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# Assessment of Magnetic Resonance Spectroscopy in Diagnosis of Brain Lesions

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The aim of this study was to assess magnetic resonance spectroscopy (MRS) in diagnosis of brain lesions. In this cross-sectional descriptive retrospective study we include 50 patients; 18 females (36%) and 32 males (64%) and their age ranged from (4-80 years). This study was conducted at Almoalem Medical City, Khartoum, Sudan, in patients whom referred for MRS by using 1.5 Tesla Toshiba Exclelart Vantage whole body MR systems with standard imaging head coil. Data collection sheet was designed to include a detailed history and demographic data. Chi-square test was used to assess the relationship between qualitative variables. The results revealed that the majority of the patients were in the 5$^{th}$ decade (24%). Glioma was the most common brain tumor (46%) and the most common tumor site was on the left side (60%) of the brain. In conclusion, diagnosis of benign and malignant brain tumors and differentiate them from other focal intracranial lesions based on imaging procedures alone is still a challenging problem. Combination of proton MRS and conventional MRI protocol provide additive valuable information helping in tissue characterization of intracranial tumors. This leading to improve the diagnosis and thus reducing biopsies. We recommend using MRS routinely in patients with brain lesions to improve the accuracy of neuro diagnosis and for other benefit in patient management.

**Keywords: Magnetic Resonance Spectroscopy (MRS), Brain lesions, Gliomas, Sudanese population**

## INTRODUCTION

Imaging is becoming an increasingly important tool in both research and clinical care. A range of imaging technologies is now provided unprecedented sensitivity to visualize brain structure and function from the level of individual molecules to the whole brain. Most of imaging methods are non-invasive and allow dynamic processes to be monitored over time (Asbury, 2011). Neuroimaging is enabling researchers to identify neural networks involved in cognitive processes; understand disease pathways; recognize and diagnose diseases early when they are most effectively treated; and determine how therapies work (Golubic, 2019). In vivo magnetic resonance spectroscopy (MRS) of the human brain has been recognized as a safe diagnostic method that coupled with MRI techniques, allows the correlation of anatomical and physiological

changes in the metabolic and biochemical processes occurring in a previously determined brain region (Bertholdo, Watcharakorn, Castillo, 2013; Mikkelsen, Snyder, Hearshen, 2016; Soares and Law, 2009). The most common nuclei that are used in MRS are H (proton), Na (sodium), and P (phosphorus). However, proton spectroscopy ($^1$H MRS) provides much higher signal-to-noise than either sodium or phosphorus. From the clinical standpoint, a proton MR spectrum is useful in diagnosis and treatment of brain tumors, stroke, epilepsy, metabolic disorders, infections and dementia (Bertholdo, Watcharakorn, Castillo, 2013; Kamran, 2013).

Proton magnetic resonance spectroscopy is a very sensitive method in diagnosis of brain lesions (Kamran, 2013; Ramin, Tognola, Spotti, 2003). It is useful in differentiating glioma from infection, because in neoplastic processes, there is a remarkable increase in the choline peak. In gliomas, there is a pronounced increase in choline levels, associated with decreased intensity of the N-acetyl aspartate peak. In addition, the presence of an alanine peak can confirm the diagnosis of such brain tumor (Ramin, Tognola, Spotti, 2003; Horská and Barker, 2010).

Although several proton MRS studies have been conducted in order to determine the metabolic pattern of brain lesions (Hollingworth et al., 2006; Pyka et al., 2017; McKnight, 2004; Möller-Hartmann et al., 2002; Chernov et al., 2006; Chawla et al., 2010), only a few investigations focused on the differentiation between benign and malignant brain lesions (Julià-Sapé et al., 2012). In particular, the clinical value of proton MRS in management of brain lesions and their correlation with conversational MRI in Sudanese population has not yet been defined.

This study designed to assess the MRS in diagnosis of brain lesions. The specific objectives are to determine the role of non-invasive MRS technique combined with conventional MRI in the management of brain lesions and to differentiate between benign and malignant lesions.

## MATERIALS AND METHODS

### Study population:

Patients who presented with a suspected brain lesion during the period of study. This study was done at the Almoalem Medical City in Khartoum, Sudan, during the period from November 2019 to March 2020. The inclusion criteria were patient with brain lesions and exclusion criteria was patient with contraindication to MRI.

### Ethical consideration:

Approval for this study was obtained from the Almoalem medical city. All participants provided oral consent for clinical data collection and publication. Permission from hospital-authorized person was taken.

### Equipment:

The Toshiba Excelart Vantage 1.5T MRI machine was used to scan the patients in the present study. This MRI machine is an ultra-short, ultra wide-bore system with adjustable lighting and ventilation features designed to ease patient anxiety without sacrificing performance. The Toshiba Excelart Vantage 1.5T MRI system delivers high-resolution images across the entire body with faster scanning times. Their system was featured an integrated coil concept that allows multiple examinations without repositioning the patient.

### Technique and protocol:

MRS studies were performed on 1.5 Tesla Toshiba whole body MR systems using standard imaging head coil. Routine brain MRI was performed in three orthogonal planes, including at least $T_1$, $T_2$, and fluid attenuated inversion recovery (FLAIR) weighted images. $T_1$-weighted images after intravenous gadolinium-based contrast material administration were obtained in at least two planes. All spectroscopy images were performed through single voxel technique. Initially, post contrast imaging was done in $T_1$ or $T_2$ and FLAIR without contrast to localize the lesion and then voxel was placed on the volume of interest. After the water suppression, appoint-resolved spectroscopy (RESS) technique was used for localization and the studies were obtained with parameters including echo time (TE) and repetition time (TR). Figure 1 shows that application of technique in a sample of the study.

### Data collection and analysis:

The data were collected by validate self-administrated through the collection data sheet adopted for the study. Then, data analyzed using a computerized program, Statistical Package for Social Sciences (SPSS).

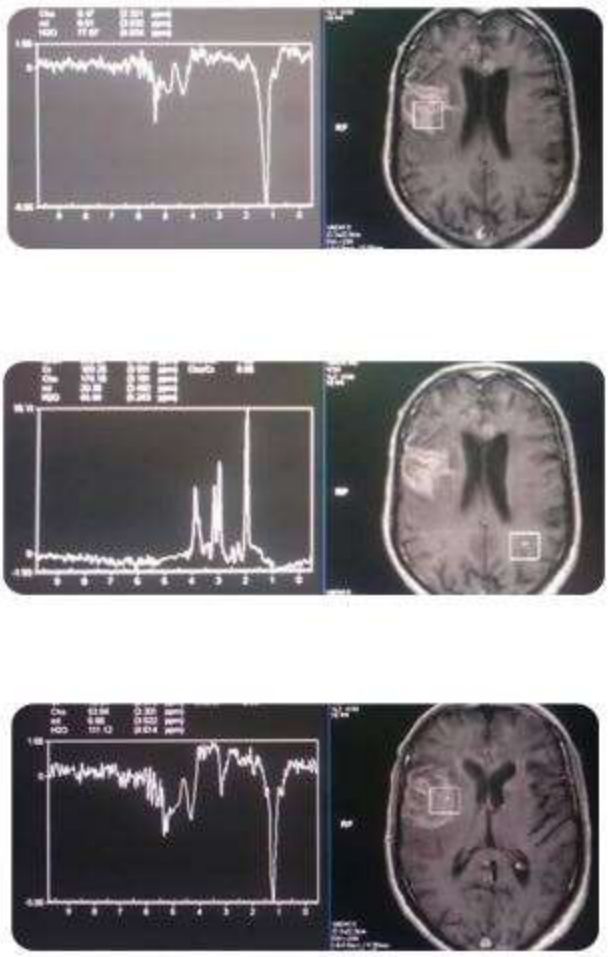

**Figure 1: A 62 years old/male. MRS findings: predominant elevation of lipid/lactate peak = tissue necrosis. Significantly reduced – absent ANN and creatine = no normal neuronal tissue. Significantly reduced – absent choline peak = no cellular proliferation or turn over. Impression: overall features are favoring inflammatory / infection process with abscess formation, rather than neoplastic or ischemic.**

## RESULTS AND DISCUSSION

The present study involved 50 patients underwent brain MR imaging and proton MRS, their age ranged from 4-80 years old. Data were classified into seventh age groups as shown in Table 1. The results demonstrate that the most affected age group ranged between 40-49 years old (24%). This result was in line with previous studies that found the majority of patients presented with brain lesions or intracranial tumors were in the fourth and fifth decade (Goyani et al., 2015; Salih et al., 2016).

**Table 1. Distribution of patients' age group.**

| Age group (years) | Number | Percent |
|---|---|---|
| 4-19 | 7 | 14% |
| 20-29 | 7 | 14% |
| 30-39 | 6 | 12% |
| 40- 49 | 12 | 24% |
| 50- 59 | 4 | 8% |
| 60-69 | 10 | 20% |
| 70-79 | 4 | 8% |
| Total | 50 | 100% |

As shown in Table 2, the present study had 32 males (64%) and 18 females (36%) with defined brain lesions. This sex distribution was found to be quite comparable with previous studies conducted by Salih et al., 2016 and Kamran, 2013. These indicate that brain tumors occur more frequently in male than in the female, specifically in Sudanese

population.

**Table 2. Gender distribution.**

| Gender | Number | Percent |
|---|---|---|
| Female | 18 | 36% |
| Male | 32 | 64% |
| Total | 50 | 100% |

The different distribution of tumor in different brain site was shown in Table 3. The most affected site is the left side (60%), Followed by the right side (28%), which is in agreements with the study by Kamran, 2013.

**Table 3. Distribution of tumor site within the brain.**

| Side | Number | Percent |
|---|---|---|
| Left | 30 | 60% |
| Center | 6 | 12% |
| Right | 14 | 28% |
| Total | 50 | 100% |

Table 4 showed that Gliomas (46%) were the most common brain lesions found with MRS, followed by malignancy (28%), Granulomas (6%), GBM (4%), Glioblastoma (4%), Oligodendroglioma (4%), Meningioma (4%), Glyomatosis (2%) and Haemangioma (2%). These results were in line with finding by Goyani et al., 2015, which found that Gliomas were the most common brain tumors found on MR images (Figurers 3-5).

**Table 4. Distribution of different brain lesion type findings with MRS.**

| Brain lesions | Number | Percent |
|---|---|---|
| Glioblastoma | 2 | 4% |
| Glioblastoma multiforme (GBM) | 2 | 4% |
| Glioma | 23 | 46% |
| Glyomatosis | 1 | 2% |
| Granuloma | 3 | 6% |
| Haemangioma | 1 | 2% |
| Malignant | 14 | 28% |
| Meningioma | 2 | 4% |
| Oligodendroglia | 2 | 4% |
| Total | 50 | 100% |

Compared to normal parenchyma, all mass lesions studied showed abnormal MR Spectra (Kamran, 2013). There is strong evidence of increased choline and decreased N-acetyl aspartate (NAA) containing components in tumor relative to normal brain parenchyma (Figure 2). In addition, for Gliomas and some metastatic lesions, there are resonance corresponding to lactate or lipid (Burtscher and Holtås, 2001; Mansour, 2018) (Figure 3).

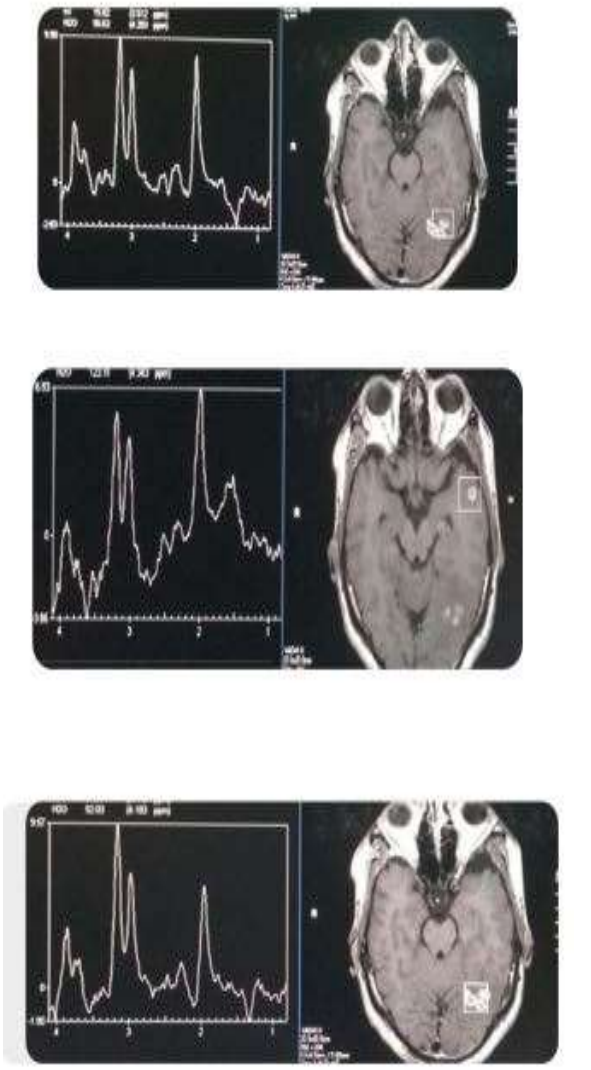

**Figure 2: A 30 years old/male. MRS findings: increased choline peaks, increased choline/Cr ratio and decrease NAA peck. Impression: overall picture is of in favoring metastasis rather than primary brain tumor.**

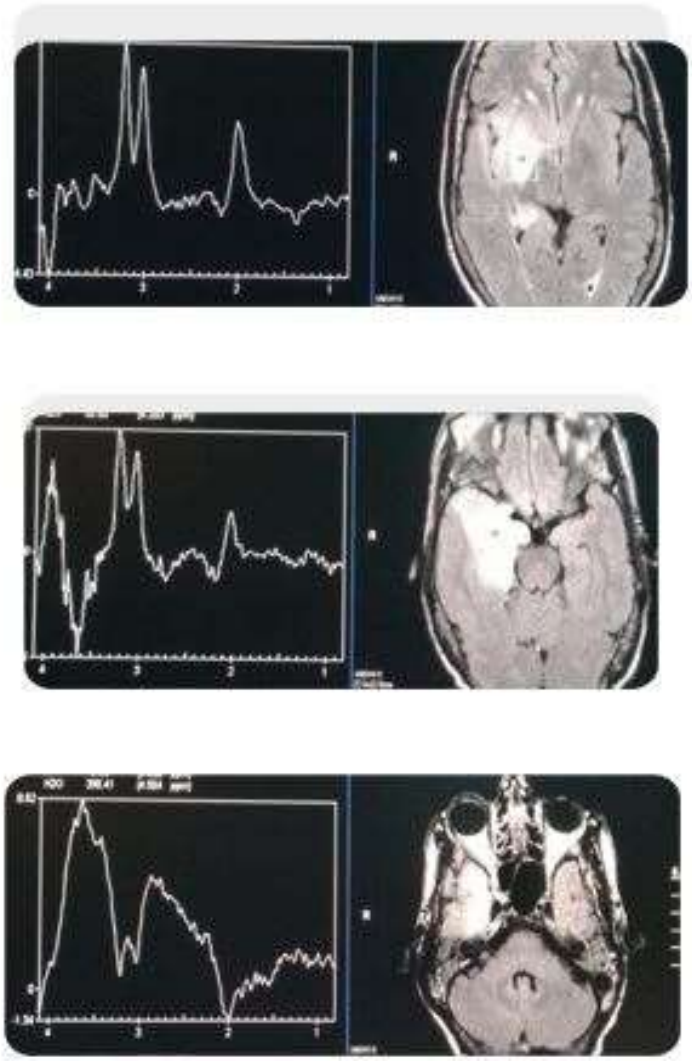

**Figure 3: A 53 years old/male. MRS findings: increased creatine peaks. Increased choline/Cr ratio Decrease NAA peck. A new peak is seen resonating at 3.6 mostly myo-inositol. Impression: features are representing neoplastic process mostly low-grade glioma.**

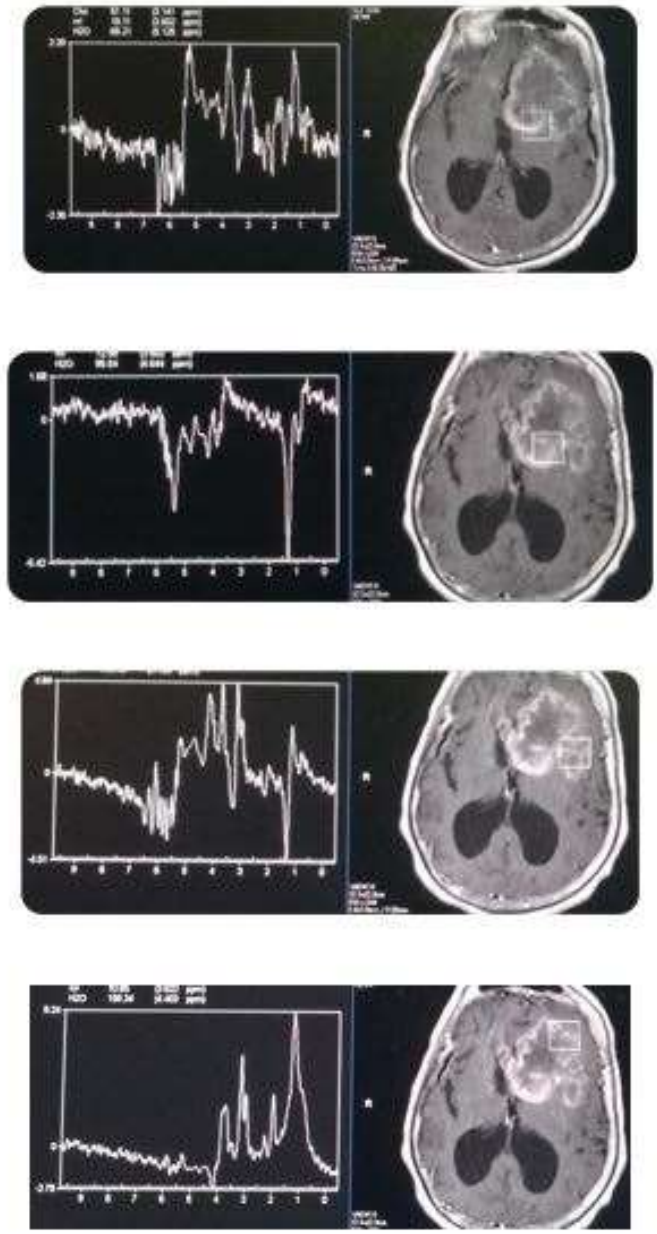

**Figure 4: A 73 years old/female. MRS findings: decreased creatine peaks. Choline/Cr ratio of 3.78 at its maximum. Decrease NAA peck of elevated choline peak. Impression: features are representing neoplastic process, mostly glioblastoma multiform.**

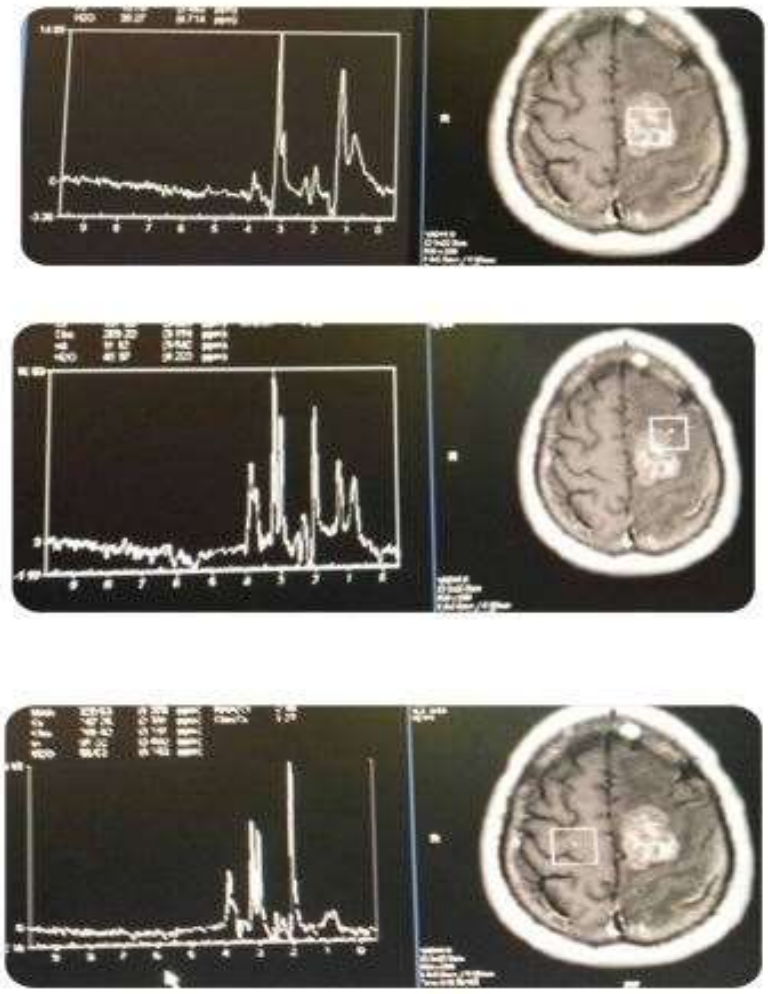

**Figure 5: A 56 years old/male. MRS findings: increased choline peak. Increased choline/Cr ratio and decrease NAA peck and increased lactate. Impression: overall picture is suggestive of neoplastic rather than inflammatory process GBM on top of DD.**

## CONCLUSION

This study concluded that the MR spectroscopy could provide additive valuable information helping in brain lesions characterization that improved diagnosis and thus reducing unnecessary biopsies. Our results reveal that the MRS is an adequate tool for the diagnosis of different brain lesions. Gliomas were the most common brain lesions found in MRS. Moreover, this study showed that the presence of decreased in NAA peak in MRS is correlated with brain tumors. On the other hand, MRS tool has a limitation in the diagnosis of some brain lesions. The technique is very sensitive to inhomogeneity in the magnetic field and requires careful manual adjustment to ensure field uniformity. Artifacts can arise from braces on teeth or proximity to the sinuses. If any bone is included in the voxel, it can cause artifacts due to the lipid signal arising from bone marrow.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

All author contributed in all parts of the paper.

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