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Radio-Diagnosis

CT ENHANCEMENT PATTERNS AND WASHOUT IN CHARACTERIZING LIVER LESIONS- A DIAGNOSTIC ACCURACY STUDY

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ABSTRACT **Background:** With the adherent use of imaging modalities there is increase in detection of the liver lesions. Accurate characterization of liver lesions is crucial for optimal patient management. Thus a contrast enhanced Triple phase CT is of an utmost value with CT enhancement patterns and washout aiding meticulously in differentiating benign and malignant liver lesions. Thus the principle of hepatic perfusion is essential for identifying and describing focal and diffuse pathological conditions in the liver. **Aims And Objectives:** Our aim is to study the enhancement pattern and washout characteristics of hepatic lesions and classifying them, following up and correlating with the histopathology or post-operative findings. **Material And Methods:** Retrospective analysis of CT Abdomen and pelvis of 40 patients in Siemens 128 slice CECT scanner (Somatom Definition AS) with liver lesions was done for a duration of 8 months. Lesions categorized based on enhancement patterns (arterial, portal, venous and delayed) and washout characteristics. **Results:** Total 40 patients were studied for various hepatic lesions out of which 16(40%) patient were malignant and 24(60%) patient were benign. Almost all malignant lesions (HCC, metastases) showed arterial enhancement (90%) and rapid washout (80%) whereas benign lesions (hemangiomas, FNH) demonstrated portal venous enhancement (85%) and slow washout (90%) with delayed enhancement was characteristic of cholangiocarcinomas (70%). Diagnostic accuracy: Enhancement pattern alone: 85%, Washout characteristics alone: 80% and Combination of both: 95%. **Conclusion:** Triple phase MDCT is an excellent tool for diagnosis of the focal liver lesion by learning the degree and pattern of enhancement in all three phases thus, helping in better characterization of the lesion.

KEYWORDS : Computerized Tomography, Hepatic, Lesion, Malignant, Benign, Tumor

INTRODUCTION:

Hepatic masses have become more frequently detected due to the increased utilization of various imaging techniques and the advancements in CT technology play a crucial role in elucidating the imaging characteristics of different liver lesions. The principles of hepatic perfusion is essential for identifying and describing focal and diffuse pathological conditions in the liver. It receives dual blood supply, with approximately 75-80% originating from the portal vein and 20-25% from the hepatic artery.(1) Most primary and metastatic liver tumors, receives their blood from the hepatic artery reversing the normal proportion of hepatic blood supply which is mainly supplied by portal vein.(2) These difference in pattern of blood flow forms the basis of triple phase scan of liver and helped to elucidate the imaging features of primary and metastatic liver tumors.(3) It is essential to differentiate between different types of liver lesions to guide appropriate treatment decisions.

A triple-phase CT scan of the liver, including the Hepatic Arterial Phase (HAP), Porto venous phase, and Delayed Phase (DP) aids in distinguishing the vascular supply to various liver lesions and further helps in categorizing these lesions into benign and malignant based on contrast uptake characteristics. The triple-phase CT protocol offers enhanced evaluation of hepatocellular carcinoma (HCC), the most common primary liver neoplasm. By capturing images during arterial, portal, and equilibrium phases, triple-phase CT aids in better characterizing hepatic lesions. Hemangiomas are the most prevalent benign liver tumors, and triple-phase CT examinations play a vital role in distinguishing them from primary and secondary malignant hepatic tumors. Metastasis commonly occurs in the liver more than primary tumors, making it essential to differentiate between hypervascular and hypovascular metastatic lesions using triple-phase CT with its multi-phase imaging capabilities.

Thus improved detection and characterization play a crucial role in identifying hepatic tumors suitable for aggressive surgical interventions versus those necessitating palliative care. While histopathological diagnosis has traditionally been the gold standard, its invasiveness poses limitations. Recent advancements in radiological imaging techniques offer a promising alternative by aiding in approaching, if not definitively reaching, a diagnosis without the need for invasive procedures.

AIMS AND OBJECTIVES:

Our aim is to study the enhancement pattern and washout characteristics of hepatic lesions and classifying them, following up and correlating with the histopathology or post-operative findings.

MATERIALS AND METHODS:

Following approval from the institutional ethical committee, this cross-sectional study was conducted on 40 patients of all age groups and both sexes, referred to the Department of Radiodiagnosis at SAIMS & PG Institute, Indore, with clinical suspicion of hepatic lesions during the period of 8 months study duration i.e., 1st September 2023 to 30th April. Patients meeting the inclusion and exclusion criteria were enrolled after obtaining informed consent.

Inclusion Criteria

All age group irrespective of sex with clinical suspicion of benign and malignant hepatic lesions, undergoing CT, within study duration.

Exclusion Criteria

- Patients who are not willing to give consent;
- Patients on life support systems;
- Patients with history of trauma; and
- Patients in which CECT scan is contraindicated.

Methodology

CT scans were conducted using a Siemens 128-slice CECT scanner (Somatom Definition AS), and images were reformatted into coronal and sagittal views. Experienced radiologists evaluated both axial and reformatted images, recording relevant data for statistical analysis.

Statistical Analysis

The data was coded and entered into Microsoft Excel 2010, and analyzed using both Excel and SPSS 20.0 for Windows. The study results were organized into tables and subjected to statistical analysis. Descriptive statistics were employed to identify characteristics and features of the collected data, with mean and percentage utilized for representation. A Chi-square test was applied to assess associations between variables, considering a p-value of less than 0.05 as statistically significant. Additionally, sensitivity, specificity, positive predictive value, and negative predictive value were calculated to further evaluate the data.

RESULTS:

The study included 40 patients with clinical suspicion of liver lesions with salient features as follows:

Out of 40 patients, 16(40%) patient were malignant and 24(60%) patient were benign.

Almost all malignant lesions (HCC, metastases) showed arterial enhancement (90%) and rapid washout (80%) whereas benign lesions (hemangiomas, FNH) demonstrated portal venous enhancement (85%) and slow washout (90%) with delayed enhancement was characteristic of cholangiocarcinomas (70%).

Diagnostic accuracy: Enhancement pattern alone: 85%, Washout characteristics alone: 80% and Combination of both: 95%

The majority of subjects were diagnosed with metastases and hemangioma (27.5%), followed by liver abscess (22.5%), hepatocellular carcinoma (HCC) (12.5%), calcified granuloma (5.0%), and hydatid cyst (5.5%).

Based on histopathological findings, 25% patients were diagnosed with metastases, followed by hemangioma (22.5%), liver abscess (17.5%), hepatocellular carcinoma (HCC) (15%), hydatid cyst (10%), adenoma (7.5%), and calcified granuloma (2.5%).

Association Between CT Diagnosis And Histopathological Diagnosis

CT DIAGNOSIS		HISTOPATHOLOGICAL DIAGNOSIS							Total
		Adenoma	Calcified Granuloma	HCC	Hemangioma	Hydatid Cyst	Liver Abscess	Metastasis	
CALCIFIED GRANULOMA	N	0	1	0	0	1	0	0	2
	%	0.0%	100.0%	0.0%	0.0%	25.0%	0.0%	0.0%	5.0%
HCC	N	1	0	4	0	0	0	0	5
	%	33.3%	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	12.5%
HEMANGIOMA	N	0	0	1	7	0	0	3	11
	%	0.0%	0.0%	16.7%	77.8%	0.0%	0.0%	30.0%	27.5%
HYDATID CYST	N	0	0	0	0	2	0	0	2
	%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	5.0%
LIVER ABSCESS	N	1	0	0	0	1	7	0	9
	%	33.3%	0.0%	0.0%	0.0%	25.0%	100.0%	0.0%	22.5%
METASTASIS	N	1	0	1	2	0	0	7	11
	%	33.3%	0.0%	16.7%	22.2%	0.0%	0.0%	70.0%	27.5%
	N	3	1	6	9	4	7	10	40
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Chi-Square Tests		Value		df		P Value		Result	
		107.633a		30		0.000		Sig	

The above table shows the association between Histopathological Diagnosis and CT Diagnosis.

Chi square test for association between two variables was applied, which shows that all association between Histopathological Diagnosis and CT Diagnosis was found to be significant (P<0.05).

DISCUSSION:

The triple phase CT helps in characterizing the lesions into benign and malignant in a very efficient manner and the present study aimed at evaluating the triple phase CT features of common hepatic lesions with emphasis on the role of different phase imaging in characterization of hepatic lesions, to differentiate benign from malignant liver lesions, so that diagnosing, staging and management of patients with liver pathology could be performed more effectively.

Hypervascular tumors are enhanced via the hepatic artery in arterial phase. These tumors will be visible as hyperdense lesions in relation to hypodense liver. However, when rest of the liver parenchyma begins to enhance in the portal venous phase, these hypervascular tumors may become concealed. In the Portal venous phase when the normal liver parenchyma enhances maximally, the hypovascular tumors are detected. These hypovascular tumors will be seen as hypodense lesions in relatively hyperdense liver parenchyma.

In the Equilibrium phase, the tumors which lose their contrast slower than normal liver or washes out the contrast rapidly are visible. For example, contrast retention in blood pool is seen in hemangioma, contrast retention in fibrous tissue is seen in capsule around HCC, central scar of FNH and Cholangiocarcinoma. The vascular tumors show rapid contrast washout.

Metastatic and primary hypervascular neoplasms can be identified during the arterial phase, whereas these neoplasms may be isoattenuating and unidentifiable during the portal venous phase.[4,5] The enhancement pattern of various hepatic lesions detected in these studies are as follows –

HEMANGIOMA

Hepatic haemangiomas are the most common benign hepatic tumors. On triple phase CT, they are hypoattenuating on non contrast images, and on contrast phase it shows enhancement similar to the attenuation of vessels and peripheral nodular discontinuous enhancement with a gradual centripetal filling-in pattern on delayed phase images.[6]

HEPATIC ADENOMA

Hepatocellular adenoma is a benign lesion and it is very rare. On CECT, it may show peripheral enhancement with a centripetal pattern of enhancement reflecting of the presence of the large subcapsular feeding vessels. Small hepatocellular adenomas are hyperattenuating and enhance rapidly after contrast injection. They show nearly homogeneous enhancement in 80% of cases, excluding the lesions with acute or chronic tumor hemorrhage and fat deposition. The enhancement mostly does not retain in adenomas because of arteriovenous shunting. [7]

HEPATOCELLULAR CARCINOMA

Hepatocellular carcinoma (HCC) is the most common primary common malignant tumor of liver. On non contrast CT, most HCC are seen as low attenuating lesions. On arterial phase imaging, the lesion which are more vascular shows intense enhancement throughout the tumor and the capsule is seen as non-enhancing hypodense rim. In Portal venous phase there is rapid washout and the lesion becomes iso to hypodense to normal liver parenchyma. On delayed phase imaging the capsule and fibrous septa may show prolong enhancement.

METASTASES

Metastases in liver are far more common than the primary tumors. Not always but usual enhancement pattern is, they typically demonstrate peripheral uptake, with potential central filling-in during the portal venous phase, followed by washout in the delayed phase.

CONCLUSION:

CT enhancement patterns and washout characteristics are essential diagnostic tools for characterizing liver lesions. By integrating these features into their interpretation, radiologists can improve diagnostic accuracy and guide appropriate patient management.

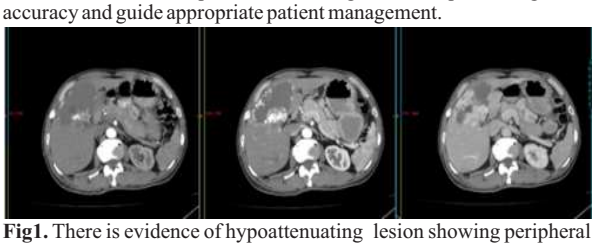

Fig1. There is evidence of hypoattenuating lesion showing peripheral nodular enhancement on arterial phase and progressive centripetal fill in on portal phase with further irregular fill in on venous phase– suggesting hepatic hemangiomas.

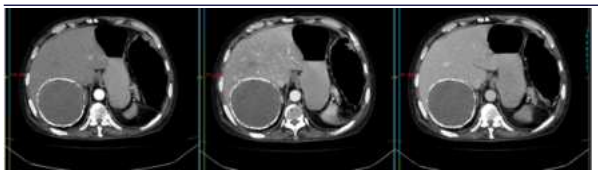

Fig2. A large well defined non enhancing round hypodense lesion with calcified wall is noted at segment VII of right lobe of liver, likely suggestive of calcified liver hydatid cyst.

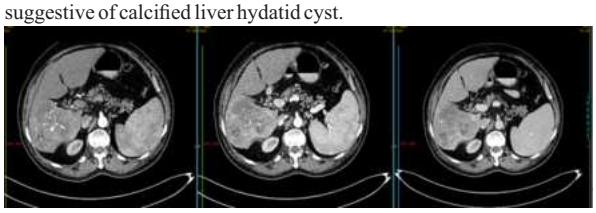

Fig3. An ill marginated, soft tissue density solid lesion showing heterogeneous arterial phase enhancement and washout in portovenoeus and delayed images noted in segment VI and VII of liver showing extension in to right portal vein, confluence and left portal vein near the confluence with heterogeneous enhancing tumoral thrombus within likely suggestive of HCC.

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