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Difference in Image Information Between DWI Sequence and DWI Blade for Optimization of Axial Brain

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ABSTRACT

Background: Diffusion Weighted Image (DWI) sequence that utilizes the movement of molecules due to random thermal motion. The aim of this research is to determine the difference in image information between DWI sequence and DWI BLADE on axial brain MRI images for optimization and to find the most optimal sequence between DWI and DWI BLADE on axial brain MRI images. Method: This study used a quantitative experimental research that aims to determine image information and optimize brain MRI examinations between DWI sequence and DWI BLADE using the MRI Siemens Magnetom Amira 1.5 T at Dr. Oen Kandang Sapi Hospital Solo in May-June 2023. The sample consisted of 11 MRI assessments through visual grading analysis to provide interpretations related to image clarity information, thus obtaining the optimal use of DWI and DWI Blade sequences. Results: Based on the research and discussion results, it can be concluded that there is a difference in anatomical image information between DWI sequence with BLADE and without BLADE on axial brain MRI examinations, with a significance value of 0.00 ($p<0.05$), indicating a difference in anatomical image information in the cortex cerebri, thalamus, cerebellum, basal ganglia, and a significance value of 1.000 ($p<0.05$) for artifact information, indicating no difference in artifact image information between DWI sequences with BLADE and without BLADE. Conclusion: DWI BLADE sequence provides better anatomical image information compared to DWI sequence without BLADE in axial brain MRI examinations.

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1. INTRODUCTION

The brain has an important role in the body because it is the control center for all body movements. This organ is located inside the cranial cavity and is protected by a strong layer. It consists of several parts, namely the cerebrum, brainstem (truncus encephali), and cerebellum[1]. The most pathologies that often attack the brain include stroke and brain cancer, where the two pathologies are two different things. The risk for stroke especially ischemic stroke is higher in patients with gliomas, reaching up to 9%, compared to the general population (2.7%). Primary brain tumors are the leading cause of cancer-related death worldwide. The annual global and age-standard

incidence of primary malignant brain tumors is 3.7% for men and 2.6% for women[2]. Magnetic resonance imaging (MRI) is a medical device in the field of diagnostic radiology used to produce images of pieces of human organs. The goal is to support the examination of patients by using magnetic fields and vibrational resonances in the nuclei of hydrogen atoms [3]. MRI examination is an examination to help the results of the diagnosis. Patients with signs and symptoms on the intracranial are performed MRI Brain examination. Routine Sequence on MRI Brain examination is SE / FSE / incoherent (spoiled), GRE T1, SE / FSE PD / T2, and Diffusion Weighted Image (DWI). DWI and DTI (Diffusion Tensor Imaging) are advanced functional magnetic resonance imaging sequences [4]. DWI sequence is a method that uses molecular motion due to random thermal motion. This movement is limited by boundaries such as ligaments, membranes, and macromolecules. DWI sequences are used to identify areas with limited diffusion in extracellular water, such as infarction tissue. In normal tissue, extracellular water diffuses randomly, but in ischemic tissue, cells s well and absorb water from the extracellular space[4], The purpose of this study is to determine the difference in image information in DWI sequences with DWI BLADE axial cut for optimization of MRI Brain images, and to find out the most optimal sequence between DWI sequence and DWI BLADE axial cut on MRI Brain image.

2. RESEARCH METHOD

This type of research is quantitative research with an experimental approach that aims to determine image information and optimize MRI Brain examination between DWI and DWI BLADE sequences. This research will be carried out from May 2023 to June 2023 at the Radiology Installation of Dr. Oen Kandang Sapi Solo Hospital MRI section using a Siemens Magnetom Amira 1.5 Tesla MRI aircraft. The population in this study was taken from MRI Brain volunteers who were examined using MRI imaging modalities at Dr. Oen Kandang Sapi Hospital Solo. For simple experimental research, the number of sample members is between 10 to 20 each [5]. In this study, the authors determined a sample of 11 samples. The technique used in this study uses purposive sampling, which is a sampling technique by selecting up to among the population as desired by the researcher, so that the sample can represent the characteristics of the population that has been subjected previously. The author made a questionnaire as a medium for assessing MRI Brain images which will later be given to 3 radiology specialists to provide interpretation related to the clarity of image information so that the most optimal picture is obtained by giving values to the table provided.

3. RESULT AND DISCUSSIONS

Pre-experimental research has been conducted with sequence differences in the MRI Brain sequence examination of DWI with DWI BLADE Axial Pieces. The study was conducted from May to June 2023 at the Radiology Unit of Dr. Oen Kandang Sapi Hospital Solo with a sample of 11 volunteers.

Table 1. Sample Description Based on Gender and Sample Description Based on Age (n=11)

Characteristics of Respondents	n	%
Gender		
Male	6	55%
Female	5	45%
Age		
20-30 years	9	82%
30-40 years	2	18%

Based on Table 1. It is known that this study used 11 volunteers with volunteers with a percentage of men of 55% and women of 45%, a percentage of the age range of 20-30 years as much as 82% and 30-40 years as much as 18%, Respondents were mostly men with an age range of 20-30 years.

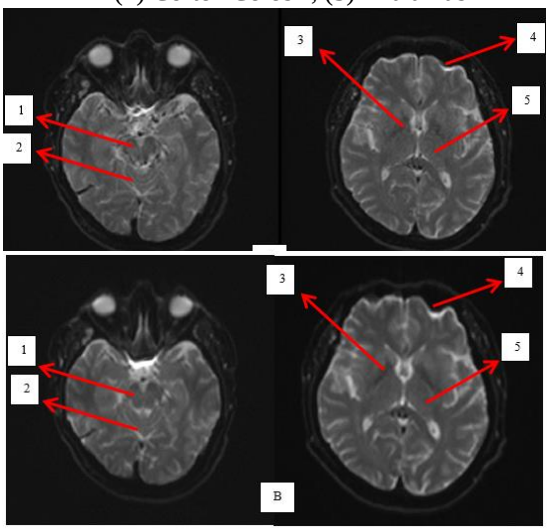
Table 2. Results of Cohen's Kappa observer Testing Values on DWI image information assessment with DWI BLADE on axial cut MRI Brain

NO	*Sequence*	Agreement Level			Average
		O1*O2	O1*O3	O2*O3	
1	DWI	0,614	0,642	0,583	0,613
2	DWI BLADE	0,773	0,814	0,958	0,848

Information : O1 : Observer 1, O2 : Observer 2 and O3 : Observer 3

Based on table 2. above, it can be seen that the value of agreement between the three respondents is in the level of substantial agreement Researchers used questionnaire assessment from Observer 3 because their working time in reading MRI was the longest compared to other observers [6].

Here is a sample of MRI Brain DWI image with DWI BLADE:
Figure 1. Anatomical images assessed by observers in sequences (A) DWI and (B) BLADE: (1) Pons, (2) Cerebellum, (3) Basal Ganglia, (4) Cortex Cerebri, (5) Thalamus



The next analysis was carried out bivariate analysis using different analysis of image information both overall anatomy and per anatomical criteria on the MRI Brain image DWI sequence with DWI BLADE axial cut then statistical analysis was carried out on 11 samples using the Wilcoxon test. Here are the results of the Wilcoxon test for the entire anatomy:

Table 3. Wilcoxon Test Results for Entire Anatomy on DWI Image with Axial Cut DWI BLADE on MRI Brain

No	*Sequence*	Significance (*p-value*)	Information
1 2	DWI DWI BLADE	p< 0,001	Difference

From the results of the Wilcoxon test in table 3. above for the entire anatomy of the DWI sequence with DWI BLADE has a p-value of <0.05. This means that there is a difference in image information between DWI and DWI BLADE. Then after that continued Wilcoxon's statistical tests for per Brain anatomy criteria.

Here's the Wilcoxon test per anatomical criteria and artifacts:
Table 4. Wilcoxon test results per anatomical criteria for DWI image information with DWI BLADE Axial pieces on MRI Brain and Artifacts

No	Organ Name	*Sequence*	Significance *(p-value)*	Information	Mean Rank
1	*Cortex Cerebri*	DWI – DWI BLADE	p<0,001	Difference	14,00 15,21
2	*Thalamus*	DWI – DWI BLADE	0,001	Difference	15,50 16,78
3	*Pons*	DWI – DWI BLADE	p<0,001	Difference	16,50 17,02
4	*Cerebellum*	DWI – DWI BLADE	0,002	Difference	15,50 16,15
5	*Basal Ganglia*	DWI – DWI BLADE	p<0,001	Difference	15,00 17,44

6	Artefak	DWI – DWI BLADE	1,000	No Difference	0,00 0,00

From the results of the Wilcoxon test in Table 4. above, it can be seen that the p-value for the anatomy of Cortex cerebri (p<0.001), Thalamus (0.001), Pons (p<0.001), Cerebellum (0.002), Basal Ganglia (p<0.001) is below 0.05 or in other words there is a difference in anatomical information of DWI images with DWI BLADE. However, in Artifacts the p-value value is above 0.05 or in other words there is no difference in artifact information on the DWI image with the DWI BLADE MRI Brain, Therefore, this means that there are 5 anatomies that have differences and 1 anatomy that has no differences. It can be seen that the mean rank value of the Wilcoxon test per anatomical criterion on DWI images with DWI BLADE on axial cut Brain MRI, where DWI BLADE generally has a high mean rank value compared to the overall anatomy DWI.

Differences in DWI image information with DWI BLADE on axial cut MRI Brain

The overall difference in DWI imagery can occur because the DWI method is used to estimate tissue that can still be saved before therapeutic intervention. However, the use of DWI sequences often causes white shadows (artifacts) that interfere with image quality on Brain MRI examination. Images on DWI images usually appear as hyperintense (bright), while artifacts can also cause hyperintensity in DWI images, so this can interfere with radiologists in assessing and diagnosing MRI brain images [7]

The use of the BLADE method will be very beneficial if used on DWI sequences, because it can reduce disturbing artifacts and improve image quality. DWI sequences can also show areas with limited diffusion in extracellular water, such as in infarct tissue. In normal tissue, extracellular water diffuses randomly, but in ischemic tissue, cells swell and absorb water from the extracellular space.

While using the BLADE technique on DWI to evaluate images on MRI Brain states that the use of the technique can increase image resolution [4]. The use of BLADE in DWI did not find any susceptibility artifacts as usually found in conventional sequences [7]. This research is in accordance with the theory which says that the use of BLADE on DWI can increase image resolution[8]

The BLADE method in DWI sequences uses a multishot data capture technique, with radial filling of k-space by multiple blades rotating 360 degrees at the center of k-space that is sampled repeatedly. This technique minimizes phase error motion and increases image resolution. In addition, the single shot technique used in DWI without BLADE lacks low spatial resolution and tends to show artifacts in bones such as temporal and frontal bones [9]

The difference between DWI image information and the most optimal DWI BLADE on axial cut MRI Brain

Based on the results of the Wilcoxon Test, it was found that the highest mean rank was in the Diffusion Weighted Imaging (DWI) sequence with the BLADE method, which was 31.54, while the DWI sequence without BLADE had a mean rank of 31.00. From the results of this mean rank, it can be concluded that the best picture is found in DWI sequences with the BLADE method, because the Wilcoxon Test shows a significant difference in image quality between the two methods.

The use of DWI sequences with the BLADE method produces images that have better anatomical image information compared to the DWI method without BLADE. In addition, no susceptibility artifacts were found in DWI sequences with the BLADE method, which is often found in the DWI method without BLADE. This shows that the BLADE method can reduce artifacts and increase image resolution, so that images on DWI BLADE become clearer and easier to understand [10]

In the BLADE scan time sequence used is 55 seconds while with DWI without BLADE scan time used is 2 minutes 51 seconds from this in accordance with the theory that the efficiency of time between using the BLADE sequence can reduce the inspection time [11].

In addition, calcium salts found in cortical bones are the most powerful magnetic field substances in the human body and almost all biological tissues (muscle, fat, brain, water) are diamagnetic but very weak. The use of a high gradient magnetic field in DWI makes the sequence sensitive to the inhomogeneity of magnetic fields such as bone, resulting in artifacts appearing in the image. The use of BLADE in DWI sequences, with k-space charging using many densely placed and repeated pulses of 180, can reduce low dephase and improve image quality, so that anatomical criteria are more clearly visible and there are no magnetic susceptibility artifacts on the image[9]

DWI sequences state that shortcomings that are only displayed in axial pieces result in thin-bodied images that cannot be evaluated appropriately. However, the advantage is that high signal intensity is easier because the white matter around has a relatively lower signal intensity [11].

4. CONCLUSION AND RECOMMENDATION

The conclution is the image information between DWI sequence with DWI BLADE there is a difference in image information produced by the difference due to movement that causes motion artifact and DWI image on MRI Brain using BLADE can produce the most optimal image and In MRI Brain Examination, axial pieces should use the DWI BLADE technique to get optimal results.

The recommendation is that in MRI Brain examination axial pieces should use the DWI BLADE technique to get optimal results.

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