Role of magnetic resonance spectroscopy in the evaluation of intra-axial supra-tentorial brain tumours

Poster No.: C-1022
Congress: ECR 2015
Type: Scientific Exhibit
Authors: A. M. R. Khalil, A. ElSharkawy, A. E.-M. N. Darweesh, N. M. Abd ElMaboud; Tanta/EG
Keywords: Tissue characterisation, Cancer, Imaging sequences, Diagnostic procedure, MR-Spectroscopy, MR, Oncology, Neuroradiology brain, CNS
DOI: 10.1594/ecr2015/C-1022

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

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].

Types of brain tumors are extra axial brain tumors (meningioma) & intra axial brain tumors which is divided into supra-tentorial & infra-tentorial brain tumors. 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, 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. This biochemical information is processed and presented as density maps of several metabolites, among them N-acetyl aspartate (marker of neuronal viability), choline (marker of membrane turnover), creatine (related to the energy state of the cells), myoinositol (exclusively found in astrocytes), lipids and lactate (observed in necrosis and other pathological processes) which mean relevant information in the context of brain tumors. 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 [5,6].

MRS may enable differentiation between lesions showing similar aspects on conventional MRI. Choline is considered the most specific marker of intracranial neoplasm. Increase in Choline levels and Choline / Creatine and Choline/NAA ratios is very suggestive of the malignant nature of the neoplasm, its grading and its follow up to evaluate the response of the treatment [7].

The aim of this study is to evaluate role of the recent magnetic resonance imaging tools as magnetic resonance spectroscopy in diagnosis of intra-axial supra-tentorial brain tumors.
Methods and materials

The study was conducted on 40 patients with suspicious of intra-axial supratentorial brain tumors.

Methods:

All patients were subjected to the following:

1- Informed consent.

2- History taking:
   - Personal history: name, age and sex.
   - Present history: symptoms as headache, weakness, tremors, blurred vision or numbness.
   - Past history: as regard any previous neurological diseases.

3- General examination and vital signs.

4- Neurological examination.

Magnetic Resonance Imaging (MRI):

All MRI scans were performed by a 1.5 Tesla unit using a head coil. The slice thickness was 6 mm, the matrix was 256 x 256 and the field of view was 220-240 mm.

Protocol included:

- Axial T1WI (TR/TE= 400-600 / 10-20 m/sec).
- Post contrast T1WI study was done after injection of gadolinium-based contrast agents (0.1 ml/Kg).

Magnetic Resonance Spectroscopy (MRS):

Multi voxel MR spectroscopy was performed using a spin-echo mode sequence (SE) with intermediate TE (144mm/sec) and short TE (35mm/sec).

The metabolites were identified including: 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 including : Cho/NAA and Cho/Cr in both intralesional and perilesional regions.
Results

40 patients were included in this study with suspicious of intra-axial supra-tentorial brain tumors.

In the studied cases as regard their pattern of enhancement after gadolinium injection there were, 36 patients (90%) had heterogeneous enhancing lesion, 2 patients (5%) had marginally enhancing lesion, 1 patient (2.5%) had homogenously enhancing lesion & 1 patient (2.5%) had non enhancing lesion.

Table (1) : Pattern of enhancement

<table>
<thead>
<tr>
<th>Pattern of enhancement</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneous</td>
<td>36</td>
<td>90%</td>
</tr>
<tr>
<td>Marginal</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>Homogenous</td>
<td>1</td>
<td>2.5%</td>
</tr>
<tr>
<td>Non enhancing</td>
<td>1</td>
<td>2.5%</td>
</tr>
<tr>
<td>( \chi^2 )</td>
<td>2.336</td>
<td></td>
</tr>
<tr>
<td>P. value</td>
<td>0.062</td>
<td></td>
</tr>
</tbody>
</table>

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 (2)

Table (2): The tumor groups according to the MRS evaluation.

<table>
<thead>
<tr>
<th>Tumor group</th>
<th>No. of cases (40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-primary</td>
<td>36 (90%)</td>
</tr>
<tr>
<td>2-Metastastic</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>( \chi^2 )</td>
<td>6.459</td>
</tr>
<tr>
<td>P. value</td>
<td>0.014</td>
</tr>
</tbody>
</table>

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.
Table (3): Intralesional CHO/Cr ratios among the studied cases.

<table>
<thead>
<tr>
<th>Type of tumor</th>
<th>Range</th>
<th>Mean</th>
<th>±SD</th>
<th>t. test</th>
<th>p. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Primary tumors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low grade</td>
<td>1 - 3</td>
<td>1.96</td>
<td>0.42</td>
<td>2.635</td>
<td>0.024</td>
</tr>
<tr>
<td>High grade</td>
<td>1.6 - 9.8</td>
<td>5.36</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Metastasis</td>
<td>1.4 - 6</td>
<td>4.35</td>
<td>1.06</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Calculated CHO/Cr ratios from perilesional areas:

Calculated CHO/Cr ratios from the perilesional areas showed increase in CHO/Cr ratios (>1) in primary high grade tumors (indicating perilesional infiltration) while there were no increase in CHO/Cr ratio (#1) in cases of metastases (indicating no perilesional infiltration)

Table (4): Perilesiona CHO/Cr ratios among the studied cases.

<table>
<thead>
<tr>
<th>Type of tumor</th>
<th>Range</th>
<th>Mean</th>
<th>±SD</th>
<th>t. test</th>
<th>p. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Primary Tumor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low grade</td>
<td># 1</td>
<td>0.63</td>
<td>0.10</td>
<td>4.633</td>
<td>0.009</td>
</tr>
<tr>
<td>High grade</td>
<td>1.9 - 6</td>
<td>3.85</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Metastases</td>
<td># 1</td>
<td>0.74</td>
<td>0.010</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Lipid & lactate levels:

Low grade primary tumors showed low lactate and lipid, with increasing malignancy, 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 to metastatic brain tumors as regard lactate peak.
Images for this section:

Fig. 1: Intra-axial well defined right parieto-occipital space occupying lesion (SOL) displaying heterogeneous signal in T1WI with heterogeneous enhancement after IV contrast injection

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 2: Intralesional voxels: In TE 144…… showed increase in choline decrease in creatine and NAA with CHO/NAA ratio 6.8 & CHO/Cr ratio 5.8

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 3: Perilesional voxels......showed increase in choline with decreased NAA & Cr with CHO/NAA ratio 3.2 .CHO/Cr ratio 2.7

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/ EG
Fig. 4: In short TE 35 …increase in lipids & lactate in short TE

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
**Fig. 5:** Intra-axial left occipital space occupying lesion is seen displaying low signal in T1WI, faint enhancement after IV contrast injection

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 6: Intralesional voxels showed increase in choline, myoinositol with decrease in creatine and NAA with CHO/NAA ratio 2.3 & CHO/Cr ratio 2.

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 7: Peri lesional voxels showed no increase in choline with CHO/Cr ratio 1.6, revealed low grade glioma

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
**Fig. 8:** Intra-axial right parieto-occipital space occupying lesion is seen displaying high signal in T2WI & homogenous enhancement after IV contrast injection

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 9: Intralesional voxels showed increase in choline, lipids & lactate with decrease in creatine and NAA, with CHO / NAA ratio 8.2 CHO/Cr ratio 4.9

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 10: In short TE 35.... show high levels of lipids and lactate

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/EG
Fig. 11: Peri lesional voxels .....showed no increase in choline with CHO/NAA ratio 1.1 , CHO / Cr ratio 1.4 , high grade tumor with no peri lesional infiltration....... solitary metastatic lesion .

© Diagnostic Radiology, Faculty of Medicine Tanta University, Tanta University - Tanta/ EG
Conclusion

MRS gives information about the biochemical changes of tissues which appear earlier than the structural changes, so recently MRS has been used as a non-invasive method for diagnosis, grading & follow up of brain tumors.

Intralesional MRS values \((\text{CHO/Cr ratio})\) was able to grade the tumor and differentiate between high and low grade tumors as high grade tumors showed higher CHO peaks and high CHO/Cr. The presence of lipid and lactate also denotes high grade tumors due to breakdown and necrosis.

Perilesional MRS values \((\text{CHO/Cr ratio})\) could be able to differentiate primary tumors from metastasis as primary tumors showed low Cr and elevated CHO peak and high CHO/Cr ratio in the surrounding perilesional area denoting perilesional infiltration which is absent in metastasis. Also Metastasis exhibit very prominent Lipid level even in absence of much tumor necrosis.

From the current study it can be concluded that MR spectroscopy with calculation of its ratios could improve the diagnostic efficacy of conventional MR imaging in the diagnosis and grading of the malignant brain tumors.
Personal information

Alaa Mohamed Reda Khalil
Radiology Resident
Department of Radiology Tanta University Hospital
Tanta - Egypt
Lolo20-12-1986@hotmail.com

Ahmed Mostafa ElSharkawy
Radiology learning assistant
Department of Radiology Tanta University Hospital
Tanta - Egypt
Ahmed.Elsharkawy84@gmail.com

Abdel Monem Nooman Darwiesh
Professor and head of Radiodiagnosis department Tanta University
Tanta - Egypt

Ashraf Fathy Barkat
Professor and head of clinical oncology department Tanta University

Noha Mohamed Abd-El Maboud
Assistant Professor
Radiodiagnosis department Tanta University


