The Egyptian Journal of Radiology and Nuclear Medicine (2016) 47, 1037–1042

Egyptian Society of Radiology and Nuclear Medicine

The Egyptian Journal of Radiology and Nuclear Medicine

www.elsevier.com/locate/ejrnm
www.sciencedirect.com

ORIGINAL ARTICLE

Role of magnetic resonance spectroscopy & diffusion weighted imaging in differentiation of supratentorial brain tumors

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Received 14 March 2016; accepted 10 May 2016
Available online 4 June 2016

KEYWORDS

Magnetic resonance imaging;
Brain tumor;
MRS;
DWI

Abstract *Purpose:* To evaluate the role of magnetic resonance spectroscopy & diffusion weighted imaging (DWI) in differentiating between primary and secondary brain tumors.
Patients & methods: This prospective study was performed for 40 patients. Diffusion weighted image (DWI) and apparent diffusion co-efficient (ADC) maps were acquired by using *b*-values of 0 and 1000 mm^2/s. Standard mean ADC values were calculated automatically and expressed in 10^{-3} mm^2/s in both intra-lesional and peri-lesional regions. Multi voxel MR spectroscopy was performed using a spin-echo mode sequence.
The metabolites were identified including the following: N-acetylaspartate (NAA) at 2.0 ppm, creatine (Cr) at 3.0 ppm, choline (Cho) at 3.2 ppm, lipid at the range of 0.7–1.3 ppm, lactate at 1.33 ppm and myoinositol at 3.56 ppm. The ratios that were calculated include the following: Cho/NAA and Cho/Cr in both intralesional and perilesional regions.
Results: Intralesional ADC values showed no difference between the metastases (0.6: 1×10^{-3} mm^2/s with mean 0.86) and high grade primary tumors (0.6: 1.1×10^{-3} mm^2/s with mean 0.73). Perilesional ADC value Findings in the study revealed that primary tumors have low ADC values (0.9: 1.1×10^{-3} mm^2/s with mean 0.95) in their peri-lesional voxels denoting peri-lesional infiltration, while higher ADC values in metastasis ($1.3–1.6 \times 10^{-3}$ mm^2/s mean 1.41) due to the absence of peri-lesional infiltration increase in CHO/Cr ratios (>1) in primary high grade tumors (indicating perilesional infiltration) while there was no increase in CHO/Cr ratio in cases of metastases. Low grade primary tumors showed low lactate and lipid, with increasing malignancy, and tumors showed increasing levels of lactate and lipid peaks (indicating necrosis) with remarkable difference in lipid peaks between low and high grade tumors. There was no significant difference between primary & metastatic brain tumors as regards lactate peak.

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Peer review under responsibility of The Egyptian Society of Radiology and Nuclear Medicine.

http://dx.doi.org/10.1016/j.ejrnm.2016.05.005

Conclusion: Intra-lesional ADC values are not useful in the differentiation between primary and metastatic tumors. Perilesional ADC values can differentiate between primary & metastatic brain tumors. Intralesional MRS values (CHO/Cr ratio) were able to grade the tumor and differentiate between high and low grade tumors, while Perilesional MRS values (CHO/Cr ratio) could be able to differentiate primary tumors from metastasis.

1. Introduction

Intracranial tumors are a significant health problem. The annual incidence of primary and secondary central nervous system neoplasms ranges from 10 to 17 per 100,000 persons (1). Brain tumors are subdivided into supra-tentorial & infra-tentorial brain tumors (2). Differentiation of low grade from high grade glioma, neoplastic from non-neoplastic brain masses by using conventional MRI is frequently difficult, and many cases require biopsy or follow-up imaging. Gadolinium enhancement is useful in evaluation of brain tumors. Recent MR imaging techniques, such as MR spectroscopy, can further improve the diagnostic accuracy of MR imaging in the diagnosis of such tumors (2,3). Magnetic resonance spectroscopy is a technique that allows the study of some metabolites in the brain or neoplasms that point to the nature of these lesions, grading of brain tumors, and follow-up and to evaluate the response of these lesions to treatment (4). Magnetic resonance spectroscopy is an analytical method used to identify molecules and to determine their biophysical characteristics (5). Thus, this technique is a multi-parametrical molecular imaging method that can complete MRI study enabling the detection of biochemical patterns of different features and aspects of brain tumor (6). Diffusion-weighted imaging (DWI) helps us to obtain additional information about the brain from the microscopic movement of water molecules. DWI has been used to detect the nature of brain tumors according to their cellularity and to differentiate between high cellular and low cellular brain tumors (7,8).

2. Patients and methods

The study protocol was approved by the local Ethics Committee, and informed consent was obtained from all patients. This prospective study included 40 patients, and their age ranged from 30 to 65 years old with suspicious of intra-axial supratentorial brain tumors by CT.

2.1. Image protocol

All examinations were performed using a 1.5 T MR Unit (SIGNA Horizon, General Electric Medical System, Milwaukee, WI) using head coil.

2.2. Magnetic resonance spectroscopy (MRS)

Multi voxel MR spectroscopy was performed using a spin-echo mode sequence (SE) with long TE (144 mm/s) and short TE (35 mm/s). Water suppression was achieved with chemical shift selection (CHESS) technique. The voxels were placed on the lesions and perilesional areas away from CSF and scalp fat to avoid contamination and voxel was placed in normal region. The metabolites were identified including the following: N-acetyl aspartate (NAA) at 2.0 ppm, creatine (Cr) at 3.0 ppm, choline (Cho) at 3.2 ppm, lipid at the range of 0.7–1.3 ppm, lactate at 1.33 ppm and myoinositol at 3.56 ppm. The ratios were calculated including the following: Cho/NAA and Cho/Cr in both intralesional and perilesional regions.

2.3. Diffusion weighted imaging with apparent diffusion coefficient calculation

DW images were obtained by using an axial echo-planar SE sequence, average, 5 mm section thickness. DW images and ADC maps were acquired by using b values of 0 and 1000 s/mm^2. Post processing of ADC maps was performed. Standard mean ADC values were calculated automatically and expressed in 10^{-3} mm^2/s.

2.4. Statistical analysis

Statistical analysis was undertaken to prove the efficacy of MRS & diffusion in the evaluation of supratentorial brain tumors. Statistical analysis was performed using the SPSS software package version 16.0 (statistical package for social science TM) and $P < 0.05$ was considered to be statistically significant. The sensitivity and specificity for each protocol were compared in order to evaluate the reliability of each of them and when they are combined.

3. Results

In this prospective study, forty patients were included in this study with supra-tentorial brain tumors. Their age ranged from 30 to 65 years old.

3.1. MRS evaluation

MRS evaluation of the studied 40 patients revealed that 36 cases of the 40 patients (90%) had primary tumors and 4 patients (10%) had metastatic tumors as shown in Table 1 & Fig. 1.

3.1.1. Calculated CHO/Cr ratios from intralesional areas

Calculated CHO/Cr ratios from the intra-lesional areas showed significant increase from low grade to high grade tumors with no significant difference between high grade primary and metastases as shown in Table 2 & Fig. 2.