vascular space in the equilibrium phase.

Table (3) showed that the lesion out line and the CT (diagnosis) was found to be significantly correlated at $p \leq 0.000$, that means the shape to be regular or not may indicate the character of the lesion if it is benign or malignant.

In the hypo attenuating enhancement patterns: the characterization of hypo-attenuating liver lesions is often difficult .Although such lesions may be malignant if found in a patient without a known primary tumor, our study represented 11cases out of 50 as feature of malignancy with metastases and with /without cirrhosis similar results was found in a study done previously [11].The first difference to be noticed between cysts and hypo-attenuating solid lesions is the presence of metastases .All hypo-attenuating- lesions (n = 14/50/22%) with or without liver cirrhosis were found to be cysts or abscess because of their sharper margin and homogeneous hypo-attenuation as presented in table(3), liver metastases constituting 11(22.0%) of the cases and also appeared as hypo dense the benign focal lesions ,hepatoma 2(4.0%) and lymphoma 1(2.0%). The diagnoses and changes in the liver feature or lesions attenuation were found to be significantly correlated at $p \leq 0.001$,on the other hand studies had judged that it could not be possible to do a certain diagnosis of benignancy in small lesions and all small hypo-/hypo-(cyst)/hypo- lesions with a standard-of-reference diagnosis represented benign disease [12] our study reported that liver /spleen size and infection changes (hepatomegaly,splenomegally or hepatosplenomegally)may be associated with hypo intense feature this was presented in table (4).

Lesions were grouped in three enhancements patterns, which all demonstrated in the arterial phase, as early enhancement, intermediate enhancement and lesions without enhancement, this was presented in table (5). Tables 6and 7 compare the findings in arterial ,venous and delay phase and results showed that 13(26.0%),of the lesions were well enhanced ,19(38%)were intermediately enhanced where 18(36%) reflect no enhancement in the arterial phase. lesions that still enhanced in the delay phase were(9/50/18%)constituting hemangioma 8(16%) and liver tumors 1(2%);where in the venous phase the enhanced lesions constituting 30(60%)and including lesions of liver metastases, hepatoma, hemangioma ,liver tumors with or without hepatic metastases or cirrhosis, while the cyst and abscess score the less values of venous enhancement. These method of evaluation of the liver or hepatic lesions can reflect the feature of the lesions as malignant or benign; this was also been discussed in other similar studies.[12]

We believe that the better results in the current study were achieved because the triphasic spiral CT technique allows optimal use of contrast dynamics due to the speed of data acquisition. Overlapping reconstructions allow centering of the plane of reconstruction with respect to lesions and, thus, leads to a higher percentage of typical appearances. The triphasic liver CT proved to have the ability to facilitate confident characterization of most hepatic lesions, significantly at $p \leq 0.001$ and can give criteria for characterizing lesions adopting to prevent false positive diagnoses as mentioned in the previous studies [13]

The study represented the interaction between the hepatic lesion and contrast media in the arterial phase and was classified as lesions with no enhancement, lesions with peripheral homogeneous enhancement, peripheral and central enhancement, and lesions with peripheral heterogeneous enhance ,this was noticed in table(8).

Characterization of liver and hepatic lesions according to interaction with contrast material was studied in all phase arterial, venous and delay .Liver Cirrhosis affected with tumor showed peripheral heterogeneous enhancement in the arterial phase contrast interaction while hemangioma may appears peripheral homogeneous enhancement 5(10.0%) or peripheral heterogeneous enhancement in 3 (6%) similarly the metastases, while the

liver tumors have both features of peripheral and central enhance and peripheral heterogeneous enhancement.Interaction at venous phase were classified as late ,no enhance or rapid washout. Hepatoma which does not enhanced in arterial phase gives good enhancement as late enhancement at the venous, similar as the hemangiona , while tumors and liver cirrhosis with metastases showed rapid wash out at that phase. This phase can characterize the liver lesions significantly at $p \leq 0.000$.Interaction in delay phase for the malignant hepatic lesions showed no enhancement, liver cirrhosis with tumor constituting 5(10.0%), hepatic tumor with normal liver texture represent 2(4.0%) while cases with hepatic tumor associate liver metastases were 12.0%, however hemangioma were 8(16.0%) and still filled with contrast at that phase. Cysts (simple or hydated) with normal or cirrhotic liver and abscess showed no enhancement at delay phase. These findings were presented in tables (8-10) .Similarly, studies had mentioned that when lesions demonstrated no enhancement in other phases (hypo-/hypo-/hypo- pattern), lesions was malignant and when an enhancing rim in the arterial phase was observed lesions were malignant. The justification of that appearance in their study and our study as well ,is that the hypervascular rim of hyper-(rim)/ hypo-/hypo- lesions has been well explained and probably represents the well-perfused viable periphery of tumor tissue[14,15,16] .These lesions often demonstrated a reversed enhancement pattern in equilibrium phase (a hypoattenuating penipheral rim surrounding a hyper attenuating center) a phenomenon already known as "the washout sign" [17,18] These provide the evidence of our significant results while using triphasic CT in differentiation of lesions.

Table (8) represented the interaction of peripheral rim with contrast at the arterial phase .Other studies have observed rim enhancement around abscesses [19], which were present in the current study.

The dual appearance of peripheral interaction in hemangioma gives us clue to have a quit observing appraisal to avoid confusion between the hyper-(rim)/hyper-/hyper- pattern and the peripheral enhancement in hemangiomas. Studies have mentioned that it is essential to differentiate the moderately homogeneous, continuous rim hyper attenuation with parenchyma.

In the hyper attenuating enhancement patterns; recent studies have reported an improvement in lesion detection if arterial phase imaging is performed in addition to portal venous scanning, especially for hyper vascular lesions. [20, 21, 22]

Hyper attenuation in the arterial phase showed that if a lesion demonstrates arterial attenuation, either complete or peripheral and extending in a centripetal fashion in subsequent phases, the appearance is pathognomonic for hemangioma[23,] Therefore our study using triphasic CT give an excellent characteristic of heamangioma.

In our study some hemangiomas did not show any enhancement in the arterial phase and only started to enhance in the portal phase, whereas others demonstrated complete enhancement in both the arterial and portal phases and in the equilibrium phase, comparing with tumors as highly vascular. This phenomenon already described by Freeny and Marks[23] who had mentioned that this results due to slow perfusion, concentration of contrast material in the lesion still exceeded the concentration in the vascular system. The combination of all phases allowed us a confident diagnosis of hemangioma making us able to differentiate hemangiomas from malignant lesions; another study had mentioned the same results and justifications. [14]

Metastases were also been evaluated in our study showing results in the above tables (8-10), studies had mentioned the metastases from hyper-vascular primary tumors are well depicted on an incremental bolus dynamic scan. [24-26]Hyper vascular metastases appeared as hyper enhanced lesions and were better delineated on arterial phase images, while the other metastases were better delineated on portal phase images.In cases of heptomegally without presence of clear hepatic lesions, the changes of texture were also been evaluated in all phases, and it is important to differentiate such a hyper-(wedge)/iso-/iso- pattern, without any sign of focal disease, from areas of contrast enhancement, which may accompany focal liver lesions, probably due to increased arterial supply to the liver region that contains the lesions this also was recommended by other similar studies [22, 27]

IV. Conclusion

Triphasic spiral liver CT is a standardized CT procedure, designed to enable detection and characterization of a large variety of liver lesions, and multilevel disease. The 5-mm portal phase images reconstructed at 2.5mm intervals, acquired at the peak of liver enhancement are the centerpiece of the protocol and are essential for lesion detection. Different phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions. Equilibrium phase images aid to demonstrate that characterization of benign focal liver lesions, such as hemangioma, cyst, with a standard character of a hypo-/hypo-(cyst)/hypo- appearance and were considered as benign. Conversely, all hyper-(rim) lesions in patients with a hyper vascular primary tumor or chronic liver disease represented malignant disease. Hypo-/ hypo-/hypo- and hypo-/hypo-/hyper lesions need to be interpreted with caution.

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