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CT imaging findings in hepatocellular carcinoma patients: a single-center study

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Abstract

Background: Hepatocellular carcinoma (HCC) is the most common primary liver malignancy and is a leading cause of cancer-related deaths worldwide. Improved detection and characterization can help determine which hepatic tumors may be amenable to aggressive surgical techniques and which should undergo palliative treatment. The present study was aimed at studying CT scan imaging findings in hepatocellular carcinoma patients. **Material and Methods:** The present study was an observational study conducted in patients with HCC diagnosed on biopsy at Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry from January 2021 to December 2022. **Results:** In the present study, 50 confirmed cases of HCC were studied. The majority were from the 60–69 year age group (42%) and the 70–79 year age group (22%). A majority of them were male (82%). The common associations noted were hepatitis B (38%), alcohol (32%) and hepatitis C (8%). The common CT findings were arterial phase hyperenhancement (92%), portal venous phase washout (92%), intrahepatic arterioportal shunt (42%), portal vein thrombosis (42%), internal cystic degeneration of the HCC (28%), liver metastasis (26%), distant metastasis (18%), arterial and portal venous phase enhancement (14%), inferior vena cava (IVC) thrombosis (14%), hepatic vein thrombosis (10%), delayed venous washout (8%), isolated portal phase enhancement (6%), internal tumor aneurysm (4%) and intrahepatic arteriovenous shunt (4%). **Conclusion:** The radiological hallmark of HCC on CT was hyperenhancement on the arterial phase and washout on the portal venous phase.

Keywords: hepatocellular carcinoma, arterial phase hyperenhancement, portal venous phase washout, intrahepatic arterioportal shunt, intrahepatic arteriovenous shunt, portal vein thrombosis, hepatic vein thrombosis.

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Introduction

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy and is a leading cause of cancer-related deaths worldwide [1]. HCC is an epithelial tumor originating in the liver and composed of cells with characteristics similar to those of normal hepatocytes.

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Cirrhosis remains the most important risk factor for the development of HCC regardless of the etiology of cirrhosis [1].

Hepatitis B virus (HBV) and Hepatitis C virus (HCV) infections, cirrhosis of the liver, and alcohol consumption are the most common risk factors associated with the development of HCC in India [2]. Obesity, diabetes mellitus (DM), and nonalcoholic fatty liver disease (NAFLD) are other important risk factors [3]. Screening includes radiologic tests, such as ultrasound, computerized tomography, and magnetic resonance imaging, and serological markers such as α-fetoprotein at 6-month intervals [4, 5].

Improved detection and characterization can help determine which hepatic tumors may be amenable to aggressive surgical techniques and which require palliative treatment. The tremendous development of multidetector CT has led to improvements in spatial as well as temporal resolution. The present study was aimed to study CT scan imaging findings in hepatocellular carcinoma patients.

Material And Methods

The present study was a prospective, observational study, conducted in the Department of Radiodiagnosis, at Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India. The study duration was for 2 years (January 2021 to December 2022).

Inclusion criteria

- Patients with biopsy proven diagnosis of hepatocellular carcinoma (HCC) willing to participate in the present study

Exclusion criteria

- Patients with infective, inflammatory lesions or traumatic lesions of the liver
- Patients who could not be followed up to the final diagnosis

The study was explained to patients in their local language and a written informed consent was obtained. Patients, who presented with clinical signs and symptoms of neoplastic processes of the liver, were further evaluated by ultrasonography or Computed Tomography and other non-radiological investigations, followed by if required biopsy/surgery and histopathology.

CT scan was performed on Siemens SOMATOM SCOPE 32 slice CT scanner machine. Volumetric data from the diaphragm to the pubic symphysis was acquired with a pitch of 1 and contiguous 2 mm slice thickness. A reconstruction algorithm was used to obtain 0.7mm voxels in the axial, coronal and sagittal planes and also in multiple planes. Each patient was administered 1 to 1.5 ml/kg body weight non-ionic intravenous contrast (Iohexol/Optiscan 350mg/ml) through a power injector at a rate of 2.5 – 3 ml/s. The images were acquired after oral and intravenous contrast with arterial, portal and venous phases.

CT images were analysed by an experienced abdominal radiologist, and enhancement patterns (in arterial or portal phase), contrast washout (in the portal or delayed venous phase), internal cystic degeneration, internal abnormal vessel, and portal vein/hepatic vein status were evaluated.

Data was collected and compiled using Microsoft Excel and analyzed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

Results

In the present study, 50 confirmed cases of HCC were studied. The majority were from the 60-69 years age group (42%) & 70-79 years age group (22%) and were male (82%). Common etiology noted was hepatitis B infection (38%), alcohol (32%) & hepatitis C infection (8 %).

Table 1: General characteristics

	No. of patients	**Percentage**

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Age groups (in years)		
30-39	2	4
40-49	6	12
50-59	10	20
60-69	21	42
70-79	11	22
Gender		
Male	41	82
Female	9	18
Causative factor		
Hepatitis B	19	38
Alcoholic	16	32
Hepatitis C	4	8
Others	11	22

In the present study, common CT findings were Arterial phase enhancement (92 %), Portal phase washout (92 %), Hepatic artery portal shunt (42 %), Portal vein thrombosis (42 %), Internal cystic degeneration within HCC (28 %), Liver metastasis (26 %), Distant metastasis (18 %), Arterial and portal phase enhancement (14 %), IVC thrombosis (14 %), Hepatic vein thrombosis (10 %), Delayed venous washout (8 %), Portal phase enhancement (6 %), Internal tumor aneurysm (4 %) & Hepatic artery hepatic venous shunt (4 %). The findings on CT are depicted in Table-2

Table 2: CT findings

CT finding	**No. of patients**	**Percentage**
Arterial phase enhancement	46	92
Portal phase washout	46	92
Hepatic artery portal shunt	21	42
Portal vein thrombosis	21	42
Internal cystic degeneration within HCC	14	28
Liver metastases	13	26
Distant metastases	9	18
Arterial and portal phase enhancement	7	14
IVC thrombosis	7	14
Hepatic vein thrombosis	5	10
Delayed venous washout	4	8
Portal phase enhancement	3	6
Internal tumor aneurysm	2	4
Hepatic artery hepatic venous shunt	2	4

Vascular changes noted were venous thrombosis (54%), Hepatic arterioportal shunt (44%), Portal vein thrombosis (42%) (Figures 1 and 2), Hepatic arteriovenous shunt (42%), IVC thrombosis (18%), Hepatic vein thrombosis (10%), Hepatic arterial hepatic venous shunt (6%) and Intratumoral pseudoaneurysm (2%).

Table 3: Vascular finding CT

Vascular changes	**No. of patients**	**Percentage**
Venous thrombosis	27	54
Hepatic arterioportal shunt	22	44
Portal vein thrombosis	21	42

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Hepatic arteriovenous shunt	21	42
IVC thrombosis	9	18
Hepatic vein thrombosis	5	10
Intratumoral pseudoaneurysm	1	2

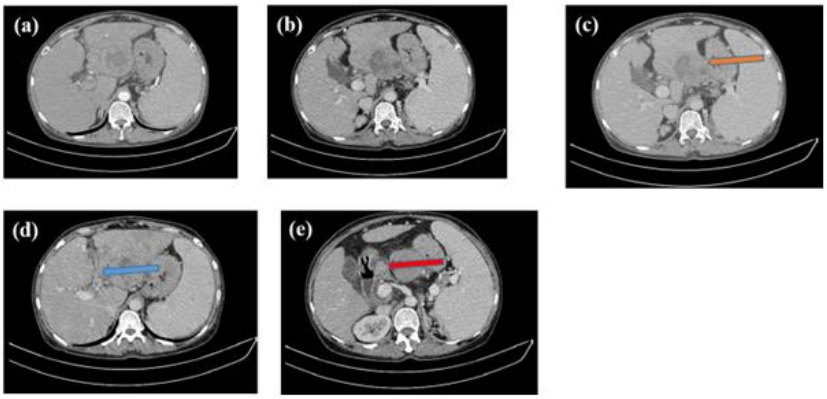

Figure 1: A 58-year-old female patient's axial CECT image in the (a) arterial, (b) portal venous and (c) hepatic venous phases shows a relatively well-defined exophytic lesion which shows arterial enhancement and washout in subsequent phases (Orange arrow). (d) Axial CECT image in the portal phase at the portal bifurcation level shows a hypodense thrombus in the left portal vein (Blue arrow). (e) Axial CECT image in arterial phase shows a large homogenously enhancing periportal lymph node (red arrow) causing compression of the common hepatic artery.

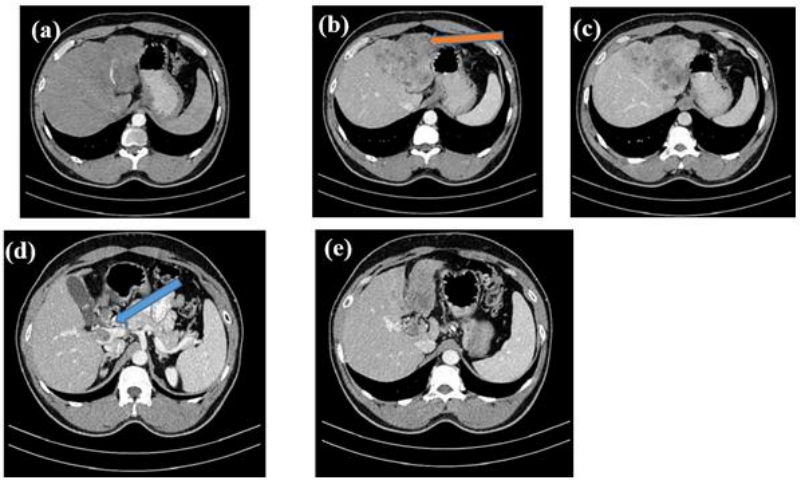

Figure 2: A 34-year-old male patient's axial CECT image in (a) arterial, (b) portal venous and (c) hepatic venous phases shows an ill-defined hypodense solid lesion with few necrotic areas within which shows mild arterial enhancement and late washout in subsequent phases (Orange arrow). (d) Axial CECT image in the portal phase shows a large hypodense thrombus in the portal vein (Blue arrow) (e) Axial CECT image in the portal phase shows hypodensity of the left lobe of the liver suggestive of hepatic infarction.

Discussion

Vascular and tumor anatomical details are helpful to plan for neoadjuvant chemotherapy and surgical or image-guided interventions. The available treatment interventions can be broadly divided into curative and noncurative therapies. Curative therapies include liver resection, thermal ablation, and liver transplant, whereas noncurative therapies include transarterial

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chemoembolization (TACE), transarterial radioembolization (TARE), stereotactic body radiation therapy, and systemic chemotherapy, which aim to improve survival by delaying the growth of the tumor [6].

HCC is a notorious cancer with multiple and overlapping risk factors across the spectrum of its evolving conditions, including NAFLD (non-alcoholic fatty liver disease), NASH (non-alcoholic steatohepatitis), and subsequent cirrhosis. Advantages of CT over MRI include lower cost, increased availability, and faster scan times. Faster scan times in particular can be an advantage in the context of a cirrhotic population with multiple morbidities and difficulty cooperating with the breath hold requirements of MRI [7].

The typical sonographic and unenhanced CT findings of HCC show a well-circumscribed hypoechoic or hypoattenuated mass with or without the hypoechoic rim of a tumor capsule. MRI typically shows that HCC is hyperintense relative to the liver on T2-weighted images and hypointense on T1-weighted images. On dynamic CT and MRI, HCC shows early enhancement in the arterial phase and contrast medium washout in the equilibrium phase [8].

Kaushal L et al. [9] noted that triple-phase CT is excellent for characterization and better evaluation of hepatic masses with a sensitivity of 91.3%, a specificity of 97.8%, a PPV of 91.3%, and a NPV of 97.8% (p-value < 0.001, kappa value 0.847). Malignant hepatic lesions can be diagnosed by triphasic CT with an accuracy of 93%, sensitivity and specificity of 93.3% and 92.5%, respectively, and PPV and NPV of 94.9% and 90.2%, respectively, and by USG with an accuracy of 87%, sensitivity and specificity of 90% and 82.5%, respectively, and PPV and NPV of 88.5% and 84.6%, respectively.

For CT diagnosis of hepatocellular carcinoma, lesions between 1 and 2 cm must be hypervascular on arterial phase imaging, and demonstrate portal vein/delayed phase washout and pseudocapsule enhancement. If both washout and pseudocapsule enhancement are not present, they must demonstrate growth on serial imaging or be confirmed on histology [10, 11, 12]. Lesions between 2 and 5 cm or more must be hypervascular on arterial phase imaging and demonstrate portal venous or delayed phase washout, or pseudocapsule enhancement. If there is no washout or pseudocapsule enhancement, the lesion must demonstrate growth on serial imaging. Lesions less than 1 cm are indeterminate (and thus, not eligible to be considered HCC) [10,11,12].

Kalpesh K et al. [13] noted that out of 15 cases of hepatocellular carcinoma, 13 (86.67%) showed heterogeneous hyperenhancement in the arterial phase; 8 (53.33%) cases of hepatocellular carcinoma were hypoattenuating, and 5 (33.33%) cases were isoattenuating in the portal venous phase, suggesting early washout. Out of 41 cases of metastases, 39 (95.12%) showed hypoattenuation in the arterial phase and portal venous phase, while in the venous phase, 12 (29.27%) cases showed hypoattenuation and 27 (65.85%) cases showed isoattenuation. Out of 65 cases of adults with neoplastic lesions of the liver, including hepatocellular carcinoma, metastases, hemangioendothelioma, hemangioma, and intrahepatic cholangiocarcinoma, the sensitivity and specificity of MDCT for hepatocellular carcinoma were 86.7% and 98%, respectively.

While HCC of the distinctly nodular type frequently shows a typical enhancement pattern with contrast CT, HCC of the vaguely nodular type tends to show an atypical enhancement pattern, such as a lack of arterial hyperenhancement or venous or delayed washout [14]. The diagnosis of HCC on multiphase CT and MRI is made on postcontrast imaging when there is late hepatic arterial-phase hyperenhancement, venous phase or delayed-phase washout appearance, and venous-phase or delayed-phase capsule appearance. The specificity and positive predictive value of HCC are nearly 100% on CT/MRI [14, 15]. For HCCs greater than 2 cm, the sensitivity of MRI is 100%, and multiphase CT is 98% [16]. For HCCs less than 2 cm, the sensitivity of MRI is 68%–85%, and the sensitivity of CT is 61–78% [17] with

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the diagnostic advantage of MRI over multiphase CT in smaller nodules, especially those less than 1 cm.

Triple-phase CT is ideal for the diagnosis of benign conditions like hemangioma and infantile hemangioendothelioma. Triple-phase CT, with its arterial, portal venous, and delayed phases, is an ideal modality for the diagnosis and characterization of HCC. With proper screening and vigilance, many patients with HCC could be diagnosed with early disease and preserve liver function.

Conclusion

In suspected cases of HCC, dynamic (3-phase or 4-phase) CT is recommended, including the late arterial phase and portal venous phase. The HCC radiological hallmark includes hyper-enhancement on the arterial phase and wash-out on the portal venous (delayed phase). CT is helpful to provide additional information like vascular invasion, capsular delineation, and arterioportal shunts, as well as a vascular road map for surgery and image-guided interventions.

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