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ANALYSIS OF IMAGE INFORMATION WHEN EMPLOYING THE DIFFUSION WEIGHTED IMAGING (DWI) SEQUENCES WITH 'B' VALUE VARIATION FOR INTRACRANIAL TUMOR CASE

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ABSTRACT

The DWI has saveral sequences where the value of 'b' must be choosen by the opeator when setting the parameters, as it affects the MR signal intensity. In radiology installations, radiographers often use a 'b' value of 1000 s/mm2 with various pathologies. The purpose of this study was to determine the effect of setting the value of 'b' (1000.1500.2000 s/mm2) on image information and to determine the best setting of the three selected 'b' values in generating DWI signals for cases of intracranial tumors. This research is experimental study. MR GE 1.5 Tesla. 6 images were created with three 'b' value settings. Three radiologists then assessed areas of white matter, gray matter, proc. coronoid, basal ganglia and tumor lesions. The results were then analyzed using the Friedman statistical test. The results showed that there were differences in signal intensity and image quality between the three setting values of 'b' with p value < 0.005. The mean rank indicates that the best setting 'b' value in producing high signal intensity in Basal ganglia, Proc. coronoid and tumor lesions is 1500 s/mm2 (Mean rank: 2.75 and 2.42). then for white matter and gray matter the best 'b' value setting is 1000 s/mm2 (average rating: 2.50). There is a significant difference in MRI Brain image information with variations in the "b" values of 1000 s/mm2, 1500 s/mm2 and 2000 s/mm2 with pulse sequence Diffusion Weighted Imaging (DWI) using GE 1.5 Tesla MRI modality in patients with intracranial tumors ($p < 0.05$).

Keyword : DWI , 'b' value, Brain, Tumor, image information

Introduction

According to Westbrook (2014) indications for MRI Brain examination include Multiple Sclerosis, Infarction, Hemorrhage, infection, trauma and tumor/metastatic disease[1]. The International Agency for Research on Cancer states that more than 126,000 people in the world are diagnosed with a brain tumor each year, with more than 97,000 of them dying. Based on these data, information can be obtained that patients with brain tumors are very high and can increase from year to year. The presence of a brain tumor at an early stage is quite difficult to know because generally the boundaries of the tumor are still unclear, have low contrast, and sometimes are almost the same or similar to the surrounding normal tissue[2]. In the world of radiology, the best diagnosis of intracranial tumors is to perform an MRI brain examination. MRI should be the first examination in patients with signs and symptoms of intracranial abnormalities[3,4].

Routine sequences for MRI Brain examination are SE/FSE/incoherent (spoiled) GRE T1, SE/FSE PD/T2, FLAIR and Diffusion Weighted Imaging (DWI). DWI and DTI (Diffusion Tensor Imaging) are advanced functional magnetic resonance imaging sequences, which have been widely used to evaluate intracranial tumors[5].

The DWI principle includes the assessment of diffusion which is the movement or movement of molecules due to random thermal

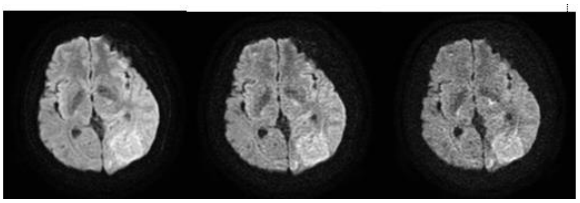
motion. The movement of these molecules is limited by natural characteristics such as ligaments, membranes and macromolecules. Diffusion sensitivity is controlled by parameter 'b'. The value of b' determines the diffusion attenuation by modifying the duration and amplitude of the diffusion gradient. The value of 'b' can be expressed in units of s/mm2. The range of 'b' values is 500 s/mm2 to 1500 s/mm2[1]. DWI is one of the advanced or advanced techniques in the MRI Brain examination that researchers met at the hospital. However, there has never been any variation regarding the 'b' value used, the 'b' value used is always 1000 s/mm2 with various existing pathologies, even though based on theory, the DWI technique can be adjusted regarding the 'b' value used, the 'b' value is a signal intensity factor that influences the image formation.

Methods

This research is a type of experimental study. The experiment was conducted to examine and determine the differences in image information of MRI Brain with variations of "b" value sequence diffusion weighted imaging (DWI) with a 1.5 Tesla GE MRI machine with Intracranial Tumor patients. The subjects in this study were radiologists who had the capacity of MRI and had more than 5 years of experience in interpreting MRI Brain sequence Diffusion Weighted Imaging (DWI) images as many as 3 people. Radiologists act as respondents in the assessment of differences in information on MRI Brain images, with variations in "b" value sequence Diffusion Weighted Imaging (DWI) with Intracranial Tumor patients.

Result and Discussion

Used 6 research samples with variations in age 43-53 years, male sex as many as 3 patients and 3 patients female, body weight 50-60 kg.



(a) (b) (c)

Figure 1. Results of MRI Brain sequence DWI image of patient F with variations of "b" value (a) 1000s/mm2, (b) 1500s/mm2, (c) 2000s/mm2

Table. 1 result of Friedman's Test of Anatomical Image Information

Area Anatomi	'b' value	P Value
White Matter	1000, 1500, 2000	0.020
Gray Matter	1000, 1500, 2000	0.016
Basal Ganglia	1000, 1500, 2000	0.015
Proc. Coroideus	1000, 1500, 2000	0.030
Lesi	1000, 1500, 2000	0.031

Friedman's non-parametric statistical test results in table 2 state that there is a significant difference between the use of the 'b' value variation on the Anatomical Information produced, with a significance value ($p < 0.05$) in the Basal Ganglia area, Proc. Coroideus, Lesions, White Matter and Gray Matter. To find out which 'b' value is better in anatomical information on the MRI Brain examination with the DWI technique on the use of the 'b' value variation, it can be seen that the mean rank result of the Friedman test in table 2.

Table 2. Mean rank results of Friedman's test

B value	Rank Area Anatomi				
	White Matter	Gray Matter	Basal Ganglia	Proc. Cor	Lessi
1000	2.50	2.50	1.75	1.75	1.67
1500	1.75	1.92	2.75	2.75	2.42
2000	1.75	1.58	1.50	1.50	1.92

Based on table 2, the results of the freidman test obtained the mean rank value for each organ to the variation of the "b" value to assess which variation of the "b" value is the best, and the results obtained: white matter has the highest mean rank value in the 1000s/mm2 variation, which is 2.50 , Basal Ganglia has the highest mean rank in the 1500s/mm2 variation, which is 2.75, Gray matter has the highest mean rank at the 1000s/mm2 variation, which is 2.50, proc. Coronoid has the highest mean rank in the 1500s/mm2 variation, which is 2.75, and abnormalities (lesions) have the highest mean rank in the 1500s/mm2 variation, which is 2.42.

The significance of the variation in the "b" value in the white matter organ is 0.020, which

means that there is a difference between each variation of the 'b' value performed, white matter has the highest mean rank value in the 1500s/mm2 variation, which is 2.50, and 1.75. on the variation of 'b' value 1000 and 2000 s/mm2. The white matter of the central nervous system contains axons, myelin sheaths, and glial cells. In the glial population, oligodendrocytes are the components that produce the most abundant myelin sheath. The other major types of glial cells are astrocytes and microglia. Most of the CNS axons are surrounded by a myelin sheath that is rich in lipids which gives them a white color, so that on the MRI image Brain white matter has very good sensitivity, therefore with a "b" value of 1000 s/mm2, it is able to show the white matter organs optimally[6].

Gray matter has the highest mean rank in the 1000s/mm2 variation, which is 2.50, then the second rank in the 'b' value 1500 s/mm2 variation, which is 1.92 and then in the 'b' value 2000 variation, which is 1.58 s/mm2. The significance is 0.016, which means that there is a difference in the Gray matter organ to the variation of the "b" value carried out. The anterior gray matter contains motor neurons. These synapse with interneurons and cell axons that have traveled down pyramidal tracts. These cells are responsible for muscle movement. The posterior gray matter contains the points where sensory neurons synapse. so that on the MRI image Brain Gray matter has very good sensitivity, therefore with a "b" value of 1000 s/mm2 it is also able to show the Gray matter organ to the maximum[6].

Basal Organs Ganglia, Proc. Coronoid and intracranial tumor abnormalities (lesions) have the highest mean rank in the 1500s/mm2 variation, namely 2.75, 2.75 and 2.42. Then the second rank is in the 'b' value variation of 1000 s/mm2 which is 1.75, 1.75 and 1.92, then on the 'b' variation. b' value 2000 is 1.58, 1.50 and 1.67 s/mm2. For the significance of each organ Basal ganglia, proc. coronoid, and intracranial tumor abnormalities (lesions) which are 0.015, 0.030 and 0.031 which means that there are differences in each organ to the variation of the "b" value performed. According to Westbrook (2011) the parameter 'b' value in the DWI sequence affects the gradient performance in the MRI machine used. The higher the selected 'b' value, the faster the gradient performance will be so that the diffusion sensitivity in assessing the blocked water molecules will also increase. However, the choice of the 'b' value range in an aircraft is also influenced by the strength of the existing magnetic field. For an MRI 1.5 T 'b' the maximum value is 1500 s/mm2 because the 'b' value is more than 1500 s/mm2 the magnetic field strength is no longer able to compensate for the faster gradient performance so that more noise is obtained[2].

The difference in the intensity of the diffusion signal in the MRI Brain axial sequence DWI image is due to the influence of the selection of the parameter 'b' value on the intensity of the diffusion signal. This is in accordance with the theory which says that the selection of the 'b' value parameter will affect the intensity of the diffusion signal and the sensitivity of the diffusion (Westbrook, 2011). Diffusion sensitivity is the ability to distinguish the presence of diffusion disorders in brain tissue or detect the presence of limited diffusion in brain tissue (eg in infarcted brain tissue). If the intensity of the diffusion signal is getting stronger, then the diffusion image of normal brain tissue will appear darker and brain tissue with limited diffusion will appear lighter in the image. If the intensity of the diffusion signal is weak, normal brain tissue will appear grayish and brain tissue with limited diffusion will appear bright so that the difference between the two is difficult to see clearly because there is no clear boundary[5].

Increasing the 'b' value will increase the amplitude of the diffusion gradient so that the intensity of the diffusion signal will increase and will be more sensitive to fluid diffusion in the normal brain. When the intensity of the diffusion signal increases, the area with normal diffusion will produce a darker image, thereby increasing the contrast between the area with normal diffusion and the area with limited diffusion[5]. According to the theory, it is stated that the 'b' value range is 500 s/mm2 to 1500 s/mm2, but in line with the improvement in technology and capabilities of the MRI machine, the 'b' value

selection range can be selected up to 2000 s/mm2. On other MRI machines there may be a more diverse selection of 'b' values. The research above shows that the 'b' value of 1500 s/mm2 produces an image with the best diffusion signal intensity for Basal Ganglia, Proc. Coronoid, and Intracranial tumor abnormalities/lesions so that it can clearly show the contrast between normal brain tissue and normal brain tissue. brain tissue with limited diffusion (eg in areas with intracranial tumors). In selecting the 'b' value of 1000 s/mm2, the intensity of the resulting diffusion signal is very good in the white matter gray matter organ because the organ components are already rich in axons and also the myelin sheath which causes a hyperintense image on MRI Brain, while in the selection of 'b' value 2000 s/mm2 the intensity of the resulting diffusion signal is not good, there is a lot of noise that fills the anatomical image of the brain so it is still difficult to distinguish between brain tissue with normal diffusion and brain tissue with limited diffusion because there is no clear contrast between normal brain tissue and brain tissue which has limited diffusion.

According to Javier (2012) noise in the DWI sequence occurs due to Eddy Currents Artifacts generated by gradients that process changes in the static magnetic field. Eddy Currents is a form of compensation to change the gradient waveform in such a way that the gradient with a high 'b' value can be stable. These Eddy Currents artifacts can be in the form of Gaussian noise images that fill a lot of MRI diffusion images. In patient 2 and patient 3, the image results were in the form of a hypointense image of the intracranial tumor lesion (abnormality)[8,9]

This hypointense picture indicates the type of pathology or grade of the tumor experienced by the patient, where a low grade tumor will cause the image on MRI DWI to be hypointense[7]. Hypointense images are also experienced in patients with a diagnosis of Follow thorough after surgery where the intracranial tumor has been succesfully removed so that no blood is supplied to the organs anymore causing a decrease in SNR and CNR values. Young age is associated with a small but statistically significant increase in water diffusibility in human white matter. It is also present in the ventricles, thalamus, basal ganglia and also the cerebrum. This increase may reflect mild structural changes that occur with increasing age, resulting in a significant increase in SNR with variations in the age of younger patients[10,11].

Conclusion

There is a significant difference in the information and image quality of MRI Brain with variations of "b" value 1000 s/mm2, 1500 s/mm2 and 2000 s/mm2 sequence Diffusion Weighted Imaging (DWI) using a 1.5 Tesla GE MRI machine in patients with intracranial tumors ($p < 0.05$). further research is needed regarding image quality in the selection of 'b' value sequence DWI.

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