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Role of diffusion-weighted MR in differential diagnosis of intracranial cystic lesions

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AIM: The purpose of this study was to evaluate the role of diffusion-weighted imaging (DWI) in characterizing cerebral cystic lesions. The usefulness of the apparent diffusion coefficient (ADC) map in lesion characterization was also evaluated.

METHODS: We compared the findings of conventional MR images with those of DWI: 63 cystic masses in 48 patients were examined with routine MR imaging and echo-planar DWI. The routine MR imaging included at least the axial T2- and T1-weighted sequences, and post-contrast T1 axial sequences. The DWI included an echo-planar spin-echo sequence with three values (0, 500 and 1000 s/mm^2) sensitizing gradient in the x, y, z direction, and it obtained an ADC map.

RESULTS: The sensitivity of DWI for differentiating abscesses from primary brain tumours was 100%; for differentiating abscesses from metastatic tumours was 73%; for differentiating benign from malignant lesions was 90%.

CONCLUSION: Although some metastatic lesions may appear hyperintense on DWI thus imitating an abscess, evaluation of the lesions with both DWI and conventional MRI may have an important contribution to the differentiation of tumours from abscesses.

Introduction

The differential diagnosis of intracranial mass lesions can be difficult, even with sophisticated morphological techniques. This is especially true in cases of suspected brain abscess, for which an immediate correct diagnosis is necessary for prompt, adequate treatment of this life-threatening but treatable condition.[1] Diffusion-weighted imaging (DWI) has been reported as useful in the differential diagnosis between abscesses and necrotic or cystic tumours.[1-6] However, experience is still limited and the real sensitivity and specificity remain to be determined. Our purpose was to evaluate the usefulness of the DWI in the differential diagnosis of cystic brain lesions.

Methods

In all, 48 consecutive patients with 63 intracerebral cystic masses were examined by routine conventional MR imaging and echo-planar DWI. Subjects were aged 2–83 years (mean ± SD 44.38 ± 20.68 years). Biopsy or surgery was performed in all cases except for the 11 metastatic lesions found in 4 patients. The definite diagnoses of participants with metastatic lesions were made by identification of the primary focus and follow-up MRs. All MR

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examinations were performed using a 1.5 T MR scanner (Siemens, Vision Plus, Erlangen, Germany) with a maximum gradient strength of 25 m T/m. Conventional MR and DWI were carried out at the same time. Conventional MR images were obtained with axial T2-weighted (TR/TE/NEX 3520/120/1; matrix, 220×256; FOV:190; section thickness: 5 mm), axial T1-weighted (600/14/1; matrix, 224×256; FOV: 200; section thickness: 5 mm), coronal FLAIR (Fluid Attenuated Inversion Recovery) (TR/TE/TI/NEX 6500/120/2200/1; matrix, 220×256; FOV:190; section thickness: 5 mm) and axial contrast-enhanced (0.1 mmol/kg of contrast agent) T1-weighted images. Contrast-enhanced images were obtained following the DWI. DWIs were obtained in the axial plane using echo-planar spin-echo pulse sequence (4000/110/1; matrix 128×96; FOV 230; section thickness 5–6 mm) with three b values (0, 500, 1000 s/mm^2). The ADC map was also obtained (the sequence labelled "0-500-1000-ADC" automatically provides ADC maps). On visual inspection, the signal intensities of the lesions on DWI and the ADC map were interpreted to the contralateral brain parenchyma and defined as "low", "same" or "high" compared with normal brain parenchyma. Two radiologists (Y.P. and Y.B.) reported on the MR images.

Results

The final diagnosis was pyogenic abscess for 22 lesions, arachnoid cyst for 6 lesions, epidermoid cyst for 5 lesions, metastatic brain tumour for 11 lesions, and primary brain tumour for 19 lesions (anaplastic astrocytoma: 9; cystic astrocytoma: 2; medulloblastoma: 1; glioblastoma multiforme: 7) (Table 1). The origins of metastatic tumours were as follows: adenocarcinoma of lung (1 case) and squamous cell carcinoma of lung (3 cases). The characteristics of patients based on the conventional MR and DWI findings are summarized in Table 2. All the lesions in the study group appeared hypointense on T1-weighted images and hyperintense on T2-weighted images. All the lesions except arachnoid and epidermoid cysts showed contrast enhancement. Only arachnoid cysts were hypointense with 100% on FLAIR sequences; lesions other than arachnoid cysts were either hypo-, hyper- or isointense. Of the 22 abscesses, 21 were hypointense (95%) on ADC whereas the remaining 1 lesion was isointense (5%). None of abscess showed hyperintensity on ADC. All 22 abscesses were hyperintense on DWI (Fig. 1); 17 (90%) of primary tumours were hyperintense on ADC maps; and 2 (10%) were isointense on ADC maps. No primary tumours showed hypointensity on ADC mapping. The cystic or necrotic areas of all primary tumours were hypo- (90%, $n=17$) or isointense (10%, $n=2$) on DWI (Fig. 2 and Table 3). All arachnoid cysts showed hyperintensity on ADC and hypointensity on DWI (Fig. 3). Similarly 5 epidermoid cysts showed hyperintensity on DWI, but 80% ($n=4$) were isointense and 20% ($n=1$) hypointense on ADC maps (Fig. 4). Of the metastatic tumours, 27% ($n=3$) occurred in the same patient and were hypointense on ADC maps and hyperintense on DWI. These lesions were no bigger than 2 cm and, in contrast to the other metastatic lesions, were isointense on FLAIR sequences (Fig. 5). The remaining 73% ($n=8$) of the metastases were hyperintense on ADC and hypointense on DWI.

The sensitivity of DWI for differentiating abscesses from primary brain tumours was 100%, specificity 100%, positive predictive value 100% and negative predictive value 100%. The sensitivity of DWI for differentiating abscesses from malignant lesions (metastatic and primary tumours) was 100%, specificity 90%, positive predictive value 88% and negative predictive value 100% (Table 4). The sensitivity of DWI for differentiating abscesses from metastatic tumours was 100%, specificity 73%, positive predictive value 88% and negative predictive value 100%.

Table 1 Distribution of the lesions

Lesion	Number of patients (%)	Number of lesions (%)
Abscess	16 (33)	2 (35)
Primary tumour	19 (39)	19 (30)
Metastasis	4 (8)	11 (17)
Arachnoid cyst	5 (10)	6 (10)
Epidermoid cyst	5 (10)	5 (8)
Total	48 (100)	63 (100)

Discussion

Currently the sensitivity and specificity of DWI in the diagnosis of cerebral infarct are widely accepted, and DWI is the definitive method for the differential diagnosis of epidermoid cyst from arachnoid cyst.[2,7] Intracranial epidermoid and arachnoid cysts give equal signal intensity with CSF on conventional MRI sequences. For this reason, their differentiation or detection may be difficult on some occasions. Epidermoid cysts should appear hyperintense because of the diffusional restriction due to their contents, whereas arachnoid cysts that