Mri spectroscopy essay

MRS (Magnetic Resonance Spectroscopy) is a non-invasive imaging technique that studies the chemical activity in the brain and detects the presence of certain chemical substances. It distinguishes between various nuclei present in the brain and the chemical background in which they exist. Through this imaging technique, images and graphs of the brain can be obtained. The graph patterns are studied to demonstrate evidence of any abnormality in the brain.

MRS does not require the use of radiation (high-energy waves) to obtain images. It utilizes a strong magnetic field along with radio waves (University of Washington, 2007). MRI scans (Magnetic Resonance Imaging) and MRS use very similar techniques, but these also have a lot of differences. In MRI scans, the resonance frequency of water protons is determined, whereas MRS scans are more precise techniques that help to determine the presence of certain molecules belonging to certain substances present in the body (Vythilingam, 2005). Gradients are not utilized when the RF coil is getting the RF pulse from the area studied in MRS. The frequency information used in MRS is required to determine the chemical composition, whereas in MRI scans, the frequency information is utilized to study the position of the structure or area. Around every chemical substance that exists in the brain, an electron cloud is produced.

This electron cloud defends the chemical substance from the spectroscopic rays and reacts to it in a certain pattern. This reaction may vary to different extents varying on the nature of the chemical substance and the exact location the molecules are present. Hence, a resonance frequency of the atoms is produced which can vary depending on the specific chemical

substance, and can be determined with the help of MRS (Ballinger, 1996). MRS was utilized first by Moon et al in 1973 to visualize RBC's (red blood cells) and by Hoult et al in 1974 to visualize the rat leg muscle tissues (both with Phosphorus-31 MRS). MRS can be utilized to detect and study disorders that are inflammatory, ischemic (arising due to lack of blood and oxygen supply to the tissues), neoplastic (uncontrolled growths) or metabolism-associated in nature. It can be used to examine several structures present in the body such as the brain, liver, kidney, prostrate and the limbs. However, in human beings, MRS is frequently utilized to study disorders affecting the brain, as other techniques such as biopsy and microscopic studies cannot be performed (Ballinger, 1996).

Frequently, MRS and MRI scans are performed together so that the results are very specific and accurate. Individuals suffering from Multiple sclerosis (a demyelinating disorder of the brain) and brain tumors, and undergoing clinical trials can be monitored efficiently using MRS (Goldman, 2004). 1-H-MRS (1-Hydrogen), F-19 MRS (Flourine-19) and Li-7 MRS (Lithium-7) and C-13 MRS (Carbon-13) are frequently utilized in the examination of the CNS. The presence of certain breakdown products (metabolites) and neurotransmitters (chemical substances that help to transmit nerve signals) can be determined by using 1-H-MRS.

The activity of certain drugs can be followed up using F-19 MRS and Li-7 MRS. C13 MRS helps to study the processing of several metabolites in the TCA cycle and Glu-Gln cycle (Vythilingam, 2005). The concentration of these chemical substances in the brain is very low, and in order to produce a diagnostic image, it has to exist in 1 mL or more (for 1-H-MRS technique)

(Vythilingam, 2005). Cell study techniques have been performed to demonstrate the presence of certain specific metabolites or breakdown products in certain cells which produces peaks in the MRS images and can be detected. When these cells get diseased, degenerated or damaged, the level or concentration of metabolites (which produce the MRS peaks) are altered which can be studied and recognized through the images obtained by the MRS technique (Grainger, 2001). Relaxation effects are used in MRI scans to produce contrast intensity, whereas in MRS scans, relaxation effects are usually avoided as it would not help to determine the exact level of the metabolites present in the brain.

Gradient pulse is also absent in cases of MRS signals and the magnetic field is usually kept constant (Vythilingam, 2005). Different patterns of pulse sequences can be utilized in MRS. Frequently, a simple RF pulse at 90 degrees is utilized that does not contain any gradient. The RF coil device usually receives the signal instantly following the single RF pulse. Several imaging principles (including spin sequences) may also be required in MRS (Ballinger, 1996).

In MRS, two types of echo time data can be acquired, namely, long echo time data and short echo time data. The level of several substances in the brain such as N-acetylaspartate (NAA), creatine and choline in the normal brain tissue, and lactate present in abnormal brain tissues can be attained using long echo time data. N-acetylaspartate is present exclusively (about 2. 01 parts per million or ppm) in the nerve processes, dendrites and the axons, and acts as a neuronal marker (suggesting neuronal integrity) (Grainger, 2001). It may be reduced in several disorders involving the nerves such as

stroke, AIDS encephalopathy and multiple sclerosis (Goldman, 2004). More advanced MRS techniques help to determine precisely the amount of NAA present in the whole brain. In temporal epilepsy, the NAA is reduced or absent in the region, which could be determined using MRS (Goldman, 2004). Cells containing the substances creatine and phospho-creatine (about 3.

03 ppm) create the creatine peak (which stands for the energy metabolism in the cell). Choline is present mainly in the cell membrane (in about 3. 22 ppm). Conditions in which the metabolism in the cell membrane is abnormal, choline determination with the help of MRS is useful. The choline levels may also be raised in several conditions such as demyelination processes (especially multiple sclerosis), brain tumors and inflamed regions (Goldman, 2004). In short echo time data attainment, the effects produced due to T2 losses are quite less and hence is frequently utilized.

Several substances such as myo-inositol, GABA, methyl group of lipids, glutamate, and glutamine are detected using short echo time data (Grainger, 2001). Lactate presence in the areas of the brain is abnormal and suggests areas of infarction and inflammation (Goldman, 2004). Some of the condition of the CNS in which MRS is required includes brain tumors, AIDS encephalopathy, multiple sclerosis, epilepsy and Alzheimer’s disease. Several disorder such as enzyme deficiency conditions (including phosphofructokinase deficiency and amylo-glucosidase deficiency due to deficiency of enzymes in the muscles), muscular dystrophies (including Duchenne muscular dystrophy and Becker muscular dystrophy), inflammatory disorders of the muscles (including inclusion body myositis,

dermatomyositis and polymyositis), thyroid disorders (including hypothyroidism), breast disorders (including breast cancer), and heart disorders (including heart failure) (Ballinger, 1996), can be studied with the help of MRS. Frequently, proton-H-1MRS is utilized to differentiate neoplasm of the brain from infections or other disorders (such a multiple sclerosis), and sometimes, one type of cancer from another type (UAMS, 2006). Several neuropsychiatric disorders are studied for the biochemical features using MRS.

MRS (proton-H-1 or phosphorus) is specifically useful in studying the biochemical activity in various psychiatric disorders such as dyslexia, chronic fatigue syndrome and schizophrenia. MRS provides a lot of data regarding the phospholipids in the cell membrane, energy metabolism in the cell, activity of the neurotransmitters, functions of the nerves and the environment existing within the nerve cells present in the brain (Cox, 2004). It is increasingly becoming evident that changes in the brain can play a major role in the development and progression of several psychiatric disorders, and MRS seems to be a tool in studying these features (Bertolino, 1999). The entire process of MRS imaging takes between half to one hour, whereas the imaging procedure may be short ranging from 2 to15 minutes. The individual undergoing MRS imaging should report the presence of artificial devices in the body such as prosthetic heart valves, bone implants, artificial teeth, dental fillings, screws, surgical plates, foreign bodies, intrauterine devices, etc. The individual may require undergoing preparatory X-rays to determine the presence of such substances in the body.

Metallic devices implanted into the body since a long-time (more than 6 weeks) may not cause any serious effect. During the examination procedure, all external metallic devices, such as jewelry, dentures, hearing aides, spectacles, etc, should be removed, as they could adversely affect with the imaging. The individual is made to lie on the sliding table that contains the surface coil, which moves in and out of the MR machine. The table can be titled to obtain images at better angles. The MR technician leaves the room, and goes into another room from which he would be observing the process of imaging-taking, and communicates with the individual with the help of headphones. The individual should avoid moving to ensure that the images produced are of high-quality.

The individual usually will not have any problems during the examination, although some may express fear in entering closed spaces. In such cases, a sedative (calming agent) medication may be required before the procedure. The individual hears a variety of noises during the imaging procedure which is absolutely normal, and can be reduced using the headphones. The results of the MRS are interpreted by a specialist known as a ‘ radiologist’ after some time (University of Washington, 2007). Alzheimer’s disease is frequently studied using MRS. Proton H-1 MRS suggests loss of NAA in dementia. Individuals with Alzheimer’s disease also demonstrate higher levels of myo-inositol in the gray mater.

Higher levels of NAA may be present in several neuro-degenerative disorders such as Parkinsonism, and Huntington’s disease (Vythilingam, 2005). In Schizophrenia, the phosphomonoester level is reduced and the phosphodiester level is increased, suggesting that phospholipids present in

the nerve membrane may be broken down at a greater rate in the dorsolateral prefrontal cortex. The NAA levels are also reduced in the frontal and temporal regions. However, these findings in schizophrenia are not consistent (Vythilingam, 2005). Limitations MRS may have low sensitivity and is rather unable to localize the lesion compared to MRI. Besides, the spatial resolution of MRS is poor (Vythilingam, 2005). References: Ballinger, R.

(1996). MR Spectroscopy. Retrieved March 21, 2007, from MRI Tutor Web site: http://www. mritutor.

org/mritutor/mrs. htmBertolino, A., and Weinberger, D. R.

(1999). Proton magnetic resonance spectroscopy in schizophrenia. Eur J Radiol, 30(2), 132-141. http://www. ncbi. nlm. nih.

gov/entrez/query. fcgi? itool= abstractplus&db= pubmed&cmd= Retrieve&dopt= abstractplus&list_uids= 10401594Cox, I. J.

, and Puri, B. K. (2004). In vivo MR spectroscopy in diagnosis and research of neuropsychiatric disorders. Prostaglandins Leukot Essent Fatty Acids, 70(4), 357-360.

http://www. ncbi. nlm. nih. gov/entrez/query.

fcgi? cmd= Retrieve&db= PubMed&list_uids= 15041027&dopt= AbstractGoldman, L., and Ausiello, D. (2004). Goldman: Cecil Textbook of Medicine (22nd ed), Philadelphia: W.

B. Saunders Company (Online – MD Consult). Grainger, R.

G., and Allison, D. (2001). Grainger & Allison’s Diagnostic Radiology: A Textbook of Medical Imaging (4th ed), Philadelphia: Churchill Livingstone (Online – MD Consult). University of Washington (2005).

MR Spectroscopy. Retrieved March 21, 2007, from University of Washington Web site: http://www. uwmedicine. org/PatientCare/MedicalSpecialties/SpecialtyCare/UWMEDICALCENTER/Radiology/mrspectroscopy. htmUniversity of Arkansas for Medical Sciences (2006). MRS Research at UAMS. Retrieved March 21, 2007, from University of Arkansas for Medical Sciences Web site: http://www. uams.

edu/radiology/info/research/mrs/research. aspVythilingam, M., Shen, J., Drwets, W. C., and Inns, R.

B. S. (2005). NMR – Interpretation and Basic Principles and Recent Findings in Neuropsychiatric Disorders. In: Sadock, B.

J., ; Sadock, V. A.

(Eds), Kaplan and Sadock’s: Comprehensive Textbook of Psychiatry (Vol. 1, 8th Ed), Philadelphia: Lippincott Williams and Wilkins (pp. 216-221).