World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-29, December 2023
ISSN: 2749-3644

USING CT AND MRI FOR IDENTIFICATION OF ARTERIAL HYPERENHANCEMENT IN PATIENTS WITH HEPATOCELLULAR CARCINOMA

Turgunov B.Sh
(PhD student of Republican Specialized Surgery Center after named V.V Vakhidov, Uzbekistan and Radiology Department of Shaoxing People's Hospital, China)
Khudoykulova M.N
(Student of Central Asian Medical Univerity, Fergana, Uzbekistan)
Uchtemirov M.U
(Graduated student of Radiology Department of Samarkand State of Medical University)

Article history:

Received: October 7th 2023
Accepted: November 7th 2023
Published: December 10th 2023

Abstract:

Given the varied prevalence and clinical settings, there has been some heterogeneity in the clinical guidelines regarding the method of imaging diagnosis for hepatocellular carcinoma (HCC). However, all methods used to diagnose HCC are based on the imaging diagnostic hallmarks of arterial enhancement and portal-delayed washout, as key alterations during hepatocarcinogenesis include elevated arterial flow and reduced portal venous flow. Arterial phase hyperenhancement is defined as enhancement in the arterial phase that is unequivocally greater than that of the surrounding liver according to the current major guidelines. Therefore, the objectives of our study were to compare the identification of hyperenhancement according to various phases on CT and MRI in patients with surgically proven HCCs as a reference standard using qualitative and quantitative imaging analyses.

Keywords: MRI, CT, Hepatocellular carcinoma, arterial enhancement

MATERIALS AND METHODS

Patients

Patients were selected through a search of our pathology department's registry database. Between January 2011 and September 2013, 597 consecutive patients with surgically proven HCCs were included in our study. Among them, 422 were subsequently excluded for the following reasons: 1) an interval between CT and MRI of more than 30 days (n = 128), 2) lack of pre-operative evaluation of contrast material-enhanced CT (n = 119) or MRI (n = 73), 3) lack of a CT scan with unenhanced images or an MR scan with subtraction images (n = 99), or 4) prior history of HCC treatment with transarterial chemoembolization (n = 3).

Then, all CT and MR images from each patient were preliminarily reviewed by two radiologists (with 2 and 5 years of experience in abdominal imaging, respectively) and a first year student of Central Asia Medical University to exclude patients with inadequate late arterial phase images due to too early scanning (absence of opacification of portal venous system) or motion artifacts.

Image Analysis

Two radiologists (with 2 and 5 years of experience in abdominal imaging, respectively) independently reviewed the CT and MR images. To minimize the recall bias by each imaging modality, the order of review was randomized in each patient. Prior to image analysis, the radiologists established a review protocol based on previous studies. If a patient had multiple HCCs, the largest tumor was used for image analysis. All images were evaluated using adjustment of the optimal window setting on picture archiving and communication system (PACS, Centricity; GE healthcare, Chicago, IL, USA).

Statistical Analysis

The identification rates for arterial hyperenhancement were calculated using five different qualitative methods in CT and MRI. The identification rates were compared using McNemar test. In addition, our quantitative analysis was performed with a Wilcoxon signed-rank test.

RESULTS

Patients

Among 147 patients, the most common cause of chronic liver disease was hepatitis B virus infection (82.9%, 122/147). Most patients had well preserved hepatic function, with a Child-Pugh score of 5 (87.1%, 128/147). The mean index tumor size was 4.2 cm (range, 1.3–17.6 cm)

Quantitative Imaging Analysis

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The absolute HCC enhancement ratio on arterial phase was significantly higher in MRI than in CT images (median; 50.26 vs. 27.20; $p < 0.001$). In addition, the relative odds ratio of HCC enhancement using dual phase in MRI was significantly higher than those in CT images (median; 1.81 vs. 1.67; $p = 0.001$)

Quantitative Analysis

Although arterial phase CT showed the best inter-observer agreement for identification of arterial hyperenhancement (κ = 0.84; 95% confidence interval = 0.74–0.94), other qualitative analysis in CT and MRI also showed moderate to excellent agreement between radiologists.

Cutoff Value of HU Difference between the Tumor and the Surrounding Liver

The optimal cut-off value for the determination of arterial enhancement was a more than 8.8 HU difference between the HCC and the surrounding liver on arterial phase CT. This criterion yielded 97.1% sensitivity, 87.5% specificity, and 94.6% accuracy. However, a considerable number of HCCs (25.9%, 38/147) showed less of an HU difference on arterial phase compared to this specific cut-off value.

DISCUSSION

Our study showed that the identification rate of arterial hyperenhancement in patients with HCCs varied depending on how arterial hyperenhancement on CT and MRI was defined. Visual comparison of arterial and unenhanced phases was significantly superior to conventional qualitative assessment using arterial phase alone for determining arterial hyperenhancement of HCCs in CT images, whereas the two methods did not differ significantly using MR images. The identification rate of arterial hyperenhancement was highest when subtraction MR images were used.

Diffusion restriction, mosaic architecture, nodule-innodule appearance, and rim enhancement can be suggested as ancillary imaging findings of HCC. However, arterial hyperenhancement and portal or delayed washout are the most important imaging characteristics based on the unique histopathological features of HCC, which is increased unpaired arterial blood flow with decreased portal flow during hepato-carcinogenesis.

Our qualitative results showed that arterial hyperenhancement of HCCs was relatively poorly identified by arterial phase CT compared to four other diagnostic methods. In our results, among 40 HCCs with iso- or hypodensity on arterial phase CT, 28 (70%) were changed to "arterial hyper-enhancement present" after visual comparison of the unenhanced and arterial phase images. In our results, subtraction MR images showed the best diagnostic performance for identification of arterial hyperenhancement in patients with HCCs.

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