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DIFFUSION-WEIGHTED MR IMAGING OF CYSTIC LESIONS OF NEUROCYSTICERCOSIS

A preliminary study

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ABSTRACT - Neurocysticercosis is an endemic disease in some developing countries. It has pleomorfic clinical and imaging findings, which are variable from patient to patient. In this preliminary note, we studied the magnetic resonance (MR) diffusion-weighted images (DWI) of sixteen patients presenting with cystic lesions of this disease diagnosed by clinical and laboratorial findings. All the lesions had hypointense signal and the similar apparent diffusion coeficient (ADC) values as the cerebrospinal fluid (CSF).

KEY WORDS: neurocysticercosis, cystic lesion, MRI, diffusion images.

Imagens por difusão de ressonância magnética em lesões císticas da neurocisticercose: estudo preliminar

RESUMO - Neurocisticercose é doença endêmica em alguns países em desenvolvimento. Ela apresenta aspectos clínicos e de imagem que variam em cada paciente. Nesta nota preliminar expomos um estudo utilizando imagens ponderadas em difusão em dezesseis pacientes que apresentavam lesões císticas da neurocisticercose comprovada clínica e laboratorialmente. Todas as lesões examinadas apresentaram hipossinal com intensidade de sinal e valores de coeficiente de difusão aparente (CDA) similares ao do líquido cefalorraquiano.

PALAVRAS-CHAVE: neurocisticercose, cistos intracranianos, ressonância magnética, imagem por difusão.

Neurocysticercosis is the most important parasitic disease that affects the nervous system, and it is a public health problem in the developing countries, mainly in Central and South America, Africa and Asia[1]. It is related to the poor sanitary conditions of the population[1, 2]. In Brazil, neurocysticercosis is endemic in some areas in the south and the southeast regions[2]. There are different clinical manifestations, depending upon the pathological findings and the phase of evolution of the disease. The clinical signs or symptoms can take from 1 to 35 years after the infestation to show up[3]. The most frequent clinical presentations include: epilepsy, meningitis, intracranial hypertension and cognitive disability[2,4]. An asymptomatic form can be seen in some patients[4].

The imaging findings on computed tomography (CT) and magnetic resonance (MR) as well as the follow-up of this disease have been studied[5,6]. Neuroimaging exams usually are able to establish the diagnosis when there are definitive signs of the parasite, like the scolex inside a cystic lesion. Because these lesions are usually of variable size, with or without edema or peripheral enhancement, and the scolex sometimes is not detectable, a list of differential diagnosis including other cystic lesions due to infections or tumors should be considered.

The biologic water has random translational motion (Brownian motion) of its molecules caused by their thermal energy and the viscosity of the medium[7]. This kind of motion is related to the apparent diffusion coefficient (ADC) and MR using diffusion weighted images (DWI) can evaluate it. The image acquisition is achieved by applying strong magnetic field gradient pulses in a T2-weighted sequence. The signal detection is based in protons dephased and rephased after the application of the magnetic gradients[8]. Only stationary protons will rephased completely, so when a pathology causes

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restriction of the diffusion or reduces the translational movement, the decreased ADC in the lesion will be represented by a bright area in DWI in comparison to the unaffected tissue[9].

The most important clinical applications of the DWI is the evaluation of acute cerebral ischemia[9], but new uses have been studied like in the differential diagnosis between intracerebral necrotic tumors and abscesses[10,11], arachnoid cysts and epidermoid tumors[12] and the evaluation of brain neoplasias[13,14]. The DWI also seems to provide complementary information in traumatic brain injury, demyelination disease and Creutzfeldt-Jakob disease[15].

This is a preliminary study in which we obtained MR axial unenhanced T1, T2, Flair and multiplanar enhanced T1-weighted images, and the diffusion-weight images in cystic lesions of patients with neurocysticercosis, in order to determinate a diffusion-weighted pattern of these cystic lesions that aids in differential diagnosis.

METHOD

We studied prospectively sixteen patients with neurocysticercosis confirmed by laboratorial findings that were followed in the Neurologic Clinic of Hospital das Clínicas da Universidade de São Paulo (USP).

The ages of the patients ranged from 19 to 60 years (mean age 39,5 years). Twelve subjects were male and four were female. Fifteen of them presented with epilepsy. One of these patient developed bilateral facial palsy and swallowing difficulties, which were probably caused by a large cyst in the IV ventricle. One patient initially presented with headache and vomits, being diagnosed intracranial hypertension, and she was submitted to a ventricular-peritoneal shunt. One patient with the largest lesion (5.0 cm) was submitted to a stereotatic biopsy of the cystic wall and drainage of its contents, after the MR study.

All the examinations were performed in a 1.5 T whole-body imager (Signa Horizon LX: GE Medical System) capable of echo planar imaging. DWI was performed with a multisection, single shot, echo planar spin-echo sequence with TR=9999 ms, TE=105 ms, NEX=1, FOV=24x19 cm, 96x128 matrix, 5.0 mm slice thickness with no gap and high-strength diffusion gradient (B = 1000 sec/mm^2). The diffusion gradient was applied along three directions (X, Y, and Z) and the ADC maps were calculated in all directions. ADC measurement was done using a variable diameter ROI manually placing in a selected lesion (the largest one). The cysts had different sizes, so the ROI dimensions varied with the lesion size.

ADC values of the CSF inside the lateral ventricles and in the normal parenchymal were measured in all patients to compare to the values of those obtained in the cystic lesions.

Conventional unenhanced axial SE T1 (TR500ms/ TE14ms/NEX2), FSET2 (TR4500ms/ TE100ms/NEX2) and FLAIR(TR8402ms /TE142ms/TI2100ms/NEX2) were performed before DWI. Coronal, axial and sagital T1-weighted were also obtained after contrast administration (Gadolinium:10 mMol/Kg).

RESULTS

All patients had cystic lesions with signal intensity similar to the CSF, with or without peripheral edema and/or enhancement. Twelve patients had only parenchymal lesions, two patients had cisternal cysts (racemose form) and two patients had combined forms, one with intraventricular and parenchymal cysts and the other with racemose and parenchymal lesions. The lesions were solitary in three patients and multiples in thirteen; the largest diameter of the lesions ranged from 0,5 to 5.0 cm.

The cystic lesions presented similar signal intensity as the CSF on T1, T2 and FLAIR images. On DWI the lesions were hypointense, comparable to or slightly hyperintense than the CSF signal intensity. There was no significant difference of the signal intensity in the lesions that exhibited peripheral enhancement or edema from those that did not have these findings or among the parenchymal, intraventricular and

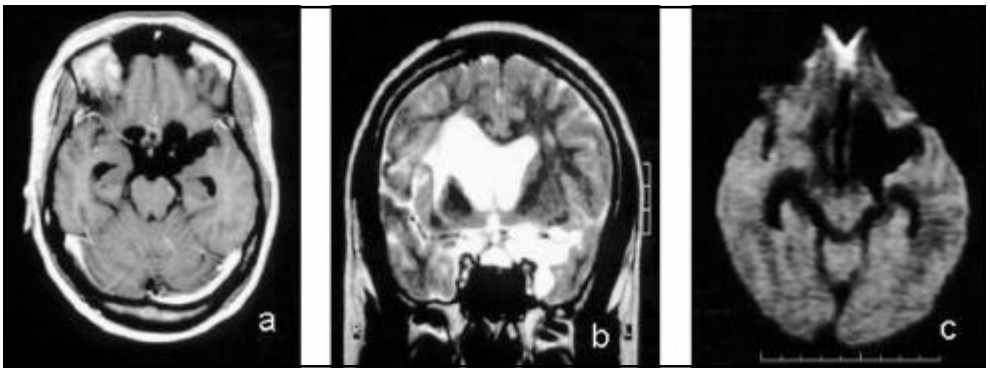

Fig 1. Cysterns racemose form: a) Axial contrast enhanced T1 WI; b) Coronal T2 WI; c) Axial diffusion WI. The lesion have the same signal than CSF in all sequences.

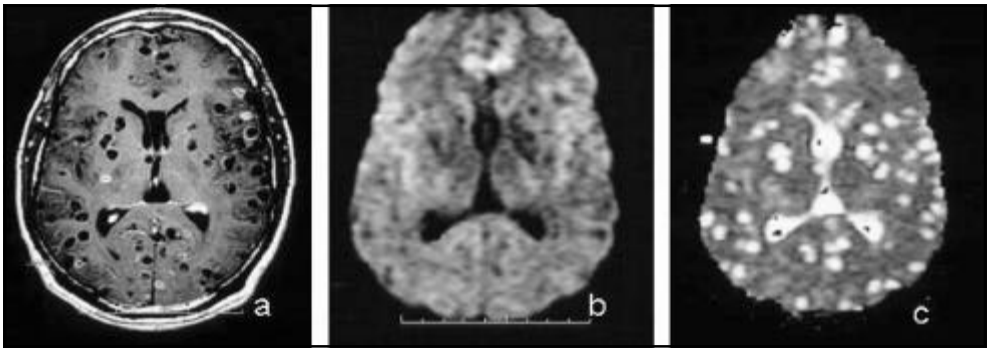

Fig 2. Diffuse parenchymal form, multiple cystic lesions in different evolutive stages: a) Contrast enhanced axial T1 WI; b) Axial diffusion WI; c) Axial diffusion map.

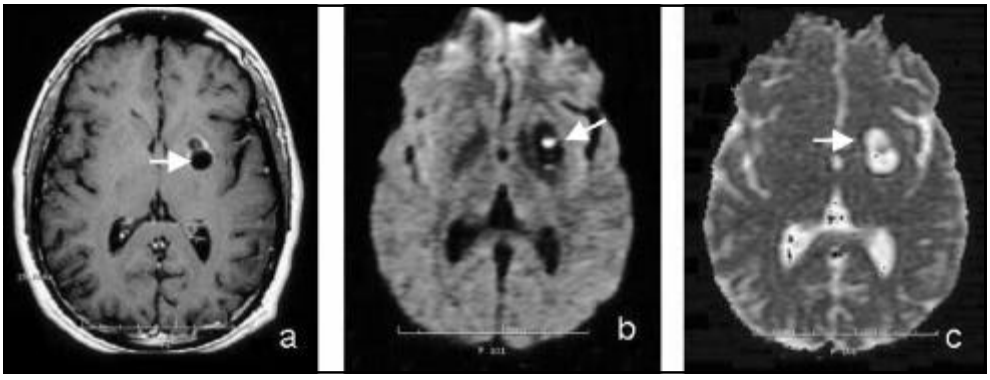

Fig 3. Parenchymal form: a) Axial T1 WI - cystic lesion with ring enhancement; b) Diffusion WI - cystic lesion with bright scolex; c) Diffusion map - cystic lesion with same signal tha CSF.

racemose forms (Fig 1), except the largest lesion (5.0 cm) and a case of racemose cysts with thick enhancement, which had an heterogeneous content with slightly higher signal intensity than the CSF on DWI. In the ADC maps, the cysts were as bright as the CSF (Fig 2).

The calculated ADC values of the cystic lesions ranged from 1.28 to 3.10 x 10^{-3}mm^2/sec, the CSF ADC values ranged from 1.12 to 3.50 x 10^{-3}mm^2/sec and the brain parenchyma ADC values ranged from 0.70 to 0.88 x 10^{-3}mm^2/sec (Table 1). There was no significant difference between the cystic lesions and CSF calculated ADC values according to the non-parametric statistic analysis (Friedman´s test).

Table 1. Calculated ADC values according to the type of tissue studied in 16 patients with neurocysticercosis.

Tissue	Diffusion coefficient (x10^{-3} mm^2 /sec) Mean	±SD	No. of measurements
cystic lesion	2.25	±0.57	16
CSF	2.34	±0.63	16
white matter	0.79	±0.05	16

Eleven patients had an eccentric nodule adhered to the cystic wall corresponding to the scolex. In seven of these patients there was a hyperintense nodule on DWI on the same topography of the scolex (Fig 3). This nodule presented the same signal intensity of the parenchyma on the ADC map. In a patient who had multiple cysts with scolex, DWI allowed identification of a small hyperintense nodule in two cysts and in another patient it could be identified a small hyperintense nodule in only one cyst. In the remaining four patients, the scolex was easily distinguished on the T2-weighted images, although it was not seen in the DWI. The scolex was too small to allow an appropriated ADC measurement without contamination with the fluid around it.

DISCUSSION

Neurocysticercosis represents an important public health problem, being endemic in development countries[1]. The infestation by the parasite was related to poor sanitary conditions. During its evolu-

tion, the disease can change its presentation in neuroimaging exams from a cyst to a calcified nodule. The initial phase is an egg-shaped cystic lesion without enhancement or edema, and if the scolex was identified the diagnosis can be done with reasonable confidence. But when it seems like a cyst with peripheral enhancement and edema without scolex the diagnosis is not so easy because the ring-enhancement mass is a nonspecific imaging finding and it can be seen in neoplastic diseases and other infections[10].

Diffusion-weighted images is helpfull in the evaluation of traumatic brain injury, demyelination disease, Creutzfeldt-Jakob disease and the differential diagnosis between necrotic tumors and abscess[10,11,15]. The necrotic or cystic tumor presents signal intensity similar to the CSF and the calculated ADC values ranged from 0.3 to 2.7 $(1.69 \pm 0.9) \times 10^{-9}$ m^2/s and from 1.7 to 3.8 $(2.2 \pm 0.9) \times 10^{-3}$ mm^2/s[14].

The findings seen in abscess were different. The abscess presents hyperintensity on DWI and lower ADC value (0.21 to 0.34 $\times 10^{-3}$ mm^2/s)[10]. The cystic or necrotic tumors are also different from acute ischemic lesion, which presents hyperintensity on DWI (like the abscess) and ADC values ranged from 0.29 to 0.33 $\times 10^{-3}$ mm^2/s, for ischemic lesions studied less than 8 hours[10] to $0.48 \pm 0,05 \times 10^{-3}$ mm^2/s[9] later on the evolution of the lesion.

In this study, all the neurocysticercotic cysts had a signal intensity similar or slightly higher than CSF in all sequences, including DWI. We did not find any hyperintense lesion, even in the colloidal stage, as was related in the literature[16], although our ADC values ranged in a similar form of those reported. The calculated ADC values were not significantly different between the CSF and the neurocystycercosis cystic lesions (Fig 1).

The small lesions were uneasy to see on DWI probably because of the low spatial resolution, characteristic of this sequence. However, they were easily recognized in the ADC map independently of the lesion size, because the ADC map gives a more conspicuous difference between the signal of the parenchyma and the lesions that are hyperintense on DWI (Fig 2).

In seven patients with cystic lesions with scolex, at least one scolex was detectable as a very hyperintense nodule within the vesicle on DWI (Fig 3). The scolex represents the solid component; indeed it is the larval body that probably causes enough water restriction to slow this signal behavior on DWI. In four patients none of the detectable scolex showed this hyperintense signal. This fact should be a matter of further studies, in order to explain why and how the scolex presents hyperintense signal on DWI.

CONCLUSIONS

In this preliminary study, we demonstrate that the cystic lesions of sixteen patients with neurocysticercosis presented similar signal intensity or slightly higher than the CSF signal intensity. We showed that DWI can be useful to aid in the establishment of the differential diagnosis between abscesses and neurocysticercotic cysts, since they can share similar image findings in the conventional MRI, although they have opposite behavior in DWI and ADC maps. Increasing the sample would give us a more reliable conclusion.

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