

Comparison Between the Image Information of T2WI FLAIR Sequences and TSE T2WI Axial Slice Brain MRI Examination with Cases of Intracranial Tumors

Aulia Annisa¹, Yuni Mesra², Dody Pratama Hasan³

¹Universitas Awal Bros Pekanbaru, Indonesia, ²Rumah Sakit Umum Daerah Prof. Dr. M Ali Hanafiah Batusangkar, Indonesia, ³Rumah Sakit Umum Naili DBS, Indonesia

Corresponding author e-mail: aulia14annisa@gmail.com

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Abstract: This study aims to determine the most optimal results of image information generated from the two sequences, especially for diagnosing intracranial tumors. This type of research is an experiment. The research was conducted with an MRI 3 Tesla in the Radiology Installation. The data is in the form of 20 MRI Brain images from the T2WI TSE and T2WI FLAIR sequences with cases of intracranial tumors. Image evaluation from the qualitative aspect was obtained from respondents' assessments which were analyzed by Wilcoxon different tests and cross-tabulation. While the quantitative assessment is obtained from the measurement of the Signal Noise Ratio (SNR) and analyzed by the Paired T-Test. Based on the results of the study, H_0 was rejected and H_a was accepted, which means that there is a difference in image information between the T2WI TSE sequence and the T2WI FLAIR sequence on the axial section of the MRI Brain examination in cases of intracranial tumors with a p-value = 0.034 ($p < 0.05$). The T2WI TSE sequence can show good intensity and tumor boundaries, while the FLAIR T2WI sequence can show edema around the tumor well, while white matter and gray matter lesion assessments show no significant difference between the two sequences. The results of the SNR measurements showed that the Signal Noise Ratio (SNR) value of the T2WI TSE sequence was higher than that of the FLAIR T2WI sequence.

Keywords: Intracranial Tumor, MRI Brain, T2WI TSE, T2WI FLAIR.

A. Introduction

A brain tumor is a mass of abnormal and uncontrolled growth of cells in or around the brain. This growth is not purposeful, is parasitic, and develops at the expense of the human host (Astuti, 2019). Diagnosing a brain tumor usually involves a neurological examination, and diagnostic imaging such as an MRI and requires analysis of brain tissue. Doctors use diagnostic information to classify tumors from the most benign to the most aggressive (malignant). MRI is able to show most brain

tumors and edema around the tumor, and can also accurately show the location, size and shape of brain tumors (McFaline & Lee, 2018).

Magnetic Resonance Imaging (MRI) is a cross-sectional imaging technique of the body based on the principle of magnetic resonance for hydrogen atomic nuclei. The MRI imaging technique is relatively complex because the image produced depends on many parameters (Weikopf et al., 2021). In general, brain MRI examinations are carried out using the T1 Weighted Image and T2 Weighted Image sequence techniques. T1 Weighted images are used to view the anatomy of the brain while T2 Weighted images aim to see pathologies or abnormalities that occur in the brain area (Bontrager & Lampignano, 2001).

One of the MRI sequences is the T2 Weighted image Turbo Spin Echo (T2WI TSE). TSE is a modification of the Spin Echo (SE) pulse sequence to speed up scanning time. Apart from TSE, a variation of the Spin Echo pulse sequence is Inversion Recovery (IR). One of the IR techniques is Fluid Attenuated Inversion Recovery (FLAIR). FLAIR is one of the IR phases that utilizes the CSF signal at the null point.

On the T2 weight, the fluid has a high signal intensity and a tumor that has a lot of vascularization or a lot of water content means it will also have a high intensity on T2. Therefore, it is said that T2 weighting is good for detecting lesions in the brain. Whereas in the FLAIR sequence weighting the removed CSF signal will be useful for detecting lesions in areas that are difficult to distinguish.

Brain MRI examinations with tumor cases use T1WI and T2WI Axial sequences, T1WI Axial Post Gd-DTPA, T1WI Cor Post Gd-DTPA, T1WI Sag Post Gd-DTPA. According to Westbrook et al. (2011), the routine sequences used are Sagittal SE/FSE/incoherent (spoiled) GRE T1, Axial SE/FSE PD/T2, Coronal SE/FSE PD/T2, and additional sequences for lesions/tumors: Axial FLAIR. Based on the author's observations during fieldwork practice in several hospitals, the two sequences were used in MRI Brain Tumor examinations and the researchers also conducted unstructured interviews in several hospitals, the sequences used for brain examination in tumor cases varied, some only used the FLAIR T2WI sequence. and some use both T2WI FLAIR and T2WI TSE sequences.

Sequence selection in an MRI Brain examination needs to be considered considering the time the examination will take place, the more protocols and sequences selected will increase the examination time while in an MRI examination, the examination time is very concerned to prevent patient movement (Edelstein et al., 2010). For this reason, it is necessary to carry out research on the comparison of image information between the T2WI FLAIR and T2WI TSE sequences to find out the most optimal results of image information generated from the two sequences, especially for diagnosing intracranial tumors.

B. Methods

This is quantitative research with an experimental approach. The research procedure carried out by the author is based on Sugiyono (2019), namely for simple experimental research with strict experimental control, successful research is with a small sample size of between 10 and 20. And in this study, an MRI of the head was carried out by taking a sample of 10 patients. with clinical intracranial tumors. Then an MRI examination of the head with T2WI TSE sequences and FLAIR sequences was carried out in these 10 patients. The research steps consist of preparation for examination and patient registration, then the implementation phase consists of patient positioning, setting sequences and parameters and measuring SNR and assessing diagnostic features. To calculate the SNR value, the Region of Interest (ROI) is determined by using the following equation:

$$SNR = \frac{PV_V}{SD_B}$$

Where, $[PV]_V$, is the average HU value of the object, $[PV]_B$ is the standard deviation of the background HU value.

In this study, the analysis of the data generated by measuring the SNR which is the measurement result of the ratio scale and the data from the average of two paired samples was analyzed statistically using the Paired T Test. While the calculation of the answers to the questionnaire given by the Radiologist regarding tumor clarity which is the result of ordinal scale measurements was analyzed with the Wilcoxon statistical test to test hypotheses and see the level of image evaluation including: lesion/tumor clarity. In this statistical analysis, the level of significance was determined with a value of $\alpha = 0.05$. H_0 is rejected if the p value < 0.05 , which means there is a difference in the evaluation of the T2WI TSE sequence image and the T2WI FLAIR sequence. H_0 is accepted if the p value > 0.05 , which means that there is no difference in the evaluation of T2WI TSE sequences and T2WI FLAIR sequences. Meanwhile, to see which sequence is better in producing image information, a cross-tabulation was performed on the two sequences.

C. Results and Discussion

Comparison of image information between T2WI FLAIR and T2WI TSE sequences in axial sections of MRI Brain examination with intracranial tumor cases performed at the radiology installation was carried out on 20 image samples consisting of 10 patients, where 1 patient was treated with T2WI TSE and T2WI FLAIR sequences. The ten (10) patients consisted of several intracranial tumors namely: glioma, meningioma, oligodendrogliomas and cavernoma.

Characteristics of the patients consisted of 3 men and 7 women, with a mean age of 57 years (ages between 36 – 78 years). All analyses used statistical software SPSS version 16.

Statistical Test and Results Tabulation assessment of MRI Image Information Questionnaire on T2WI TSE and T2WI FLAIR Sequences.

Calculation of image information data is obtained by giving an assessment score with a range of 1 – 3 for each image generated by the T2WI TSE and T2WI FLAIR sequences. Then the scores for each diagnostic description of the three respondents were summarized and analyzed using the Wilcoxon test because the data were from 2 groups that were paired and not normally distributed, the results of the difference test between the T2WI TSE and T2WI FLAIR sequences are presented in the following table:

Table 1. Results of the Wilcoxon Sign Test on the T2WI TSE and T2WI FLAIR sequences

Image Information	Sum of Ranks	Significance level
T2WI TSE Sequence	31,50	$p\text{-value} = 0,034$
T2WI FLAIR Sequence	4,50	$(p < 0,05)$

Based on the results of the different tests in the table above, a significance value ($p < 0.05$) was obtained, meaning there was a significant difference between the image information of the T2WI TSE and T2WI FLAIR sequences on the MRI Brain Tumor examination.

Next, the researcher also assessed the criteria for each diagnostic image generated from the T2WI TSE and T2WI FLAIR sequences using the Wilcoxon Sign Test. Below is the Wilcoxon Sign Test assessment table with criteria for the T2WI TSE and T2WI FLAIR sequences on MRI Brain Tumor examination.

Table 2. Results of the Wilcoxon Sign Test for Evaluating the Criteria for the T2WI TSE and T2WI FLAIR sequences

Assessment criteria	Sum of Ranks	Significance level
Tumor intensity	97,50	<i>p value</i> = 0,001 (<i>p</i> < 0,05)
Tumor margins	180,00	<i>p value</i> = 0,000 (<i>p</i> < 0,05)
Edema around the tumor	15,00	<i>p value</i> = 0,008 (<i>p</i> < 0,05)
White Matter Lesions	22,00	<i>p value</i> = 0,52 (<i>p</i> > 0,05)
Gray Matter Lesions	28,00	<i>p value</i> = 0,16 (<i>p</i> > 0,05)

Based on the results of the different criteria test in the table above, it was found that there were significant differences in several categories of assessment criteria. Next, a cross-tabulation was carried out on the results of the three respondents' assessment of the 20 T2WI TSE and T2WI FLAIR diagnostic images in the description that can be seen in the following table.

Table 3. Results of Respondents' Assessment of 20 T2WI TSE and T2WI FLAIR Diagnostic Images

Anatomical Criteria	Sequence	Value category			Amount
		Not enough	Enough	Good	
Tumor intensity	T2WI TSE	0 %	11,6 %	38,3 %	50 %
	T2WI FLAIR	0 %	18,3 %	31,6 %	50 %
Tumor edge	T2WI TSE	0 %	10,0 %	40,0 %	50 %
	T2WI FLAIR	1,6 %	36,6 %	11,6 %	50 %
Edema around the tumor	T2WI TSE	0 %	23,3 %	26,6 %	50 %
	T2WI FLAIR	0 %	5,0 %	45,0 %	50 %
White matter lesions	T2WI TSE	0 %	20,0 %	30,0 %	50 %
	T2WI FLAIR	0 %	16,6 %	33,3 %	50 %
Gray matter lesions	T2WI TSE	0 %	21,6 %	28,3 %	50 %
	T2WI FLAIR	0 %	13,3 %	36,6 %	50 %

Statistical Test of SNR Measurement Results

SNR measurement results are obtained by measuring the SNR (signal-to-noise ratio) in each diagnostic image by making an ROI (Region of Interest) as a comparison between the tumor and noise outside the image area of the head.

Table 4. Tabulation of SNR (Signal to Noise Ratio) Measurement Results

No Patient	SNR TSE	SNR FLAIR
1	3637,26	1074,7
2	4357,19	2706,75
3	2097,07	1967,6
4	1063,15	619,07
5	1280,34	647,67
6	1640,56	450,28
7	1802,50	1162,29
8	2268,61	910,52
9	2229,19	1227,71
10	2858,81	1196,22

Table 5. SPSS SNR Measurement Results on T2WI TSE and T2WI FLAIR Images

Image Information	Mean	Significance level
T2WI TSE Sequence	2323,4680	<i>p-value = 0,001</i> (<i>p-value < 0,05</i>)
T2WI FLAIR Sequence	1196,2810	

1. Differences in image information between T2WI TSE and T2WI FLAIR sequences on MRI Brain Intracranial Tumor Examination

In a comparison study of image information between T2WI FLAIR sequences and T2WI TSE sequences on axial sections of MRI Brain examination with intracranial tumor cases, the results of reading the questionnaire by radiologists were processed using statistical difference tests, for the assessment of respondents on 20 images between T2WI FLAIR and T2WI TSE sequences. using the Wilcoxon Sign Test, while the SNR (Signal to Noise Ratio) test uses the Paired T Test.

For the assessment of tumor intensity, there appears to be a significant difference between the T2WI TSE and T2WI FLAIR diagnostic images with p value = 0.001 (p value < 0.05). While the results of the percentage assessment by cross-tabulation (crosstabulation) obtained respondents' answers "good" (T2WI TSE = 38.3% and

T2WI FLAIR = 18.3%). The results of this assessment are the same as the results of the assessment of the tumor margins, where from the results of the Wilcoxon Sign Test, there appears to be a significant difference between the image of the tumor margins on the T2WI TSE and T2WI FLAIR diagnostic images with a p value = 0.000 (p value <0.05). While the results of the percentage assessment by cross tabulation (crosstabulation obtained respondents' answers were "good" (T2WI TSE = 40.0% and T2WI FLAIR = 11.6%). On the assessment of intensity and tumor margins the T2WI TSE sequence has a higher value than T2WI FLAIR. These results are in accordance with the opinion of Herskovits et al. (2001) which states that the T2WI TSE sequence is more sensitive in detecting abnormalities in the brain area. This is also due to the tissue structure of the tumor which is in the form of water where Berquist (2012) stated that T2 weighting is more sensitive to water so that it will show a high intensity, therefore a tumor that has a lot of water content vascularization will have a high signal intensity at T2 weighting.

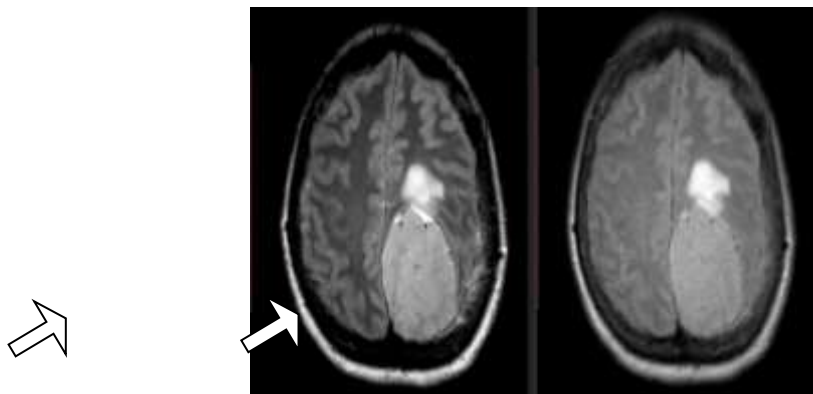


Figure 1. Differences in intensity and tumor margins on T2WI TSE and T2WI FLAIR.

Then for the assessment of edema around the tumor, based on the Wilcoxon Sign Test, there was a significant difference between the image of tumor intensity on the T2WI TSE and T2WI FLAIR diagnostic images with a p-value = 0.008 (p-value <0.05). While the results of the percentage assessment by cross-tabulation on the description of edema around the tumor obtained the percentage of image information assessment, namely the respondents' answers were "good" (T2WI TSE = 40.0% and T2WI FLAIR = 11.6%). The FLAIR sequence is used to suppress liquids, this can be understood because the main parameters in IR are TR, TE, and Time Inversion (TI). The inverse pulse of 180 produces a very good contrast of fluid and other tissue (fat) and with long TR use will remove CSF at the null point. When the NMV of CSF is at the null point, there is no longitudinal magnetization so no signal is detected. The emitted signal is useful for detecting lesions in areas that are difficult to distinguish, therefore the edema around the tumor appears more hyperintense than other tissues (Westbrook, 2011). This is in line with research by Wessam (2021) FLAIR weighting is better for lesion signal intensity and is recommended as a routine or additional weighting on

T1WI to improve early detection and help improve doctors' diagnoses of brain pathological conditions.

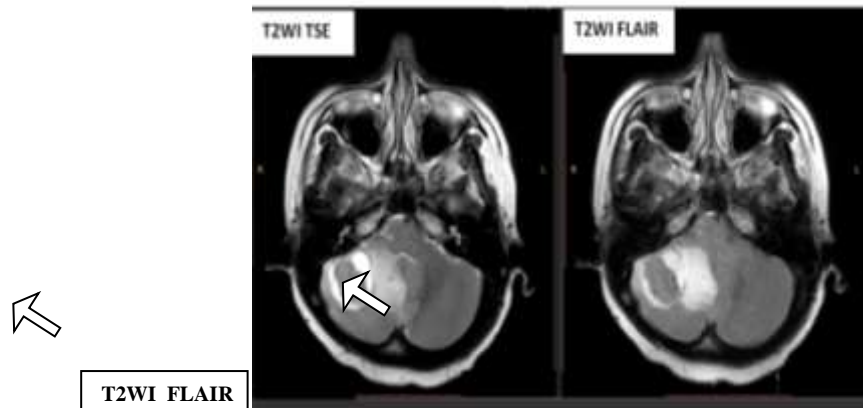


Figure 2. Differences in the appearance of edema around the tumor on T2WI TSE and T2WI FLAIR.

For the assessment of white matter lesions, based on the Wilcoxon Sign Test, there was no significant difference between the appearance of white matter lesions on the T2WI TSE and T2WI FLAIR diagnostic images with $p\text{-value} = 0.5$ ($p\text{-value} > 0.05$). While the results of the assessment by cross-tabulation (crosstabulation) obtained the percentage of respondents' answers as "good" (T2WI TSE = 30.0% and T2WI FLAIR = 33.3%). Then for the assessment of gray matter lesions, based on analysis using SPSS 16, with the Wilcoxon Sign Test different test it appears that there is no significant difference between the appearance of gray matter lesions on T2WI TSE and T2WI FLAIR diagnostic images with $p\text{-value} = 0.16$ ($p\text{-value} > 0, 05$). T1WI provides a strong basis for bright image display and a combination of high signal on T1WI weighting and low signal intensity on T2WI weighted images.

Next is the assessment of the SNR (Signal Noise Ratio) for each image. resulting from the T2WI TSE and T2WI FLAIR sequences in 20 images showing that the T2WI TSE SNR is higher than the T2WI FLAIR sequence. The results of the paired t-test showed that there was a significant difference between the T2WI TSE sequence and the T2WI FLAIR sequence with a $p\text{-value} = 0.001$ ($p\text{-value} < 0.05$). Inversion Recovery weighting produces high contrast but the Inversion Recovery sequence has a lower SNR than the T2WI FLAIR sequence.

2. Better Image Information Assessment Results Between T2WI TSE and T2WI FLAIR Sequences on MRI Brain Intracranial Tumor Examination

The assessment of all anatomical information was carried out based on the subjectivity of the respondents, namely radiologists who had experience in reading MRI images. If seen from the results of the Wilcoxon test there is a significant difference between

the T2WI TSE and T2WI FLAIR sequences, while the mean rank results show the same value between the comparisons of the T2WI TSE and T2WI FLAIR sequences.

From the results of cross-tabulation percentage analysis, a comparison of criteria image information shows various results. For cross-tabulation results of tumor intensity and tumor margins, T2WI TSE sequences scored higher or better. In the assessment of edema around the tumor from the results of cross-tabulation of the FLAIR T2WI sequences, which obtained good results, while for the assessment of white matter lesions and gray matter lesions, both sequences both produced good results or there was no difference in which one was better.

From the results of this study, it can be concluded that for comparison of image information between the T2WI TSE and T2WI FLAIR sequences on Brain tumor examination, there is a significant difference. From a comparison of ten existing patients using the Philips 3 tesla MRI machine, it was found that the intensity assessment and tumor margins were clearer on the T2WI TSE sequence and for the assessment of edema around the tumor it was clearer on the FLAIR T2WI sequence, therefore to establish a brain diagnosis tumor requires both sequences. Both sequences have their own advantages and limitations in diagnosing brain tumors.

D. Conclusion

Based on the results of the research and discussion that has been carried out, the following conclusions can be obtained: 1) The T2WI TSE sequence is better at showing tumor intensity and tumor margins while the T2 FLAIR sequence is good at showing edema around the tumor; 2) Based on the Paired T Test, the SNR measurement results for the T2 TSE sequence are higher than the T2 FLAIR sequence, meaning that the image quality of the T2WI TSE SNR is better than the T2WI FLAIR sequence image; 3) To produce diagnostic images of brain tumors, especially intracranial tumors with T2WI weighting, the TSE and T2WI FLAIR sequences have different objective functions. Therefore, these two sequences must always be used, because the two sequences have their respective advantages in describing the criteria to be displayed on the image of Brain tumors.

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