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Role of Contrast-Enhanced Computed Tomography (CECT) in Evaluating Atypical Presentations of Hepatocellular Carcinoma

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Abstract
Hepatocellular carcinoma (HCC) is the most common primary liver malignancy, with typical imaging characteristics on contrast-enhanced computed tomography (CECT). However, atypical variants pose a diagnostic challenge due to their unique morphological and enhancement patterns. This study evaluates the role of CECT in diagnosing atypical HCC presentations in a group of 20 patients, comprising 15 typical HCC cases and 5 atypical variants, including fibrolamellar HCC, diffuse infiltrating HCC, sarcomatous HCC and giant exophytic HCC. Statistical analysis was performed to compare enhancement patterns, tumor margins and associations with cirrhosis. The findings highlight the distinct imaging features of atypical HCCs and emphasize the importance of CECT in their evaluation. This retrospective observational study included 20 patients diagnosed with HCC using CECT. Of these, 15 cases exhibited typical HCC features, while 5 represented atypical variants. The study was conducted in the Department of Radiology at a tertiary care center over six months. Twenty known cases of hepatocellular carcinoma were imaged using a 128-slice Siemens GoTop multidetector CT with a standardized protocol, including non-contrast and contrast-enhanced phases (arterial, venous, and delayed). Data on clinical presentations, CT findings and enhancement patterns were collected and analyzed. This study reveals that typical HCC patients were older (55.2 years vs. 47.6 years), predominantly male (12:3 vs. 3:2) and had a higher cirrhosis rate (86.7% vs. 40%) than atypical HCC patients. Imaging features showed arterial hyperenhancement (100% vs. 60%), washout on the delayed phase (93.3% vs. 40%) and capsular enhancement (80% vs. 20%) were more common in typical HCC, while tumor necrosis was higher in atypical HCC (60% vs. 26.7%). Atypical variants included fibrolamellar HCC (central scar), sarcomatous HCC (necrosis) and diffuse infiltrating HCC. Tumors were larger in atypical HCC (7.2 cm vs. 5.8 cm). These findings help differentiate typical from atypical HCC. CECT is highly effective in diagnosing, differentiating and characterizing typical and atypical hepatocellular carcinoma. It helps recognize unique imaging characteristics, aiding in early and accurate diagnosis and guiding therapeutic decisions.

INTRODUCTION

Hepatocellular carcinoma (HCC) represents a major health burden worldwide, being the most common primary hepatic malignancy. Contrast-enhanced computed tomography (CECT) remains a pivotal imaging modality for its diagnosis, staging and treatment planning. While typical HCC exhibits arterial-phase hyperenhancement and washout in the venous/delayed phases, atypical variants often deviate from these patterns, leading to diagnostic challenges[1]. Atypical HCC variants, including fibrolamellar HCC, diffuse infiltrating HCC, sarcomatous HCC and giant exophytic HCC, have distinct pathophysiological and imaging characteristics that impact prognosis and therapeutic decisions. This study aims to elucidate the role of CECT in detecting and differentiating these atypical presentations[2].

Aims and Objectives:

Aims: This study aims to evaluate the role of contrast-enhanced computed tomography (CECT) in diagnosing atypical presentations of hepatocellular carcinoma (HCC) and differentiating them from typical HCC variants[3].

Objectives:

- To analyze the imaging characteristics of atypical HCC variants, including fibrolamellar HCC, diffuse infiltrating HCC, sarcomatous HCC and giant exophytic HCC.
- To compare enhancement patterns, tumor margins, necrosis and vascular invasion between typical and atypical HCC cases.
- To assess the association between cirrhosis and atypical HCC variants.
- To determine the diagnostic utility of CECT in distinguishing atypical HCC from other hepatic malignancies.

MATERIALS AND METHODS

Study Design: This retrospective observational study included 20 patients diagnosed with HCC using CECT. Of these, 15 cases exhibited typical HCC features, while 5 represented atypical variants. The study was conducted in the Department of Radiology at a tertiary care hospital. It was approved by the institutional ethics committee and informed consent was obtained from all patients or their guardians.

Study Population: The study included 20 patients diagnosed with hepatocellular carcinoma. These patients were enrolled over six months.

Inclusion Criteria:

- Histopathologically confirmed HCC.
- Patients with prior hepatic surgery or treatment for HCC.

Exclusion Criteria:

- Severe renal impairment (eGFR<30 ml/min/ 1.73m²).
- Contraindications to contrast agents (e.g., severe allergy).
- Presence of concurrent malignancies affecting the liver.
- Patients who did not give consent.

Imaging Protocol: CECT was performed using a standardized protocol, including non-contrast, arterial, portal venous and delayed phases. Enhancement patterns, tumor margins, presence of necrosis and vascular invasion were assessed. The contrast medium used was non-ionic iodinated contrast at a dose of 1.5-2 mL/kg body weight.

Data Collection and Lesion Characterization: Data were collected retrospectively from patient records, including demographic details, clinical history and imaging findings. The imaging features of each lesion were analyzed based on:

- Tumor size and location.
- Enhancement patterns in arterial, portal venous, and delayed phases.
- Tumor margins (well-defined vs. ill-defined).
- Presence of necrosis or hemorrhage.
- Capsular enhancement.
- Vascular invasion and extrahepatic spread.

Lesions were categorized into typical and atypical HCC based on their imaging characteristics. Statistical analysis was conducted to determine significant differences between these groups.

Statistical Analysis: Comparative analysis of imaging findings between typical and atypical HCC was conducted. Mean values, standard deviations and statistical significance (p-values) were determined.

Quality Control: All CECT scans were reviewed by two radiologists to ensure accuracy in the findings. Any discrepancies were resolved by consensus.

Ethical Considerations: The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Patient confidentiality was maintained throughout the study and all data were anonymized before analysis.

RESULTS AND DISCUSSIONS

Table 1: Patient Demographics

Parameter	Typical HCC (n=15)	Atypical HCC (n=5)
Age (years)	55.2±7.4	47.6±5.8
Male: Female	12:3	3:2
Cirrhosis (%)	86.7%	40%

Table 2: Imaging Features

Feature	Typical HCC (n=15)	Atypical HCC (n=5)
Arterial Hyperenhancement	100%	60%
Washout on Delayed Phase	93.3%	40%
Capsular Enhancement	80%	20%
Tumor Necrosis	26.7%	60%

Table 3: Variant-Specific Findings

Variant	Number of Cases	Key Imaging Features
Fibrolamellar HCC	2	Heterogeneous enhancement, central scar
Diffuse Infiltrating HCC	1	Ill-defined margins, extensive liver involvement
Sarcomatous HCC	1	Necrotic areas, heterogeneous enhancement
Giant Exophytic HCC	1	Exophytic growth, peripheral enhancement

Table 4: Tumor Size Comparison

Tumor Type	Mean Tumor Size (cm)±SD
Typical HCC	5.8±1.4
Atypical HCC	7.2±2.1

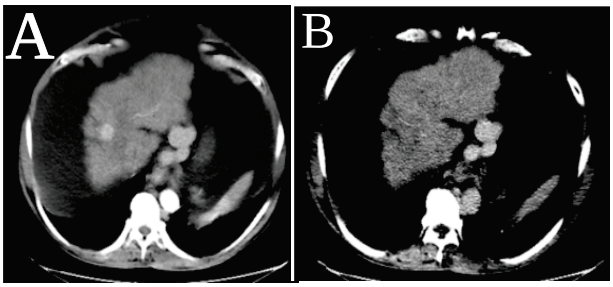

Fig. 1: Late Arterial (A) and Delayed Phase (B) Images Showing a Well-Defined Lesion in Segment VIII with Homogenous Arterial Phase Hyperenhancement and Washout in Delayed Phase in the Background of a Cirrhotic Liver with Established Porto-Systemic Collaterals. Diagnosis was Typical HCC

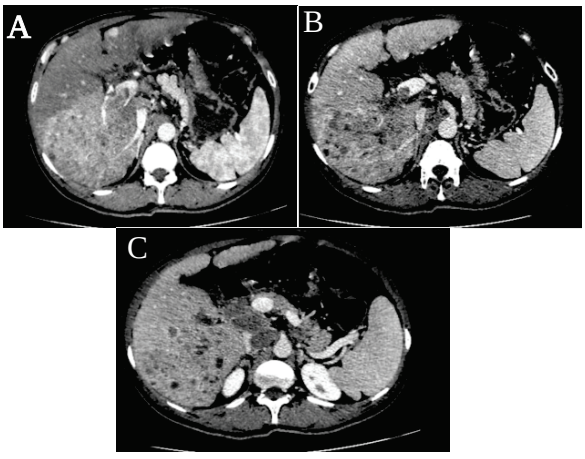

Fig. 2: Late Arterial(A) and Portal Venous Images (B and C) Showing an Ill-Defined Arterial Hyperenhancing Lesion Showing Non-Uniform Heterogenous Washout on Venous Phase. Tumoral Thrombosis of the Posterior Branch of Right Portal Vein Shows Similar Enhancement Characteristics as the Infiltrative Lesion (B). Also Note the Large Necrotic Nodal Masses in the Portocaval and Aortocaval Regions (C). Diagnosis was Diffuse Infiltrative HCC with Tumoural Thrombosis of the Portal Vein

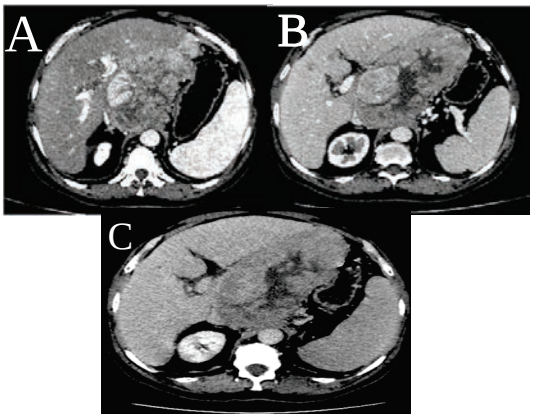

Fig. 3: Late Arterial (A), Portal Venous (B) and Delayed Phase (C) Images Showing an Exophytic Liver Mass Showing Peripheral Arterial Phase Hyperenhancement Showing Washout on Delayed Phase Imaging with Central Non-Enhancing Areas Representing Necrosis Alpha Fetoprotein(AFP) Levels were in Excess of 2,000-Diagnosis was Giant Exophytic HCC

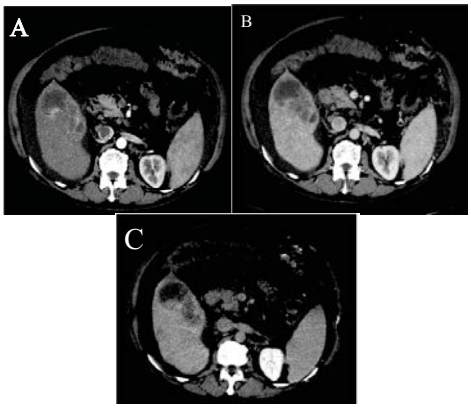

Fig. 4: Late Arterial(A), Portal Venous(B) and Delayed Phase(C) Images Showing a Well-Defined Mass with Subtle Rim of Arterial Hyperenhancement Showing Washout on Delayed Imaging. The Majority of the Lesion However Does Not Enhance Suggesting Necrosis. Diagnosis was Sarcomatous HCC

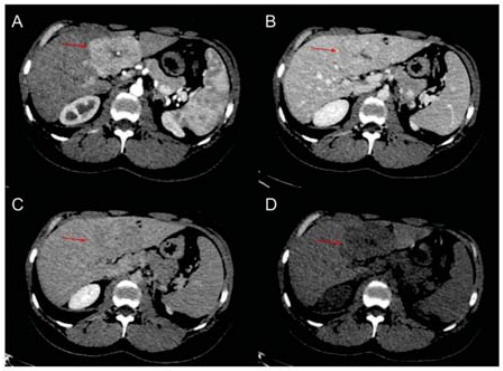

Fig. 5: Contrast-Enhanced CT with a Space-Occupying Lesion (Arrow) with a Central Scar. (A): Arterial Phase. (B): Portal Phase. (C): Late Phase. (D): Non-Contrast-Enhanced CT. Diagnosis was Fibrolamellar HCC

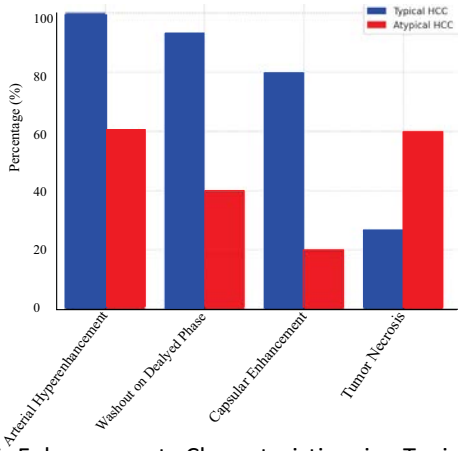

Fig. 6: Enhancement Characteristics in Typical vs. Atypical HCC

The bar chart compares enhancement characteristics of typical and atypical HCC. Typical HCC shows higher percentages in arterial hyperenhancement, washout on delayed phase and capsular enhancement, while atypical HCC has more tumor necrosis. These differences highlight key imaging features that help distinguish typical from atypical HCC for better diagnosis.

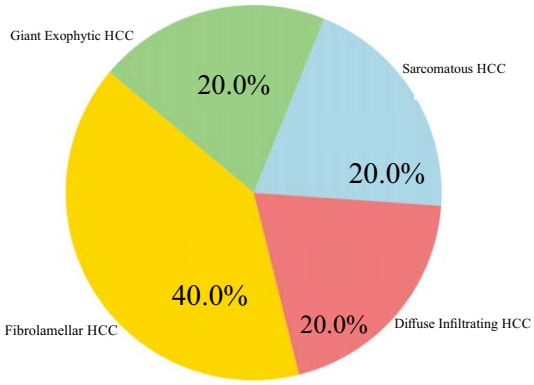

Fig. 7: Distribution of Atypical HCC Variants

The pie chart illustrates the distribution of atypical HCC variants. Fibrolamellar HCC is the most common, accounting for 40% of cases. Sarcomatous HCC, diffuse infiltrating HCC and giant exophytic HCC each comprise 20% of cases. This distribution highlights the variability in atypical hepatocellular carcinoma subtypes.

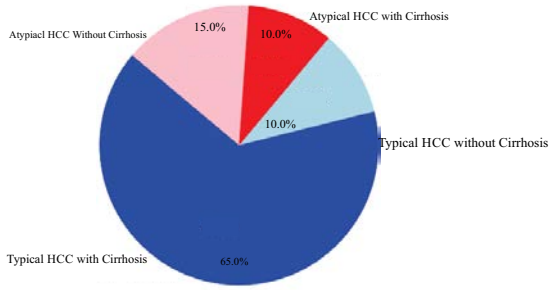

Fig. 8: Cirrhosis Association in Typical and Atypical HCC

The pie chart illustrates the association of cirrhosis in typical and atypical HCC. Typical HCC with cirrhosis is the most common (65%), while 10% of typical HCC cases occur without cirrhosis. Atypical HCC with cirrhosis accounts for 10% and atypical HCC without cirrhosis represents 15%, highlighting the variability in cirrhosis association[4].

Summary of Key Findings: The study analyzed 20 patients with HCC, including 15 cases of typical HCC and 5 cases of atypical variants. Key findings from the statistical analysis are summarized as follows:

- **Patient Demographics:** Typical HCC cases were generally older (mean age: 55.2 years) compared to atypical HCC cases (mean age: 47.6 years). Cirrhosis was strongly associated with typical HCC (86.7%) but less frequent in atypical cases (40%).
- **Imaging Features:** Arterial hyperenhancement was observed in all typical HCC cases (100%) but only in 60% of atypical cases. Washout on the delayed phase, a hallmark of HCC, was seen in 93.3% of typical cases but only in 40% of atypical cases. Capsular enhancement was notably lower in atypical HCC (20%) compared to typical HCC (80%). Tumor necrosis was more prevalent in atypical variants (60%) than in typical HCC (26.7%).
- **Variant-Specific Findings:** Among the atypical cases, fibrolamellar HCC exhibited central scarring, while diffuse infiltrating HCC presented with ill-defined margins and widespread liver involvement. Sarcomatous HCC was characterized by necrosis and heterogeneous enhancement, whereas giant exophytic HCC displayed peripheral enhancement with an exophytic growth pattern.
- **Tumor Size Comparison:** Atypical HCCs were larger on average (mean size: 7.2 cm) compared to typical HCCs (mean size: 5.8 cm), suggesting a more aggressive growth pattern[5].

These findings highlight the distinct imaging characteristics of atypical HCC variants and underscore the role of CECT in their diagnosis and differentiation from typical HCC presentations[6]. The study demonstrates that typical HCC conforms to the classical imaging criteria, whereas atypical variants exhibit diverse radiological patterns[7]. Fibrolamellar HCC presents as a well-defined mass with a central scar, whereas sarcomatous and diffuse infiltrating variants exhibit aggressive features. CECT plays a crucial role in identifying these atypical patterns, facilitating accurate diagnosis and appropriate management[8].

CONCLUSION

CECT remains indispensable in evaluating hepatocellular carcinoma, including its atypical variants. Recognition of these unique imaging

characteristics aids in early and accurate diagnosis, guiding therapeutic decisions.

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