

# Gadoxetic acid-enhanced MR imaging criteria for the diagnosis of hepatocellular carcinoma based on “hypervascularity in the arterial phase and washout in the later phase”: Which later phase should be chosen?

Ijin Joo<sup>1</sup>, Jeong Min Lee<sup>1</sup>, Dong Ho Lee<sup>1</sup>, Ju Hyeon Jeon<sup>1</sup>, Joon Koo Han<sup>1</sup>, and Byung Ihn Choi<sup>1</sup>  
<sup>1</sup>Seoul National University Hospital, Seoul, Seoul, Korea

**Target Audience:** Radiologists and radiology residents and fellows.

**Purpose:** To compare portal venous phase, late dynamic phase (3 min delay), and hepatobiliary phase images of gadoxetic acid-enhanced MR imaging for the diagnosis of hepatocellular carcinoma (HCC) based on “hypervascularity in the arterial phase and washout in the later phase” in patients with chronic liver disease and arterially-enhancing nodules.

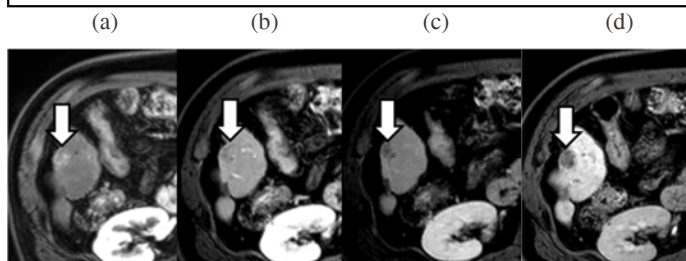
**Methods:** This retrospective cohort study was approved by institutional review board and informed consent was waived. Total 424 nodules (331 HCCs and 93 not-HCCs including 15 malignant nodules other than HCCs and 78 benign nodules) measuring 1 cm or greater which showed arterial hyperenhancement on gadoxetic acid-enhanced MRI in 305 patients with chronic liver disease were included in this study. Presence of washout of all arterially hyperenhancing nodules at portal venous, late dynamic, and hepatobiliary phases were assessed by two radiologists in consensus. Based on the relative enhancement of the nodules on portal, late dynamic, and hepatobiliary phase images, imaging criteria of 1) arterial hyperenhancement and portal washout, 2) arterial hyperenhancement and washout on portal or late dynamic phase images, and 3) arterial hyperenhancement and defect on hepatobiliary phase images were applied for the diagnosis of HCC. For each imaging criterion, diagnostic performances of MR for the diagnosis of HCC including sensitivity, specificity, and accuracy were calculated.

**Results:** For differential diagnosis of HCCs from not-HCC lesions, sensitivity, specificity, and accuracy of imaging criteria of 1) arterial hyperenhancement and portal washout; 2) arterial hyperenhancement and washout on portal or late dynamic phase images; and 3) arterial hyperenhancement and defect on hepatobiliary phase images were 66.2%, 95.7%, 72.6%; 84.3%, 86.0%, 84.7%; and 90.6%, 45.2%, 80.7%, respectively. Lower specificity of criterion 2) than 1) was due to lesions of “washout on late dynamic phase without washout on portal phase” including cholangiocarcinoma, metastasis, and hemangioma. Criterion 3) demonstrated the lowest specificity because there were many hypervascular lesions other than HCC such as cholangiocarcinoma, hemangioma, as well as inflammatory lesion, which did not show washout on dynamic phase but were seen as defects on hepatobiliary phase images.

**Discussion** Our study demonstrated that imaging criterion of “arterial hyperenhancement and washout in the portal phase” had the highest specificity of 95.7% for differential diagnosis of HCCs from not-HCC lesions. Compared to “washout in the portal phase”, “washout in the portal or late dynamic phase” may increase sensitivity but decrease specificity for diagnosis of HCC. As “defect on hepatobiliary phase” showed the highest sensitivity but lowest specificity, hepatobiliary phase image can be used for lesion detection not for differential diagnosis of HCC.

**Conclusion:** In the gadoxetic acid-enhanced MR imaging diagnosis of HCC based on “hypervascularity in the arterial phase and washout in the later phase”, washout should be determined in the portal phase rather than in the late dynamic or hepatobiliary phases for high specificity.

**Figure 1.** Hepatocellular carcinoma in a 63-year-old male patient with chronic hepatitis B. HCC shows arterial hyperenhancement (a) and washout in the portal (b) and late dynamic phase images (c) (arrows). (d) On the hepatobiliary phase image, HCC is seen as a clear defect. All imaging criteria including 1) arterial hyperenhancement and portal washout, 2) arterial hyperenhancement and portal or late dynamic washout, and 3) arterial hyperenhancement and defect on hepatobiliary phase image can correctly diagnose this nodule as HCC.



**Figure 2.** Hemangioma in a 61-year-old male patient with chronic hepatitis B. (a) Small arterial phase-enhancing nodular lesion (arrow) is seen in the subcapsular area of the left lobe of the liver. This lesion shows iso signal intensity to liver parenchyma in the portal phase (b) and low signal intensity in the late dynamic phase (c) and hepatobiliary phase (d). Imaging diagnosis of this lesion would be not-HCC based on “arterial enhancement and washout in the portal phase”, while the diagnosis would be made as HCC based on “washout in the portal or late dynamic phase” or “defect on hepatobiliary phase.”

