Diffusion-weighted MRI in the Discrimination between Intracerebral Necrotic Tumors and Cerebral Abscesses.

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Introduction

A cerebral abscess can be a lethal condition if correct treatment is not initiated acutely. Unfortunately, both the clinical presentation as well as the radiologic picture can mimic an intracerebral necrotic tumor, as ring-enhancement after contrast medium administration is seen on conventional MRI in both conditions. A few recent studies has demonstrated that intracerebral necrotic tumors and cerebral abscesses can be discriminated by the use of diffusion-weighted imaging (DWI) (1,2,3). However, the number of patients included has been limited, and the sensitivity and specificity of DWI for intracerebral necrotic tumor and cerebral abscesses is uncertain (2). Typically, on DWI an abscess cavity has a high signal, whereas a necrotic tumor has a low signal in the central cavity. Diffusion changes are quantified by the apparent diffusion coefficient (ADC), and most often diffusion (i.e. ADC) is markedly reduced in an abscess cavity and enlarged in a necrotic tumor.

The purpose of this study was to determine the sensitivity, specificity and precision of DWI in detection of cerebral abscesses and necrotic tumors. Furthermore to measure quantitative and relative ADC values in the cavities of the abscesses and the necrotic tumors.

Materials and Methods

From January to September 2003, records of patients with cerebral abscess or intracerebral necrotic tumor from department of neurosurgery were reviewed. Nineteen patients with a ring-enhancing cerebral mass, as well as a recent MRI (including DWI), and a surgically confirmed diagnosis were included in the following analysis. These patients comprised 4 with brain abscesses, 12 with primary brain tumors and 4 with metastasis.

MRI Imaging Protocol. A sagittal T1-weigthed spin-echo and an axial T2-weighted fast spin-echo was performed a 1.5 T GE imager. DWI was performed using multi-slice spin-echo EPI with diffusion gradients applied in three orthogonal directions (b=1000 s/mm^2), in addition to one unweighted image (b=0), from which an isotropic diffusion-weighted image was calculated. Mean ADC maps were calculated using functool on the GE imager ($ADC = - [\ln(S_x/S_0) + \ln(S_y/S_0) + \ln(S_z/S_0)]/(3b)$). Finally, post-contrast T1WI was acquired.

Data analysis. The DWI images and ADC-maps were reviewed by two neuroradiologists (AN,EN) who were blinded to the histological diagnosis, and consensus was reached (i.e. intracerebral abscess or necrotic tumor). Sensitivity, specificity and precision was calculated. Regions-of-interest (ROIs) were applied manually on one slice in the center of the largest cystic cavity, and a mirror ROI was applied on the contralateral healthy side. Quantitative ADC values were obtained in these two ROIs , as well as relative values were calculated as the ratio between ADC value in the cystic cavity and the contralateral side. Unpaired t-test compaired ADC values of necrotic tumor and abscess cavities.

Results

On conventional MR-images, all brain tumors and abscesses were alike with a ring-enhancing lesion on post-contrast T1WI, and surrounding oedema on T2WI. However, all abcess cavities had an *increased signal* on DWI and *reduced diffusion* on ADC maps (Figure). All necrotic tumors but one, had a *reduced signal* on DWI and *increased ADC* in the central cavity. Therefore, with DWI 14 out of 15 necrotic tumors were correctly diagnosed, as well as 4 out of 4 cerebral abscesses. This yields a sensitivity of 93%, a specificity of 100%, and a precision of 94%.

The mean ± SD ADC in the cavity of the 15 necrotic tumors and the 4 abscesses were $2.53 \pm 0.82 \times 10^{-3}$ mm^2/sec and $0.84 \pm 0.06 \times 10^{-3}$ mm^2/sec, respectively, i.e. there was a three-fold difference. The relative ADC in the cavity of the 15 tumors and 4 abscesses were 228% ± 78% and 68% ± 6%, respectively. There was a significant difference between the absolute as well as the relative ADC values of the necrotic tumors and abscesses ($p<0.001$). Finally, whereas the ADC values of the 15 necrotic cavities were all *higher* than 1.0×10^{-3} mm^2/sec, *lower* values were found in all 4 abscess cavities.

Discussion

Among the 19 patients, we found a high sensitivity (93%), specificity (100%) and precision (94%) of DWI in the detection of intracerebral necrotic tumors and cerebral abscesses. Furthermore, we found that the ADC values in the necrotic cavity of malignant tumors were three times that of cerebral abscesses. Some authors have found a 100% sensitivity and specificity (1,3). In agreement with our results, other groups have reported a few abscesses with *increased* ADC (and low signal on DWI) or necrotic tumors with *reduced* ADC (and high signal on DWI), and therefore a lower sensitivity and specificity (93% and 91%, respectively) (2). Pooling all these data reveals a sensitivity and specificity of 94% and 97%, respectively. Finally, we suggest that an absolute ADC value of 1.0×10^{-3} mm^2/sec in the cavity can probably be used to discriminate necrotic brain tumors from the cerebral abscesses, which has not been demonstrated earlier.

In conclusion, DWI is a very valuable technique for differentiating cerebral abscesses from necrotic brain tumors, and precipitate the diagnosis and appropriate treatment of this potential lethal condition. An absolute ADC value of 1.0×10^{-3} mm^2/sec in the cavity can probably be used to discriminate cerebral abscesses from necrotic brain tumors.

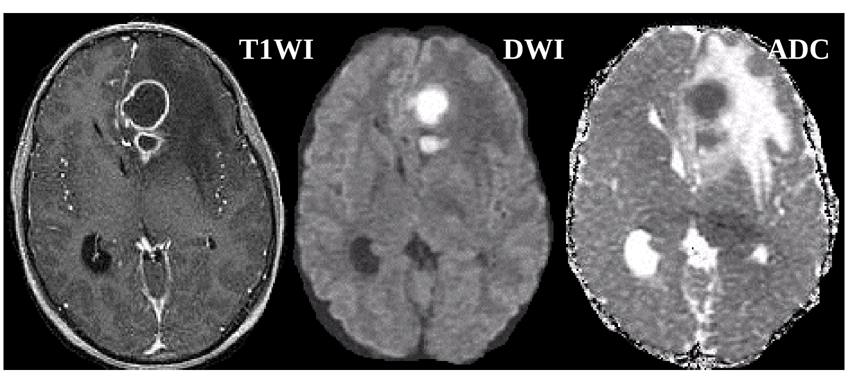

Figure. A 12-y old boy suffered from progressing cerebral symptoms. MR showed a left frontal lesion with ring-enhancement on post-contrast T1WI. High signal in the central cavity on DWI and reduced ADC suggested an abscess. Surgery revealed a pyogenic abscess (staphylococcus aurius). One month earlier the boy accidentally had a stick stabbed up his nose,

References

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