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Additional diffusion-weighted imaging in the detection of new, very small hepatocellular carcinoma lesions after interventional therapy compared with conventional 3 T MRI alone

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AIM: To evaluate the added value of diffusion-weighted imaging (DWI) combined with conventional magnetic resonance imaging (MRI) in the detection of new, very small hepatocellular carcinoma lesions (≤1 cm) in patients with hepatocellular carcinoma following interventional therapy compared to conventional MRI alone.

MATERIALS AND METHODS: After interventional therapy, 45 patients with hepatocellular carcinoma underwent conventional MRI and DWI with a b-value of 0 and 700 s/mm^2. Twenty-one new, small hepatocellular carcinoma lesions were confirmed in 16 patients at follow-up MRI. Two observers independently retrospectively analysed the two imaging sets in random order. The diagnostic performance using each imaging set was evaluated by received operating characteristic curve analysis.

RESULTS: Twenty-one new, very small hepatocellular carcinoma lesions found in 16 patients was confirmed as the final result. The area under the receiver operating characteristic curve of the DWI/conventional MRI combination (observer 1, 0.952; observer 2, 0.976) and conventional MRI images alone (observer 1, 0.905; observer 2, 0.905) were statistically significant. The kappa value of the DWI/conventional MRI combination was 0.884, and that of conventional MRI was 0.722. Among the 21 lesions, 100% (21/21) of the lesions were both recognized by two independent reviewers on DWI, while only 76% (16/21) and 71% (15/21) of the lesions were regarded as very small hepatocellular carcinomas on conventional MRI.

CONCLUSION: Due to the higher detection rate of new subcentimetre lesions in hepatocellular carcinoma patients following interventional therapy, DWI could be considered complementary to conventional MRI in the diagnosis of hepatocellular carcinoma.

Introduction

It is clinically important to detect very small hepatocellular carcinoma (HCC) early. According to the Barcelona Clinic Liver Cancer (BCLC) staging classification, very-early-stage HCCs are defined as single nodules <2 cm in

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a well-compensated cirrhotic liver without portal hypertension.[1] These patients with very-early-stage HCCs can benefit from resection and have estimated 5-year survival rates exceeding 90%. However, when the disease develops into early-stage HCC, the 5-year survival rate decreases to approximately 75%. Recently, Livraghi and colleagues[2] demonstrated that similar clinical outcomes can be obtained by percutaneous radiofrequency ablation (RFA), with lower costs and periprocedural risks. Serial magnetic resonance imaging (MRI) studies of the detection of HCCs have been predominantly based on the arterial blood supply and differentiated grades of HCCs. However, in clinical practice, these techniques have remained a limitation in the detection of some HCCs, such as hypovascular or well-differentiated lesions, and particularly for very small HCC nodules (<1 cm) due to the influence of the background of the cirrhotic liver and the overlap with different characteristic nodules.[3]

Several studies have investigated the prevalence and importance of HCC deemed too small to be sufficiently characterized by computed tomography (CT).[4] Although the majority of very small (≤10 mm) focal liver lesions discovered incidentally or in patients with established malignancy are benign, 5–27.5% of those lesions turn out to be malignant.[4] These studies emphasize the importance of correct characterization of even small HCC, particularly as obtaining tissue diagnosis of small lesions by biopsy is not only invasive but often technically challenging.

Recent advances in MRI technology have allowed for further improvements in abdominal diffusion-weighted imaging (DWI) quality by reducing blurring and minimizing susceptibility-induced artefacts. Conventional MRI produces images of the arterial, portal, and venous phases that not only precisely depict anatomy and contrast medium uptake, but also contain vascular information.[5] DWI has been shown to be a valuable tool in both the detection and characterization of focal liver lesions[6]; however, routine use of DWI for the detection of very early HCC lesions has not been evaluated.

The aim of the present study was to determine the added value of combined DWI and conventional MRI in the detection of very small (≤1 cm) recurrent HCC following interventional therapy (IT) compared to conventional MRI alone.

Materials and methods

Patients

From December 2009 to April 2011, 60 patients with HCC after IT, including transcatheter arterial chemoembolization (TACE), then followed by radiofrequency ablation (RFA), were included retrospectively in the study, and were followed up routinely every 1–2 months using MRI. The 60 patients were diagnosed as having very-early-stage or early-stage HCC according to the BCLC staging system.[1] Of the 60 patients, 15 patients were excluded from the study for the following reasons: eight patients had neither histological proof nor follow-up confirmation; three patients had large lesions >1 cm or infiltrative HCCs involving more than two segments of the liver; four patients were excluded because of poor-quality DWI images, which had artefacts that significantly degraded image quality. The protocol was preapproved by the local review boards, and written informed consent was obtained from all patients before treatment.

MRI

All MRI examinations were performed on a 3 T MRI system (Signa HDx, GE Healthcare, Waukesha, WI, USA) with a TORSO coil. Baseline MRI images, including a respiratory-navigated, T2-weighted (T2W), fast spin-echo sequence with fat suppression [11,250 ms repetition time (TR); 118.4 ms echo time (TE); 7 mm section thickness; 0.7 mm gap; 90° flip angle; 224 (phase) × 288 (read) matrix size; 38 cm field-of-view (FOV)], and a breath-hold, three-dimensional (3D) dual gradient-echo, in-phase and opposed-phase sequence [41 ms/1.2 ms TR/TE (opposed-phase), 41 ms/2.4 ms TR/TE (in-phase); 12° flip angle; 180 (phase) × 260 (read) matrix size; 38 cm FOV)]. The dynamic imaging, breath-hold, T1W, liver acquisition with volume acceleration (LAVA), dynamic contrast-enhanced (DCE) sequence was performed using the following parameters: 2.6 ms/1.2 ms TR/TE; 12° flip angle; 170 (phase) × 272 (read) matrix size; 4 mm true section thickness; and 38 cm FOV.

Dynamic imaging was performed before and after administration of gadopentate dimeglumine (Magnevist; Schering, Berlin, Germany), consisting of early and late arterial (delay time 18, 25 s), portal (50 s), and equilibrium (90, 150 s) phases, were acquired after a bolus injection of 20 ml gadopentate dimeglumine with fixed delay. The contrast material was injected into the antecubital vein at a rate of 2.5 ml/s via a power injector.

Three scan trace DWI images were obtained prior to gadolinium injection in the axial plane using a single shot spin-echo (SE) echo planar imaging (EPI) sequence with RT (respiratory-triggered) gating [7500 ms/62.9 ms TR/TE; 7 mm section thickness; 0.7 mm gap; 128 (phase) × 128 (read) matrix size; 38 cm FOV] with a b-value of 0 and 700 s/mm^2. A total of 48–56 sections were obtained during 60–80 s using the array spatial sensitivity encoding technique (ASSET) with an acceleration factor of 2 added to reduce the acquisition time.

Imaging analysis

HCC was diagnosed if the lesion fulfilled any two of the following four criteria: moderate hyperintensity on T2-weighted images when compared with surrounding liver parenchyma; hepatic arterial enhancement; portal venous or equilibrium phase washout; and capsule at unenhanced or delayed contrast-enhanced imaging.[7]

The 21 new lesions were confirmed to be new tumours (which subsequently enlarged), distant from the treated lesion in 16 patients at the follow-up MRI using the above