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THE EFFECT OF TE (TIME ECHO) VARIATIONS ON DIAGNOSTIC ACCURACY OF MAGNETIC RESONANCE SPECTROSCOPY FOR SPACE OCCUPYING LESION

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ABSTRACT

Magnetic Resonance Spectroscopy (MRS) is an advanced radiology technique used to analyze brain metabolites, particularly in the diagnosis of abnormalities such as Space Occupying Lesion (SOL). Variations in parameters, such as Time Echo (TE), can affect the resulting spectrum, making it important to understand their impact. This study aims to analyze the effect of TE variations on MRS spectrum results in patients with SOL through a literature review. The methodology used is a literature review, collecting and analyzing various previous studies that discuss the impact of TE variations in MRS examinations. Data sources are taken from scientific journals, articles, and books relevant to the research topic. The literature review shows that TE variations, both short TE and long TE, have a significant impact on signal intensity and the types of metabolites detected in the MRS spectrum. These results indicate that the appropriate selection of TE can enhance diagnostic accuracy in detecting SOL. Data analysis shows significant differences in the Area Under Curve (AUC) values of the metabolites NAA, Creatine, Choline, Lactate, and myo-Inositol between different TE usages. These findings indicate that TE variations affect signal intensity and the types of metabolites detected in the MRS spectrum. Time Echo variations have a significant effect on MRS spectrum results in patients with SOL, which can improve diagnostic accuracy and understanding of MRS techniques in clinical practice. These findings are expected to serve as a reference for the development of knowledge in the field of radiology.

Keywords: MRS; Spectroscopy; Time Echo; Space Occupying Lesion; Metabolites.

Introduction

Magnetic Resonance Spectroscopy (MRS) is a non-invasive imaging technique used to analyze the composition of metabolites in brain tissue. MRS provides important information in the diagnosis of various disorders, especially in

identifying Space Occupying Lesions (SOLs) such as tumors, hemorrhages, and granulomas. SOL is a lesion that can cause a mass effect on brain tissue, so early diagnosis is essential to determine the right intervention.

Although MRS has been shown to be effective in the diagnosis of SOL, there are still challenges in optimizing these techniques to improve diagnostic accuracy. One of the factors that affects MRS results is the variation in Time Echo (TE). TE is the time between the transmission of a radiofrequency pulse and the reception of the signal. Variations in TE settings can affect the intensity of the signal obtained from the metabolites, as well as the types of metabolites that can be detected. Previous research has shown that different uses of TE can result in varying spectrums, but there are still few studies that specifically explore the impact of TE variations on the accuracy of SOL diagnosis.

The lack of a deep understanding of the influence of TE variations on MRS results is one of the reasons for the importance of this study. Many clinical practitioners still use standard TE settings without considering the potential impact of these variations on diagnostic outcomes. This can result in errors in the interpretation of MRS results, which in turn can affect clinical decisions and patient management. Therefore, by understanding the influence of TE variations, it is hoped that this study can provide new insights into clinical practice and improve diagnostic outcomes for patients with SOL.

Methods

This study uses a literature review approach by collecting and analyzing various relevant studies regarding the influence of TE variations on MRS results. Data sources are taken from scientific journals, articles, and related publications that discuss MRS and SOL. Inclusion criteria include studies that address the use of MRS in the diagnosis of SOL with a focus on TE variations. The data obtained were analyzed to identify patterns, findings, and conclusions that could be drawn regarding the influence of TE variations on MRS diagnostic accuracy.

MRS Metabolites

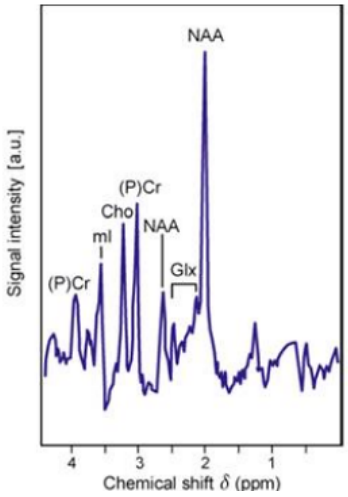

Figure 1. Spectrum results of Magnetic Resonance Spectroscopy

The results of metabolites that can be detected through MRS in the human brain consist of several substances that have different functions and clinical significance. Here are some of the key metabolites that are often measured in MRS:

1. N-acetylaspartate (NAA)

   NAA is the most commonly measured metabolite in MRS and is considered an indicator of neuronal health. NAA is produced in neurons and serves as an energy source as well as a precursor for neurotransmitter synthesis. Decreased NAA levels are often associated with neuronal damage, which can occur in conditions such as stroke, trauma, and brain tumors. Normal NAA values range from 8-10 ppm, and a decrease in NAA levels may indicate the presence of lesions or neurological disorders.
2. Choline (Dog)

   Choline is a metabolite that plays a role in the synthesis of cell membranes and the neurotransmitter acetylcholine. Increased choline levels often indicate high cellular activity, which can occur in brain tumors or inflammatory processes. In the context of MRS, the ratio of choline to NAA (Cho/NAA) is often used as an indicator to assess the presence of tumors. Normal choline values range from 1.5-2.5 ppm.

3. Creatine (Cr)

   Creatine functions as an energy store in cells and is involved in the brain's energy metabolism. Creatine levels are usually stable and are used as a reference for comparing other metabolites. Normal values of creatine range from 3.0-3.5 ppm. In the context of MRS, the ratio of creatine to other metabolites, such as NAA and choline, can provide additional information about the metabolic status of the brain.
4. Lactate (Lac)

   Lactate is a byproduct of anaerobic metabolism and can accumulate in hypoxia or ischemic conditions. The presence of lactate in the MRS spectrum often indicates the presence of a pathological process, such as a stroke or tumor. Lactate is usually detected at a value of 1.3 ppm. Increased lactate levels can be an indicator of brain tissue damage.
5. Myo-Inositol (mI)

   Myo-Inositol is a metabolite involved in osmoregulation and lipid synthesis. Increased myo-inositol levels are often associated with glial disorders, such as glioma or multiple sclerosis. Normal values of myo-inositol range from 3.5-4.0 ppm. In the context of MRS, elevated myo-inositol levels can be an important marker in the evaluation of brain tumors.
6. Lipid

   Lipids are metabolites that can be detected in MRS and often appear in the context of tumors or tissue necrosis. The presence of lipids in the MRS spectrum can indicate the presence of cellular damage or inflammatory processes. Lipids are usually detected at values of 0.9-1.5 ppm. Increased lipid levels can be an indicator of tumor lesions or tissue damage.

Space Occupaying Lesion

Space Occupaying Lesion or commonly abbreviated as SOL is a substantial physical lesion, such as a neoplasm, hemorrhage, or granuloma, that occupies space. Intracranial SOL is defined as a neoplasm, benign or malignant, primary or secondary as well as a hematoma or vascular malformation located within the skull cavity. Some sources divide SOL into benign lesions in the form of abscesses (acute or chronic), cysts (arachnoids, parasites, dermoids) and tumors (meningioma, acoustic neuroma) and malignant lesions in the form of primary and secondary brain tumors. SOL provides signs and symptoms due to intracranial pressure, intracranial shift, or brain herniation, which can result in 'brain death'.

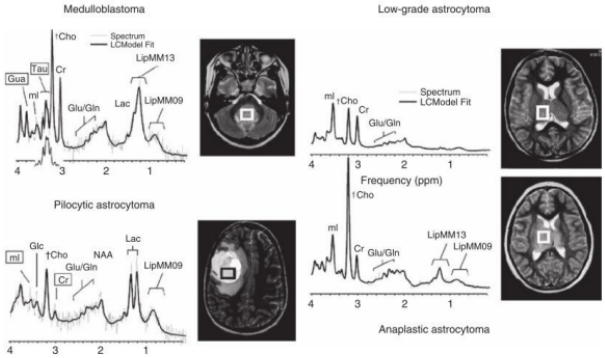

Figure 2. MRS results in several types of Space Occupaying Lesion Brain, including Medulloblastoma, Low grade astrocytoma, Pilocytic astrocytoma and Anaplastic astrocytoma.

With conventional MRI, it is also still difficult to distinguish between necrotic tumors and abscesses. After the discovery of Magnetic Resonance Spectroscopy (MRS), distinguishing the type of lesion with the MRI modality became more and more accurate. MRS is very sensitive in differentiating gliomas, perileal tumor infiltration and more specifically in describing abscesses. Thus, MRS can provide additional information to distinguish the type of lesion by the spectrum of metabolite results that emerge.

Results and Discussion

This study was conducted to analyze the effect of Time Echo (TE) variation on the results of the Magnetic Resonance Spectroscopy (MRS) spectrum in patients with Space Occupying Lesion (SOL) at Fatmawati Hospital. A total of 30 patients diagnosed with SOL have been included in the study. Each patient underwent MRS examination with two different TE settings: short TE (30 ms) and long TE (135 ms). Spectral results obtained from both TE settings were analyzed to identify the detected metabolites and the intensity of the generated signals.

MRS Spectrum with Short TE

The results of the analysis showed that the use of short TE (30 ms) resulted in a richer spectrum of metabolites. Metabolites detected include N-acetylaspartate (NAA), choline (Cho), creatine (Cr), and lactate (Lac). The intensity of the NAA signal, which is an indicator of neuronal health, showed an average value of 2.5 ± 0.3, while for choline, which is related to cell proliferation, showed an average value of 1.8 ± 0.2. These results suggest that short TE allows for the detection of more metabolites and provides more comprehensive information regarding the condition of brain tissue.

MRS Spectrum with Long TE

In contrast, the use of long TE (135 ms) results in a more limited spectrum. Although NAA and Cr are still detected, the signal intensity is lower compared to the short TE, with an average value of NAA 1.8 ± 0.2 and Cr 1.5 ± 0.2. Choline and lactate are not detected well in this setting. This suggests that long TE tends to reduce sensitivity in detecting certain metabolites, which can result in the loss of important information in the diagnosis.

Comparison of Results between Short TE and Long TE

From the statistical analysis carried out, there is a significant difference between the spectral results obtained with short TE and long TE. The t-test showed a p-< value of 0.05, indicating that the variation in TE had a significant effect on MRS spectral results. Short TE not only increased the number of metabolites detected, but also improved accuracy in assessing brain tissue conditions in patients with SOL.

Discussion

The results of this study show that TE variations have a significant impact on MRS spectral results, which is in line with previous findings that the selection of parameters in MRS can affect the information obtained. Short TE allows for the detection of more metabolites, which is critical in the context of SOL diagnosis. This is in line with research by 15, which states that the use of short TE can improve sensitivity in detecting metabolites.

The importance of NAA as an indicator of neuronal health and choline as an indicator of cell proliferation in the context of brain tumors is the main highlight. A decrease in NAA intensity in long TE may indicate neuronal damage, while an increase in choline may indicate high cellular activity, which is often associated with neoplasms. Thus, the use of short TE can provide more accurate and relevant information in assessing the condition of patients with SOL.

In addition, the results of this study also show that MRS can be a very useful tool in the early diagnosis and evaluation of brain disorders. With the accuracy of MRI in intracranial SOL evaluation reaching 98.58% 15, the addition of MRS as a metabolite analysis technique provides significant added value in patient management. MRS not only aids in diagnosis, but also in monitoring the response to therapy, which is crucial in brain tumor management.

However, this study also has some limitations. First, a relatively small sample size can affect the generalization of results. Second, this study did not consider other variables that might affect MRS outcomes, such as patient age, tumor type, and other clinical factors. Therefore, further research with larger samples and a more comprehensive design is needed to confirm these findings.

Conclusion

This study shows that TE variation has a significant influence on MRS spectral outcomes in patients with SOL. Short TE has been shown to be more effective in detecting metabolites and providing more comprehensive information for diagnosis. Therefore, it is recommended that clinical practitioners consider the use of short TE in MRS examination to improve the accuracy of diagnosis and management of patients with SOL. Further research is needed to explore more deeply regarding the influence of other MRS parameters and to develop better guidelines in clinical practice.

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