Role of In-vivo Proton Magnetic Resonance Spectroscopy (PMRS) and Diffusion Weighted Imaging (DWI) in the Differential Diagnosis of Intracranial Cystic Mass Lesions

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Synopsis:
We studied fifty-five patients of cystic intracranial lesions, which include abscesses (n=25), benign cysts (n=5) and tumor cysts (n=25) by diffusion weighted imaging (DWI) and proton MR spectroscopy (PMRS). Results were conclusive in 18/25 cases of abscesses on DWI whereas PMRS was conclusive in all but one. When both techniques were combined, the results were conclusive in all the patients with abscesses. DWI was conclusive in 19 tumor cysts and 5 benign cysts whereas PMRS was conclusive in remaining 6 cases of tumor cysts. When PMRS is combined with DWI, it helps in better differentiation of cystic brain lesions

Introduction:
Intracranial cystic mass lesions make a significant part of neurosurgical problems. The management of these cystic lesions depends upon its nature and it varies from definite surgery (cystic glioma) to minimal invasion (abscesses, arachnoid cyst). Conventional contrast enhanced computed tomography (CECT) and magnetic resonance (MR) imaging might not always be sufficient to reach a definitive diagnosis. In the last few years non-invasive techniques like proton MR spectroscopy (PMRS) and diffusion weighted imaging (DWI) are being increasingly used as a tool for diagnosis of intracranial lesions. PMRS has been found to be useful in differentiating various cystic intracranial lesions (1). Cystic intracranial lesions include true cysts lined by epithelial, ependymal, or meningothelial cells, dermoid and epidermoid cysts, parasitic cysts (cysticercosis, hydatid cysts) or may be pseudocystic neoplastic or inflammatory lesions secondary to accumulation of necrotic, intercellular mixed or proteinaceous material. DWI is considered useful in differentiating cystic gliomas from cerebral abscesses (2) and there are no reports of its use in differentiation in other types of cystic lesions. This study was carried out to evaluate the diagnostic efficacy of PMRS and DWI in cases of intracranial cystic mass lesions.

Methods:
Fifty-five patients with cystic intracranial lesions on conventional CT or MRI formed the study group. There were 42 males and 13 females with ages ranging from 1.5 to 67 years (mean age 27 years). The lesions were classified on the basis of pathological/surgical diagnosis and were abscesses (n=25), benign cysts (n=5) and tumor cysts (n=25). MR imaging was performed on a 1.5-tesla super conducting system using quadrature head coil. Besides fast spin echo T2, T1 and FLAIR, we also performed DW echo planar imaging (EPI) in the axial plane by using a single shot EPI-SE pulse sequence with the following parameters: repetition time (TR)/ echo time (TE) = 10.5 s/ 110 ms (minimum), Field of view = 24x24 cm, number of excitations= 2, slice thickness =5 mm, inter-slice gap= 0.5mm, matrix size of 128 x 256. Diffusion sensitizing gradients were applied along the three orthogonal directions with diffusion sensitivity of b =0 and 1000 s/mm^2. Ramp sampling was utilized to reduce the echo spacing thereby minimizing the geometric distortion. In-house software with user-friendly graphical user interface was developed using Visual Studio (version 6.0) for generation and analysis of ADC maps. Average ADC was calculated after putting twenty-five regions of interest (ROIs) of 2x2 pixel dimensions in cavity of intracranial cyst. Single voxel volume selective water suppressed PMRS was performed using SE sequence. A voxel of 4-6 ml depending upon the size of lesion was placed within the cavity with an aim to avoid contamination, if possible, from the surrounding brain parenchyma. Experimental parameters used for SE sequence were TR/TE/n= 3000 ms/144 ms/128. *In vivo* SE spectroscopy data was analyzed using standard java based version of magnetic resonance user interface (jMRUI) signal processing software. Assignments of various resonances were based on the existing literature. The signal of lactate at 1.33 ppm was used as internal chemical shift reference.
Results were considered as conclusive for various pathologies as under: Abscesses- hyperintensity on DWI with ADC values < or = 0.09x10^{-3} mm^2/s (equal to the normal gray and white matter), PMRS showed amino acids with lactate and other metabolites; tumor cysts- hypointensity in DWI with ADC>0.09x10^{-3} mm^2/s and, PMRS- Choline, lactate with other metabolites; benign cysts- hypointensity in DWI with ADC>0.09x10^{-3} mm^2/s and, PMRS- lactate and acetate with Succinate for neurocysticercosis, lactate for arachnoid cysts. Findings otherwise were considered as inconclusive.

Results:
Quantifiable DWI and PMRS data was available in a total of forty-nine out of fifty-five patients for analysis. Six patients were excluded from the study due to poor spectral quality. ADC values for abscesses were 0.42 to 2.95×10^{-3} mm^2/sec (mean ± SD =0.85 ± 0.51×10^{-3} mm^2/sec), for tumor cysts 1.99 to 3.41×10^{-3} mm^2/sec (2.85 ± 3.38×10^{-3} mm/sec) and for benign cysts 3.02-3.24×10^{-3} mm^2/sec (3.13 ± 0.08×10^{-3} mm^2/sec). DWI was conclusive in 18 of 25 cases of abscesses whereas PMRS was conclusive in all but 1 patient. When both DWI and PMRS were combined, the results were conclusive in all the patients with abscesses. In addition, it was further possible to differentiate tubercular (n=4) from pyogenic abscesses (n=21) based on PMRS findings. In tumor cysts, DWI was conclusive in all (n=19), whereas PMRS was conclusive in 6 cases. Benign cysts (n=5) were conclusively diagnosed by PMRS and it was possible to differentiate neurocysticercosis (NCC) (n=2) from arachnoid cysts (n=3). Though hyperintensity on DWI could differentiate 18 abscesses from other non-abscess cysts, there was overlap of ADC values for tumor and benign cysts as well as for some of the abscesses and they could not be differentiated.

Discussion and conclusion:
Our study suggests that PMRS alone is the best option for the diagnosis of brain abscess, however when combined with DWI, the yield for conclusive diagnosis of the abscesses becomes 100%. These results are in contradiction to the literature where DWI has been shown to be superior to PMRS in a series with 14 patients (3). We have seen overlapping high ADC values in some of the abscesses, seen in all patients of the tumor cysts and benign cysts. Its inability to differentiate tumor cysts from benign cysts; and abscesses with high ADC values (>2.0×10^{-3} mm^2/sec) from other cystic lesions was complemented by PMRS. In 7 patients with high ADC spectra was conclusive, whereas in one patient of abscess spectroscopy was inconclusive with characteristic low ADC.

DWI is a useful tool to differentiate abscesses from benign and tumor cysts, however it cannot differentiate tumor cysts from benign cysts. PMRS is more specific than DWI in differentiation of most abscesses and benign cysts. When PMRS is combined with DWI, there is an increase in specificity in the etiological differentiation of these lesions.

References:

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