

***Role of Magnetic Resonance Spectroscopy in
Discrimination between Tumors and Tumor
like Lesions in Brain Masses.***

*Essay
For Partial Fulfillment of
Master Degree in Radiodiagnosis
By*

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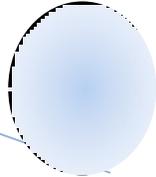
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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

أَقْرَأَ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴿١﴾ خَلَقَ الْإِنْسَانَ
مِنْ عَلَقٍ ﴿٢﴾ أَقْرَأَ وَرَبُّكَ الْأَكْرَمُ ﴿٣﴾ الَّذِي عَلَّمَ
بِالْقَلَمِ ﴿٤﴾ عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ﴿٥﴾

سُورَةُ الْعَلَقِ



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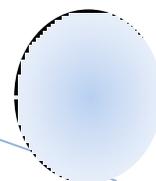
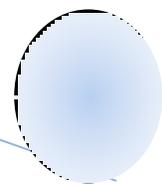


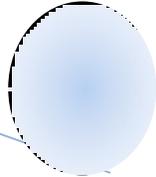
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List of Abbreviations

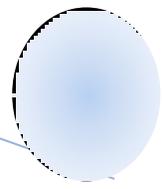
γ	<i>Gyromagnetic ratio</i>
1HMRS	<i>Proton Magnetic Resonance Spectroscopy</i>
2D	<i>Two Dimensional</i>
3D	<i>Three Dimensional</i>
AAs	<i>Amino Acids</i>
Ac	<i>Acetate</i>
ACTH	<i>Adreno Cortico Trophic Hormone</i>
AD	<i>Alzheimer's Disease</i>
Ala	<i>Alanine</i>
B	<i>The effective magnetic field strength</i>
Bo	<i>Magnetic field strength</i>
CBV	<i>Cerebral Blood Volume</i>
CHESS	<i>Chemical Shift Elected pulse Sequence</i>
Cho, Ch	<i>Choline</i>
Or Co	
cMRI	<i>Conventional Magnetic Resonance Imaging</i>
CNS	<i>Central Nervous System</i>
Cr	<i>Creatine</i>
Crypto	<i>Cryptococcoma</i>
CSF	<i>CerebroSpinal Fluid</i>



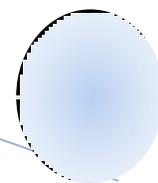
CSI	<i>Chemical Shift Imaging</i>
CT	<i>Computed tomography</i>
DM	<i>Diabetes Mellitus</i>
DNETs	<i>Dysembryoplastic Neuro Epithelial Tumors</i>
F	<i>Fluorine</i>
FDA	<i>Food and Drug Administration</i>
FLAIR	<i>Fluid Attenuation Inversion Recovery</i>
FSH	<i>Follicular Stimulating Hormone</i>
GBM	<i>Glioblastoma Multiforme</i>
GC	<i>Gliomatosis Cerebri</i>
Glx	<i>Glutamine & Glutamate</i>
GM	<i>Gray Matter</i>
GFAP	<i>Glial Fibrillary Acidic Protein</i>
H	<i>Hydrogen</i>
HE	<i>Hepatic Encephalopathy</i>
ICH	<i>Intracranial Haemorrhage</i>
JPA	<i>Juvenile Pilocytic Astrocytoma</i>
Lac	<i>Lactate</i>
LCH	<i>Langerhans Cell Histiocytosis</i>
LGG	<i>Low Grade Glioma</i>
LIP	<i>Lipids</i>
ml	<i>Myo-inositol</i>



<i>MS</i>	<i>Multiple Sclerosis</i>
<i>MVS</i>	<i>Multi Voxel Spectroscopy</i>
<i>NAA</i>	<i>N-Acetyl Aspartate</i>
<i>NMRS</i>	<i>Nuclear Magnetic Resonance Spectroscopy</i>
<i>PKU</i>	<i>Phenylketonuria</i>
<i>PML</i>	<i>Progressive Multifocal Leukoencephalopathy</i>
<i>PNETs</i>	<i>Primitive Neuro Ectodermal Tumors</i>
<i>ppm</i>	<i>Parts Per Million</i>
<i>PRESS</i>	<i>Point Resolved Spectroscopy</i>
<i>PROBE</i>	<i>Proton Brain Examination</i>
<i>PXA</i>	<i>Pleomorphic Xantho Astrocytoma</i>
<i>rCBV</i>	<i>Relative Cerebral Blood Volume</i>
<i>SBS</i>	<i>Shaken Baby Syndrome</i>
<i>SNR</i>	<i>Signal to Noise Ratio</i>
<i>SOL</i>	<i>Space Occupying Lesion</i>
<i>STEAM</i>	<i>Stimulated Echo Acquisition Mode</i>
<i>Succ</i>	<i>Succinate</i>
<i>SVS</i>	<i>Single Voxel Spectroscopy</i>
<i>TCA</i>	<i>Tricarboxylic acid</i>
<i>TE</i>	<i>Echo Time</i>
<i>TMS</i>	<i>TetraMethylSilane</i>
<i>Toxo</i>	<i>Toxoplasmosis</i>



<i>TR</i>	<i>Time to Repeat</i>
<i>TSH</i>	<i>Thyroid Stimulating Hormone</i>
<i>RF</i>	<i>Resonance frequency</i>
<i>VOI</i>	<i>Volume Of Interest</i>
<i>WHO</i>	<i>World Health Organization</i>
<i>WM</i>	<i>White Matter</i>



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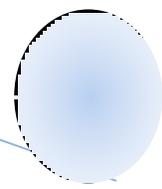
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INTRODUCTION & AIM OF THIS WORK

There are two types of brain tumors : primary brain tumors that originate in the brain and metastatic (secondary) brain tumors that originate from cancer cells that have migrated from other parts of the body. A primary brain tumor rarely spreads beyond the central nervous system, and death results from uncontrolled tumor growth within the limited space of the skull. Metastatic brain cancer indicates advanced disease and has a poor prognosis (*Nakamura et al., 2007*).

Primary brain tumors can be cancerous or noncancerous. Both types take up space in the brain and may cause serious symptoms and complications. All cancerous brain tumors are life threatening (malignant) because they have an aggressive and invasive nature. A noncancerous primary brain tumor is life threatening when it compromises vital structures. Brain cancer is the leading cause of cancer-related death in patients younger than age 35 (*Nakamura et al., 2007*).

Primary brain tumors account for 50% of intracranial tumors and secondary brain cancer accounts for the remaining cases. Approximately 17,000 people in the United States are diagnosed with primary cancer each year and nearly 13,000 die of the disease. The annual incidence of primary brain cancer in children is about 3 per 100,000. Secondary brain cancer occurs in 20–30% of patients with metastatic disease and incidence increases with age. In the United States, about 100,000 cases of secondary brain cancer are diagnosed each year (**wolf, 2011**)

The diagnosis of brain tumors by magnetic resonance imaging (MRI) is usually based on basic unenhanced T1- and T2-weighted images and post contrast T1-weighted images. Conventional MRI techniques are not sufficient for the grading and specification of brain tumors. Furthermore, several pseudotumor lesions, such as arachnoid cysts, heterotopic gray matter, tubers of tuberous sclerosis, cavernous



hemangiomas, aneurysms, granulomas, abscesses, radiation necrosis and acute demyelination with a mass effect can mimic brain tumors on MRI **(Louis et al., 2007)**.

Proton Magnetic Resonance Spectroscopy ($^1\text{H-MRS}$) can differentiate benign from malignant tumors **(Louis et al., 2007)**.

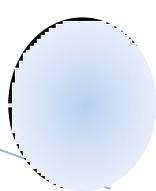
$^1\text{H-MRS}$ is superior to MRI in the detection of tumor growth in morphologically normal tissue and in the differential diagnosis of untreated intracranial space-occupying lesions (SOLs) **(Louis et al., 2007)**.

$^1\text{H-MRS}$ has not only been used to identify tumors, but also to noninvasively grade and classify brain tumors **(Essig et al., 2007)**.

$^1\text{H-MRS}$ is especially useful in cases where MRI demonstrates enhancement, but it is difficult to determine whether it is radiation necrosis (positive treatment response) or recurrence (negative treatment response), and upon $^1\text{H-MRS}$ diagnosis of recurrence, the surgeon becomes able to proceed quickly to treatment instead of waiting for symptoms of recurrence or biopsy confirmation **(Lin , et al, 2005)**

Discrimination between brain abscess and cystic tumors with similar neuroimaging appearance can be achieved by $^1\text{H MRS}$, which is very important for determining the treatment strategy **(Essig et al., 2007)**.

The spectral pattern of intracranial tumors usually includes reduction in N-acetyl aspartate (NAA) level and NAA/Creatine (Cr) ratio, decreased creatine (Cr) level, Increase in Choline (Cho) and Cho/NAA and Cho/Cr ratios, also higher Lactate peak is seen in higher grade tumors, and the presence of lipids is a strong indication of tissue



necrosis. ml/Cr ratio is usually higher in lower grade than in higher grade tumors , While the spectral pattern of brain abscess is characterized by the presence of amino acids, acetate, and succinate. **(Essig et al., 2007).**

MRS may have an important role to play in guiding the surgeon to the area of highest abnormal spectral changes in the brain lesion prior to stereotactic surgery for histological diagnosis and tumor staging. As multivoxel spectroscopy accesses the lesion in its complete extension and is able to identify the area with the greatest increase in Cho levels, hence greater tumor activity, which is the ideal site for biopsy. **(wolf , 2011)**

MRS cannot totally replace brain biopsy for histological diagnosis, but might be able to better delineate and define tumor boundaries and separate an infiltrative growing glioma from normal brain tissue, thereby helping in presurgical planning of brain neoplasm. **(Essig et al., 2007).**

MRS has been shown to be a helpful tool in evaluation of a new contrast-enhancing lesion at the site of a previously identified and treated primary intracranial neoplasm, differentiating recurrent tumor from radiation injury. Recurrent tumors are characterized by reappearance of high choline peak, while in radiation injury the choline peak is absent or depressed. **(wolf , 2011)**