Perilesional Enhancement Assessment of Hepatic Metastases by Dynamic MRI

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Abstract: Evaluation of liver metastases is one of the most common indications for magnetic resonance (MR) imaging of the liver. In an era when contrast-enhanced CT and MRI are widely used for the assessment of focal liver lesions, peripheral rim enhancement of lesions on early phase images has been recognized as one of the characteristic findings of metastatic tumors. The purpose of this study is to determine whether perilesional parenchymal enhancement of hepatic metastases was correlated with the degree of tumoral enhancement on arterial phase images or tumor size using dynamic MRI. 67 hepatic metastases lesions in 33 patients were studied for perilesional enhancement and the study findings were high percent of perilesional enhancement at metastases compared to other histologic types of hepatic tumors like hepatocellular carcinoma and cavernous hemangioma. In addition, perilesional enhancement patterns observations showed it was the main component of rim enhancement rather than tumor hypervascular periphery that its size showed inverse correlation with the size of perilesional parenchymal enhancement. Characterizing the metastases from other hepatic tumors as well as different features of perilesional rim enhancement can influence therapeutic planning and an expectation of a better prognosis.
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Key words: perilesional • enhancement • MRI • dynamic • metastases

1. Introduction:

MRI is gradually emerging as the imaging modality of choice for detection and characterization of liver lesions. Identification of contrast enhancement pattern is crucial for characterization of hypervascular liver lesions [1].

Evaluation of liver metastases is one of the most common indications for magnetic resonance (MR) imaging of the liver. Metastases are the most common malignant liver lesions and are about 18–40 times more common than primary liver tumors [2].

In an era when contrast-enhanced CT and MRI are widely used for the assessment of focal liver lesions, peripheral rim enhancement of lesions on early phase images has been recognized as one of the characteristic findings of metastatic tumors [3].

Several reports with histologic correlation in metastatic tumors showed the growing tumor margin in the peripheral portion and the rather hypovascular components in the more central portion. Rim enhancement has been regarded as representing the hypervascular tumor periphery [3]. This rim enhancement has been explained by perilesional hepatic parenchymal enhancement around the tumor border [4].The main clinical impact of this type of perilesional enhancement is the potential for inaccuracies in tumor size estimation, which can have an influence on therapeutic planning and prognosis [5]. It has been established that complete surgical resection of liver metastases prolongs survival in eligible surgical candidates. Hence, detection, absolute quantification and localization of liver metastases are crucial as the findings alter the clinical outcome of the disease and patient management [6]. The purpose of this study is to determine whether perilesional parenchymal enhancement of hepatic metastases was correlated with the degree of tumoral enhancement on arterial phase images or tumor size using dynamic MRI.

2. Patients and Methods:

Patients

The study included 33 patients with known or suspected hepatic metastasis, 9 patients had histologic proof of primary extrahepatic lesions and liver lesions and 24 patients had histologic proof of primary extrahepatic lesions with definite serial increase in size of hepatic lesions.

The patients in this study were 19 men and 14 women; age range, 37–73 years; mean, 57 years ± 2SD . The primary cancer in the 33 patients with hepatic metastases was 13 colorectal cancers, 11 breast cancers, 5 pancreatic carcinomas, 2 lung cancers, one urinary bladder cancer and one renal cell carcinoma. 16 patients had single lesions, and 17 had multiple lesions.

All patients were examined with IV gadolinium chelate –enhanced dynamic MRI and all were analyzed for perilesional enhancement on arterial phase dynamic MRI in addition to unenhanced MR images.

Patients of this study were only patients success to meet the criteria for entry to this analysis, these criteria were identification of discrete focal lesions, successful arterial phase MRI that revealed contrast filling in intrahepatic portal veins without hepatic vein enhancement, no previous localized percutaneous ablation therapy for the focal hepatic lesions, and clearly visible lesions on unenhanced MR images for proper sizing of lesions before contrast media enhancement.

MRI

MRI was performed on a 1.5-T system (Signa, GE Healthcare) using a phased-array torso coil. T2-weighted imaging with the STIR turbo spin-echo technique (TR/TE, 3,500–4,000; inversion time, 65–80/165 msec; refocusing pulse, 130°; bandwidth, 325 Hz/pixel) was performed on the axial plane. After phase-contrast imaging with a double echo spoiled gradient-echo sequence (192/2.7 for opposed phase and 5.3 msec for in phase; flip angle, 80°; bandwidth, 488 Hz/pixel), Precontrast T1-weighted imaging and multiphase contrast-enhanced dynamic imaging were performed with the volumetric interpolated breath-hold examination (VIBE) with 3D spoiled gradient-echo sequences with fat suppression (.TR range/TE, 3–4/1.1; inversion time, 15 msec; flip angle, 15°; matrix, 256 x 128; section thickness, 10 mm; receiver bandwidth, 125 kHz; and number of signals acquired, one half. A 0.55 rectangular field of view was used to reduce the number of phase-encoding views[).]

For arterial phase imaging, all patients received a 20-25ml (1-2 mg/kg BW) of gadopentetate dimeglumine at a rate of 3 ml/sec through a catheter placed in a peripheral vein. Sequential spoiled gradient echo MR images were obtained through the lesion at 20 seconds, 60 and 120 seconds after injection.

Image Analysis:

For accurate measuring at the same level comparison and synchronization of the anatomic level of the arterial phase images with the precontrast images was done.

The tumor size was measured by using the longest dimension on axial images at precontrast images, then, comparing the precontrast images with arterial phase enhanced images to determine the presence of rim enhancement, perilesional enhancement was defined as circumferential high signal intensity around the lesions distinguished from the background hepatic parenchyma on contrast-enhanced images.

Every rim enhancement was measured as a whole by measuring the outer and inner diameters along the longest dimension for each lesion, after that, differentiate the size of thickness of circumferential perilesional enhancement from tumor vascularity in the periphery of each lesion by subtracting the unenhanced tumor size from the outer dimension of the rim enhancement to estimate the outer thickness of the rim enhancement (perilesional enhancement) and subtracting the inner dimension of the rim enhancement from the unenhanced tumor size to estimate the inner thickness of the rim enhancement that used to represent the tumor vascularity in the periphery of each lesion

Inner dimension of the rim was considered zero for diffuse enhancement lesions without any recognizable peripheral rim, perilesional enhancement was estimated in these lesions by subtracting the tumor size on the unenhanced image from the size of the lesion on the arterial phase images.

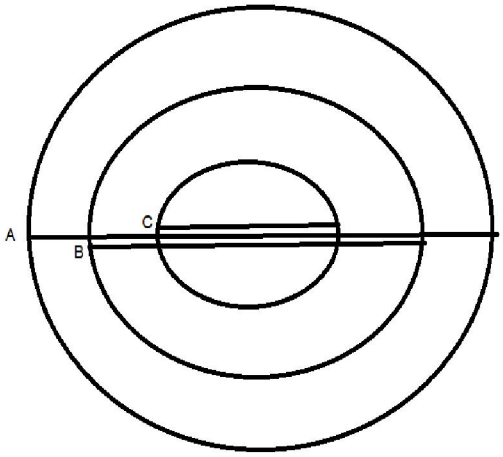
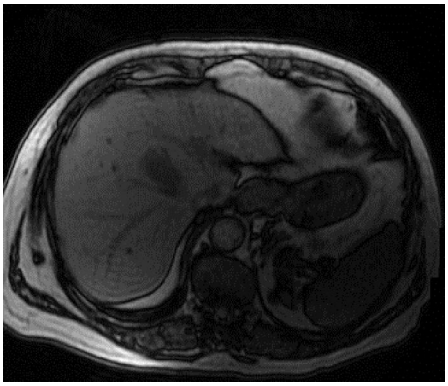
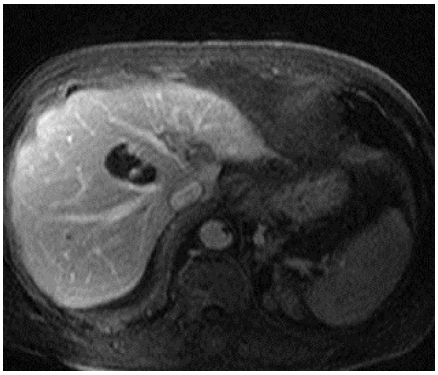


Fig. (1) Diagram for calculating thickness of perilesional enhancement and tumoral enhancement on arterial phase dynamic MR images. A line represents outer dimension of rim enhancement, B line represents tumor size on precontrast study and C line represents inner dimension of rim enhancement. Outer thickness of rim enhancement was estimated by subtracting B from A, and result was regarded as thickness of circumferential perilesional enhancement. Inner thickness of rim enhancement was estimated by subtracting C from B, and result used to represent tumor vascularity in periphery of each lesion.

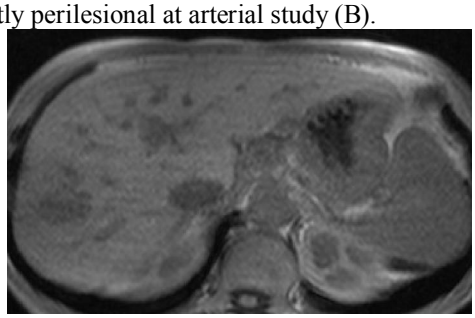


A

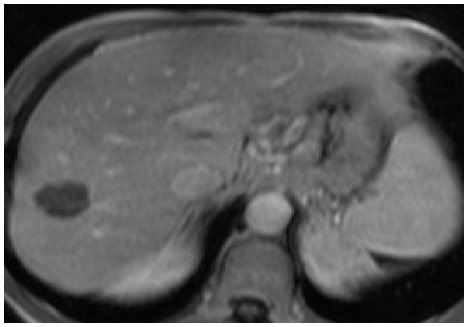


B

Fig. (2): 57 years old man with hepatic metastasis from known colon cancer. Precontrast study (A) shows low signal intensity with rim enhancement mostly perilesional at arterial study (B).

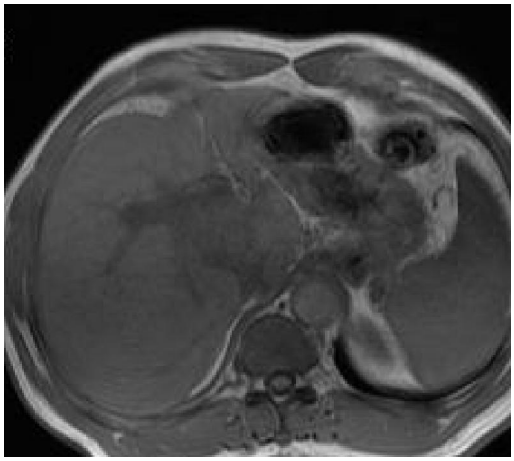


A

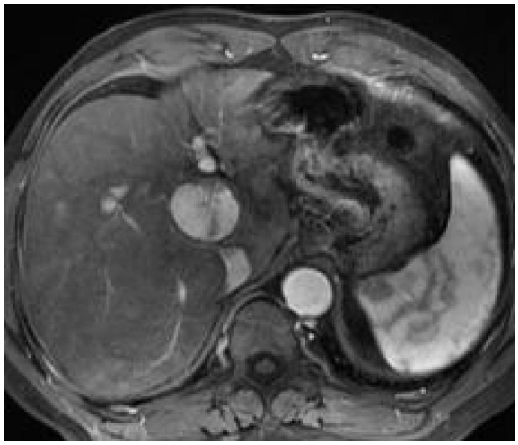


B

Fig. (3) 63 years old man with hepatic metastasis from known colon cancer. Precontrast study (A) shows low signal intensity with rim enhancement mostly perilesional at arterial study (B).



A



B

Fig. (4): 53-year-old man with metastases from colon cancer. Precontrast study (A) shows low-signal-intensity lesion in liver with diffuse enhancement at arterial phase (B).

3. Results

The study included 33 patients showed 67 hepatic metastatic lesions.

42 lesions (about 63%) from the all 67 lesions showed hyperintense rim enhancement distinguished from the surrounding liver on arterial phase dynamic MR images with the thickness of rim enhancement calculated by the difference between the outer dimension and the inner dimension of the rim enhancement ranged from 2 to 14 mm (mean, 6 mm). the longest dimension of most of these lesions (39 from 42 lesions, 92 %) showed more than 2mm increase in size at arterial phase image when compared with the unenhanced images.

9 lesions (about 13%) showed diffuse enhancement of the entire lesion on the arterial phase dynamic MR images. The size of the hyperintensity on the arterial phase images was larger than that measured on the unenhanced T1-weighted images,

the difference between the 2 sizes represent perilesional enhancement.

16 lesions (about 24%) showed no rim enhancement on arterial phase dynamic images.

The 67 lesions demonstrated variable sizes ranged from 10 -112mm with mean 24mm. 4 lesions from the 16 lesions with no rim enhancement on arterial phase dynamic study showed more than 2 mm reduction in diameter on the arterial phase dynamic images, suggesting the presence of peripherally increased tumor vascularity with isointense contrast enhancement indistinguishable from the surrounding hepatic parenchyma. The other 12 lesions showed less than a 2mm reduction in diameter.

Size of lesions with hyperintense rim enhancement (n = 42; 2 5± 18 [SD] mm) showed no significant difference with lesions without distinguishable rim enhancement (n = 16; 26 ± 22 mm) (p > 0.05). For the 42 lesions with rim enhancement, the thickness of the outer portion of the rim enhancement (mean, 6 ± 3 mm) was significantly larger than that of the inner portion (mean, 1 ± 2 mm) (p < 0.001), which suggested that the main component of the rim enhancement was perilesional enhancement rather than tumoral enhancement. In these cases, the tumor size was not correlated with the thickness of the rim enhancement (p > 0.05).

However, the degree of tumoral enhancement (inner thickness of the rim enhancement) showed a significant inverse correlation (r = -0.389) with the thickness of the perilesional rim enhancement (p < 0.001).

4. Discussion:

Previous studies observations supposed rim enhancement was mainly shown at the extralesional area [7] and showed a positive correlation with the degree of histologic changes of the extralesional tumor border, including desmoplastic reaction, inflammation, or vascular proliferation [11].

From our study observations, the main component of rim enhancement might be extralesional and partly may represent the hypervascular tumor periphery portion during the arterial phase dynamic MRI.

One of the main observations in this study is the lesions with a higher vascular component showed a lesser degree of perilesional enhancement, and the lesions with a lower vascular component showed a greater degree of perilesional enhancement, this observation differs from the results of previous investigations involving other types of tumors, including hepatocellular carcinoma or hepatic cavernous hemangioma, (Ueda *and others 2006)*[9] reported that perilesional corona enhancement was observed after complete filling of hypervascular hepatocellular carcinoma in their single level CT arteriography study. Moreover, in a report by (Yu *and others 2002)*[10] with dynamic MRI, perilesional enhancement tended to be found in larger and more hypervascular tumors in hepatocellular carcinomas.

Another important observation at this study was the high incidence of perilesional enhancement in hepatic metastases (63 %) comparing to overall incidence of perilesional enhancement for uncomplicated hepatocellular carcinoma without gross portal vein invasion with a value of less than 12% (10).

(Terayama *and others 2002)*[11] in a study of single-level CT hepatic arteriography with pathologic correlation reported hypovascular metastases tended to show early appearance of rim enhancement and hypervascular metastases showed more delayed rim enhancement. They proposed that the rim enhancement of hepatic metastases is caused by altered hemodynamics in the surrounding liver parenchyma for hypovascular lesions in addition to the drainage flow from the hypervascular lesions.

Observation in this study was the reverse correlation between the thickness of the perilesional enhancement and the hypervascular area of the tumor.

In addition to characterizing the metastases from other hepatic tumors, these different features of perilesional rim enhancement can influence therapeutic planning and an expectation of a better prognosis, the area of perilesional rim enhancement is open to the possibility of microscopic tumor cell infiltration, and we can justify the widening of safety margin for local ablation therapy or partial hepatic resection.

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