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# MAGNETIC RESONANCE SPECTROSCOPY (MRS) FOR VIEWING THE PHYSIOLOGY PROFILE OF THE BRAIN

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## ABSTRACT

**Background**: MRS is The MRI scan uses a powerful magnet, radio waves, and a computer to create detailed images, wehreas spectroscopy is a series of tests that are added to the MRI scan of the brain or spine to measure the chemical metabolism of a suspected tumor. The measurement shows the correlation of metabolic or biochemical anatomical and physiological information contained in the body, both in normal and abnormal conditions MRS is done after a routine brain without contrast or contrast. Proton MRS of brain tissue shows the spectral of several metabolites. Some of the main metabolites in brain tissue detected by MRS are NAA, Cholin, Creatinien, and Lipid, Lactate and Myo Inositol. MRS results are in the form of a graph showing the ratio of NAA levels per cholin to the patient's body metabolites and a graph on normal metabolites forming Hunter's angle.
**Methods:** This method is a qualitative research with a descriptive approach using comprehensive literatures studies.
**Results:** MRI and MRS examinations in cases of brain disorders will strengthen the diagnosis by looking at changes in the pattern of metabolites in the brain. Some characteristic spectrum patterns can be used as markers of certain diseases, so they can replace biopsy. MRS examination showed that online game addicts had lower levels of NAA concentrations than normal people in the right frontal cortex and lower levels of choline (Cho) in the medial temporal cortex.
**Conclusion:** MRS does not play a role in replacing MRI imaging, but as an addition to non-invasive metabolic information that has a high degree of accuracy for diagnosing abnormalities in brain regions by evaluating spectrum patterns or metabolite ratios.

Keyword : MRI; MRS; brain

## Introduction

Internet Addiction (IA) is defined as preoccupation or excessive, uncontrolled compulsion or behavior regarding computer use and Internet access that leads to distraction or anxiety[1]. The main symptoms, namely an unhealthy mental state, palpitations, insomnia, forgetfulness, nausea, and poor appetite that appear in IA subjects are thought to be the result of dysfunction of the heart, liver, spleen and kidneys[2]. Some of the neuroimaging tools that are often used for internet addiction research are Electroencephalogram (EEG), Functional Magnetic Resonance Imaging

(fMRI) and Magnetic Resonance Spectroscopy (MRS).

MRS has actually been used long before the use of Magnetic Resonance Imaging. MRS itself is one of various spectroscopic instrumentation, where its application is used in organic chemistry to assess the composition of the molecular structure of a compound or to detect the presence of certain compounds in the sample being examined[3]. MRS is a radiological examination that uses MRS supporting software in MRI modalities that can show the correlation of anatomical and metabolic or biochemical information on anatomy and physiology in the body, both under normal and abnormal conditions. MRS was performed after routine brain without contrast or with contrast. Proton MRS in brain tissue shows spectrally of several metabolites[4, 5].

Proton MRS in brain tissue shows spectrally of several metabolites where the minimum concentration is between 0.5 and 1.0 mMol. These metabolites resonate at different frequencies, so that the position of each metabolite plotted along the horizontal axis graph is different from one another, and refers to a chemical shift, having a unit scale in parts per millon (ppm). Normal concentrations of metabolites in brain tissue vary according to the age of the patient. The variation is more visible in the first 3 years from birth³. A significant difference is in the increase in the ratio of NAA/Cr and decrease in the ratio of Cho/Cra with increasing age. Some of the main metabolites in brain tissue detected by MRS are NAA, Cholin, Creatinien, and Lipid, Lactate and Myo Inositol.

Two basic pulse sequence methods are used for volume sampling in MRS, namely Stimulated Echo Acquisition Mode (STEAM) and Point Resolved Spectroscopy (PRESS)[6]. STEAM is used to display metabolites with short T2 relaxation times (eg Lipids (lip), Glutamine and glutameate (Gx), Myo-inisitol (mI)), for high voxel precision. PRESS is used to evaluate brain lesions for long-term concentrations of T2 metabolites (eg NAA, Choline, creatine, and lactate). Sampling of the anatomical area of the brain proton MRS can use single voxel (SV) or multivoxel (MV) techniques [8]. The single voxel technique is most commonly used, the scanner is square and usually 2x2x2 $cm^7$ in size. Used for the evaluation of smaller lesions, so the examination time is relatively fast. The multi voxel technique uses the chemical imaging shift (CSI) acquisition method, using several cubical areas (voxels) so that it reaches a wider anatomical area [7]. CSI can be used to compare changes that occur in certain cases. Voxel placement must avoid inhomogeneous magnetization areas to produce high spectral quality. These areas are: blood, blood products, air, spinal fluid (Cerebro Spinal Fluid), calcifications and bone. The MRS results are in the form of a graph showing the ratio of NAA levels per choline in the patient's body metabolites and a graph on normal metabolites forming a Hunter's angle[7].

**Methods**

This research is a type of qualitative research with a descriptive approach using literature studies. The study was carried out in the period from December to February 2021

**Result and Discussion**

MRI and MRS examinations in cases of brain disorders will sharpen the diagnosis by looking at changes in the pattern of metabolites in the brain. Some characteristic spectrum patterns can be used as markers of certain diseases, so they can replace biopsy. MRS does not use an ionizing radiation source (such as a PET scan), so this examination can be repeated serially to monitor a disease progression process or post-therapy evaluation. MRS can be used

both before and after the administration of contrast media. Several literatures and studies state that there is no significant difference between MRS examinations performed before and after administration of MRI contrast media[8]. Radiographers are very influential in this MRS examination. The patient's position should be symmetrical and patient communication is essential in this examination. Axial slices were made parallel to the corpus callosum genu and splenium to facilitate duplication when further examination was to be performed.

MRS can provide qualitative and quantitative information of an area of brain tissue represented by voxels. Quantitatively, each metabolite in the particle spectrum has a peak height that represents the concentration of the metabolite. Multi voxels can compare peak heights across multiple voxels. One or more brain tissue is abnormal, has a metabolite concentration higher or lower than the normal peak and does not form a hunter's angle[7].

STEAM in MRS is used to display metabolites with short T2 relaxation times (eg Lipids (lip), Glutamine and glutameate (Gx), Myo-inisitol (mI)), for high voxel precision. PRESS is used to evaluate brain lesions for long-term concentrations of T2 metabolites (eg NAA, Choline, creatine, and lactate). A good shimming technique must be applied so that the magnetic area is homogeneous by narrowing the distance of the water line witdh (distance of the spectroscopy curve graph for the water spectrum), then with the Chemically Selective Saturation (CHESS) technique, the water signal or brain fluid is completely damped so that we get a signal and spatial resolution of high metabolite frequencies. The poor spectral results can be corrected by increasing the voxel size to increase the signal to noise ratio (SNR), the number of NEX/NSA acquisitions with a consequent increase in examination time or by moving the voxel cube to another location. The molecular signal detected on the MRS is processed (with compensation techniques of Eddy Current, Offset Correction, Zero Filling, and Apodization) then converted through Fourier transform and adjusted for phase correction and base line, resulting in a spectrum graph that is ready to be analyzed[9].

The proton metabolites of the brain each reflect certain cellular processes. NAA has the highest peak in normal brain tissue. NAA is a marker of axonal viability and a decrease indicates suspected nerve loss or damage[3]. Cr is a marker of cellular energy metabolism and has a relatively stable concentration, making it a good internal reference in calculating the ratio of metabolites. Cho is a marker of cellular membrane turnover, so it most likely reflects cellular proliferation. Additional metabolites are usually helpful, if lactate, lipids and myo-inositol are found. Lactate is usually undetectable in normal adults, but its concentration will increase in anaerobic metabolism, such as ischemia, hypoxia, seizures, and metabolic disturbances. Lipids are components of cell membranes whose peaks are absent or minimally detectable in the normal brain. Abnormal lipid peaks occur in cell membrane damage or necrosis. Myo is a simple sugar that is considered a glial marker, as it is mostly synthesized in astrocytes.

MRS examination showed that online game addicts had lower levels of NAA concentrations than normal people in the right frontal cortex and lower levels of choline (Cho) in the medial temporal cortex[2]. Cho decline plays an important role in learning and memory, sleep-wake cycles and emotions. Based on the daily experience of AI, they have great difficulty in resisting any temptation related to online games or other services, they cannot concentrate on learning activities, become restless or irritated and suffer from sleep disturbances and emotional or physiological disturbances

after they stop internet activity or reduce internet usage time[2].

## Conclusion

MRS does not play a role in replacing MRI imaging, but as a non-invasive addition to metabolic information. MRS has a high degree of accuracy for diagnosing abnormalities in brain regions by evaluating the spectrum pattern or ratio of metabolites. Adolescents with AI had lower levels of NAA concentrations in the right frontal cortex and lower levels of choline (Cho) in the medial temporal cortex.

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