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## Comparison of Brain Magnetic Reasoning Imaging (MRI) Image Information between T1 Turbo Inversion Recovery (TIR) With T2 Fluid Attenuated Inversion Recovery (Flair) in Case of Epilepsy

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### ABSTRACT

**Background:** Examination MRI of brain coronal oblique slices in cases of epilepsy is usually performed using T1 turbo inversion recovery (TIR) or T2 fluid attenuated inversion recovery (FLAIR) sequences.

**Objective:** The purpose of this research is to determine the differences in MRI of brain image information between the sequences of T1 TIR and T2 FLAIR coronal oblique slices in cases of epilepsy and to find out the better image information between the two sequences.

**Methods:** This research is a quantitative study with an experimental approach. Data were collected from June to August 2016 in Radiology of General Hospital Haji Surabaya by using a questionnaire to the two respondents. Wilcoxon test is used to determine the means differences in image information generated by T1 TIR and T2 FLAIR sequences. The calculation is aided with SPSS 16 software.

**Results:** There are differences in MRI brain image information between T1 TIR and T2 FLAIR sequences coronal oblique slices in cases of epilepsy with a  $p$ -value = 0.008 ( $p < 0.05$ ). This difference is due to the characteristics of different parameters between the two sequences and time inversion of T1 TIR is shorter than T2 FLAIR. The results show that the mean rank of T1 TIR is 5.00 and T2 FLAIR is 0.00. At MRI brain coronal oblique slices in the case of epilepsy, T1 TIR sequence is better than the T2 FLAIR because it can reveal the anatomy of the brain more clear and informative as well as the anatomy of the gray matter, white matter, and hippocampus while on the anatomy of cerebrospinal fluid (CSF) there is no significant difference between T1 TIR and T2 FLAIR sequences.

**Conclusion:** There are differences in MRI brain image information between T1 TIR and T2 FLAIR sequences coronal oblique slices in cases of epilepsy.

**Keywords:** MRI brain, T1 TIR, T2 FLAIR, coronal oblique slices, epilepsy.

### INTRODUCTION

Magnetic resonance imaging (MRI) is a medical imaging technique that uses magnetic fields and radio frequencies to visualize and analyze bodily tissues, bloodstream, and body's metabolic

functions. In its application, the magnetic field strength used 0.064 Tesla -1.5 Tesla (Notosiswoyo, 2004).

The brain is very vital organs for humans. There are a lot of abnormalities in the human brain,

among others, epilepsy, hydrocephalus, Alzheimer's, Parkinson's and cancer. Among the various brain diseases, epilepsy became one of the diseases in the brain that need special attention because besides the cases are quite common and influences the quality of life of people (deBoer, 2008).

Image evaluation in epileptic disease progresses rapidly with the CT scan in early 1970, because it can reveal a good soft tissue contrast, multi-planar imaging, and least artifacts. But the disorder of epilepsy can be visualized with a much more sensitive and accurate with Magnetic Reasoning Imaging (MRI). Thus, Currently, MRI is of choice for displaying high-resolution structural imaging in epilepsy (Karis, 2008).

Selection of the proper sequence on MRI brain in epilepsy clinic is very important to show abnormalities clearly so that they can be treated with the proper diagnosis. According to Karis (2008), epilepsy patients need watching the signs of their mesial temporal sclerosis (atrophy of the hippocampus), the internal structure of the chaotic and hyperintensity on T2 weighting. But among the signs, the atrophy of the hippocampus is the most often found. This condition is rare in children under the age of 10 years. If the pathogenesis is not known, there might be a correlation with infection and seizure due to fever when they were children. This condition is characterized by atrophy of the hippocampus and the best sequences to look at it is T2 weighted FLAIR coronal oblique because the lost volume of hippocampus will be joined by increased T2 signal and loss of contrast between gray matter and white matter. According to Hajnal JV et al (1992), T2 weighted FLAIR coronal sequences are very useful to confirm the abnormalities of the hippocampus and to detect abnormalities in the cortex and sub-cortex. According to Karel & Eric (2008), the optimal imaging of the hippocampus and the medial temporal lobe is done with slices of 2-3 mm coronal oblique images orthogonal to the long axis of the hippocampus. So far the "gold standard" MRI brain scanning protocol in cases of epilepsy

are T1 Inversion Recovery (T1 IR) sequences coronal and FLAIR coronal sequences.

In the implementation of the hospital to confirm the abnormalities of the hippocampus in the case of epilepsy, some hospitals besides using oblique coronal T1 TIR also use T2 FLAIR coronal oblique. Some use them together, but some only use one of the sequences.

## METHODS

This research is a quantitative study with an experimental approach. Data were collected from June to August 2016 in Radiology RSU Haji Surabaya. Population and sample is the image of MRI brain images of the two groups paired T1 TIR with T2 FLAIR sequences coronal oblique slices of the 10 patients with the inclusion criteria of men/women with age 18-60 years old, been indicated abnormalities in the brain epilepsy, while for exclusion criteria were patients of claustrophobia, given anesthetic drugs and using the contrast media. The subjects of this study are two radiologists who assesses the results of image research through questionnaires. Sliced assessed were slices of hippocampus displaying the most obvious image.

Data analysis was performed statistical tests with applications SPSS 16 using test Cohen's Kappa to determine the level of agreement of the second respondent, the Wilcoxon test because the data in the form of ordinal to determine the level difference information image of MRI brain between T1 TIR with T2 FLAIR sequences slice coronal in cases of epilepsy with the value of  $\alpha = 0.05$  ( $p < 0.05$ ), the mean rank of the Wilcoxon test to find out information better image.

## RESULT

### 1. Characteristics of Samples

This study was conducted on 10 patients with MRI examinations of the brain performed with T1 TIR and T2 FLAIR sequences oblique coronal slices in cases of epilepsy with a total time of scanning for both sequences for each patient during 7 minutes.

**Table 1.** Description of the research sample

Categories	Classification	Numbers	Percentage (%)
sex	Men	4	40
	women	6	60
	Total	10	100
age	18-40 years old	7	70
	41- 60 years old	3	30
	Total	10	100

2. Differences in Image Information of MRI Brain Between T1 TIR with T2 FLAIR

Before performing the different test, respondents were tested beforehand to determine the level of agreement or objectivity of ratings to the image of the cervical spine of MRI brain by using Cohen's Kappa statistical test.

**Table 2.** Result of Cohen’s Kappa test on two respondents

Sequences	Level of agreement Cohen’s Kappa	Amount of Data
T1 TIR	0,708	40
T2 FLAIR	0,799	40

Based on Table 2, the level of agreement from respondents in T1 TIR sequence of 0.708, while the T2 FLAIR sequence of 0.799.

Wilcoxon test is then performed to determine the difference of the image information between T1 TIR with T2 FLAIR to see the significance value of (p-value).

a. Differences Test in Image Information for Each Criterion Between T1 TIR with T2 FLAIR

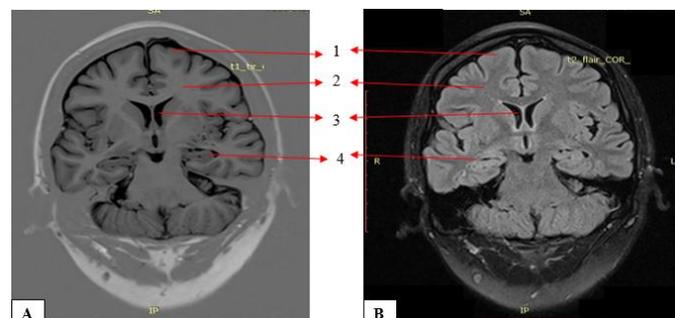
**Table 3.** Result of difference test in image information each of criteria between T1 TIR with T2 FLAIR sequences coronal oblique slices in cases of epilepsy

Criteria	Sequences	p-value	Explanation
gray matter	T1 TIR	0,024	significant
	T2 FLAIR		
white matter	T1 TIR	0,033	significant
	T2 FLAIR		
CSF	T1 TIR	0,257	Not significant
	T2 FLAIR		
Hippocampus	T1 TIR	0,011	significant
	T2 FLAIR		

b. Differences Test in Image Information for All Criteria Between T1 TIR with T2 FLAIR

**Table 4.** Result of difference test in image information all criteria between T1 TIR with T2 FLAIR sequences coronal oblique slices in cases of epilepsy

Sequences	p-value	explanation
TSE	0.008	Significant
GRE		



**Figure 1.** The research sample coronal oblique slices image parallel to the hippocampus on T1 TIR (A) with T2 FLAIR sequences (B)

Note:

1. gray matter
2. white matter
3. cerebrospinal fluid (CSF)
4. hippocampus

3. The Better Image Information of MRI Brain Between T1 TIR with T2 FLAIR

The results of assessment on the image information is analyzed with to determine the mean rank for the better image information between T1 TIR with T2 FLAIR sequences oblique coronal slices in cases of epilepsy

a. The Better Image Information for Each Criterion Between T1 TIR with T2 FLAIR.

**Table 5** Result of mean rank Wilcoxon test of image information each criterion between T1 TIR with T2 FLAIR sequences oblique coronal slices in cases of epilepsy

Criteria	Sequences	Mean rank
gray matter	T1 TIR	3.50
	T2 FLAIR	0.00
white matter	T1 TIR	4.64
	T2 FLAIR	3.50
CSF	T1 TIR	2.67
	T2 FLAIR	2.00
Hippocampus	T1 TIR	4.00
	T2 FLAIR	0.00

b. The Better Image Information for All Criteria Between T1 TIR with T2 FLAIR

**Table 6** Result of Wilcoxon test's mean rank on image information for all criteria between T1 TIR with T2 FLAIR sequences oblique coronal slices in cases of epilepsy

Sequences	Mean Rank
T1 TIR	5.00
T2 FLAIR	0.00

## DISCUSSION

The result of Cohen's Kappa test shows that the level of agreement in T1 TIR sequence is 0.708 while the T2 FLAIR sequence is 0.799. According to Sim and Wraight (2005), a measure of agreement between the two assessors in classifying some subjects into one of two categories is a consensus (objective) if the value of Cohen's Kappa in the range  $\leq 0$  (poor), 0.01 to 0.2 (slight), 0.21 to 0.40 (fair) 0.41 to 0.60 (moderate), 0.61 to 0.80 (substantial) and 0.81 to 1.00 (almost perfect). Based on Cohen's Kappa test results, it is concluded that the ratings of two respondents are objective.

1. Differences in Image Information MRI of Brain Between T1 TIR with T2 FLAIR Sequences Coronal of oblique Slices In Cases of Epilepsy  
Initial hypothesis assumes that there is a significant difference to the criteria of the gray matter, white matter, and hippocampus in the MRI brain image between T1 TIR with T2 FLAIR sequences. The value of significance (p-value) of anatomy criteria shows that gray matter = 0.024; white matter = 0.033; hippocampus = 0.011, while on anatomical criteria CSF has a value of significance (p-value) of 0.257, indicating that  $H_0$  is accepted as the p-value is  $> 0.005$  meaning there is no significant difference for anatomical criteria hippocampus on MRI brain images between T1 TIR to T2 FLAIR sequences coronal of oblique slices.

Wilcoxon test on the overall image information indicates that there is a significant difference in image information for the overall criterion with

the p-value of 0.008 ( $p < 0.05$ ) for MRI brain images between T1 with T2 FLAIR TIR sequences coronal of oblique slices.

The difference happens as each sequence has advantages and disadvantages. In this study, each sequence has the characteristics of different parameters, such as time inversion (TI), repetition time (TR) and the acquisition time to obtain a good image in every sequence, in this case, the T1 TIR and T2 FLAIR apply sequences coronal of oblique slices.

At the image of MRI brain T2 FLAIR coronal oblique slices, it has a higher contrast than T1 TIR. Background image in T1 TIR sequences is gray while in T2 FLAIR is black. The length of time T1 TIR inversion recovery sequences is shorter than T2 FLAIR, which is 400 ms compared to 2500 ms.

This is in accordance with Moran et. al (1986) that the T1 TIR has the background of mid gray color air supplied because it uses a polarity gradient M (z) phase corrected and parameters normally used to sequences are TR = 7000 ms, TI = 400 ms and TE = 70. T2 FLAIR sequences have black background as it only uses gradient magnitude M (z) and the parameters used in the sequence is very long TR 8000+ ms, TI range is about 2000 to 2500 ms and for the null signal from CSF and TE are approximately 80-140 ms (Hajnal, et. al, 1992).

2. The Better Image Information of MRI Brain Between T1 TIR with T2 FLAIR

The better image Information in MRI brain between T1 TIR with T2 FLAIR sequences oblique with coronal slices obtained from the mean rank of Wilcoxon test per the criteria of image information is described below:

a. Gray Matter

From the results of the Wilcoxon test criteria anatomy gray matter, T1 TIR sequences has a higher mean rank (3.50) value than the T2 FLAIR (0.00). According to the authors, it is because of the differential factor time inversion T1 TIR sequences and T2 FLAIR. Timing parameters that control the contrast inversion

are the inversion time (TI). TI on T1 TIR is shorter than the TI T2 FLAIR so that the contrast of gray matter is more optimal. While contrasting gray matter on T2 FLAIR sequences looks hipper -intense.

T1 TIR sequences have a short time inversion of 400 ms which not to allow a longitudinal full recovery (Moran et al, 1986), while T2 FLAIR sequences have a range about 2000 to 2500 ms inversion time to null signal from CSF enabling the longitudinal full recovery (Hajnal, et al, 1992). This is consistent with the theory of Redpath et.al (1994), that the sequence of T1 TIR gray matter in the organs are very good for the gray matter and T1 TIR is a selective sequence, in particular, suppress signal on gray matter organ.

#### b. White matter

In the anatomy of white matter criteria, Wilcoxon test results showed that the mean rank T1 TIR is higher than T2 FLAIR sequences in the amount of 4.64 against 3.50. According to the authors, it is because of the differential factor time inversion (TI) between T1 TIR and T2 FLAIR sequences. Time inversion on T1 TIR is shorter than in T2 FLAIR so that the contrast of the white matter is more intermediated when compared with T2 FLAIR sequences which are more hypo-intense.

This is consistent with the theory of Redpath et. al (1994), that the sequence of organ white matter on T1 TIR sequences looked intermediated but lighter than the gray matter.

#### c. Cerebrospinal fluid (CSF)

On anatomical criteria of CSF, Wilcoxon test results showed that the mean rank between T1 TIR and T2 FLAIR is 2.67 and 2.00. T1 TIR sequences are higher than T2 FLAIR but the difference in value between the sequences are relatively small in the amount of 0.67. According to the authors, the difference in relatively small different value to the mean rank between T1 TIR and T2 FLAIR sequences on signal intensity because the two sequences are equally hypo-intense.

This is consistent with the theory of Moran et. al (1986), that the T1 TIR sequence anatomy CSF seemed darkest (hypo-intense) because these sequences were using the inverse correction phase recovery that maintains information about the polarity of Mz, the more negative the value is given the darker. Meanwhile, according to Hajnal (1992), the T2 FLAIR sequences anatomy CSF appears dark because of the sequence is using the value of TI from 2000 to 2500 to zero signals from the CSF, coupled with a very long TR (8000+) and TE (80-140 ) to make T2 weighting.

#### d. Hippocampus

Wilcoxon test criteria anatomy for hippocampus, indicates that T1 TIR sequences (4.00) have a higher mean value than the T2 FLAIR sequences (0.00). According to the author, this because of the differential factor in time inversion (TI) between sequences T1 TIR with T2 FLAIR. TI on T1 TIR is shorter than the TI T2 FLAIR so that the contrast of the intermediated hippocampus than T2 FLAIR sequences which are hipper intense.

According to Fajar (2012), suspicion of epilepsy is due to the density of components and the integrity of an overview of certain pyramidal cells in the cortex included in the hippocampus that is vulnerable to seizure activity. According to Hajnal et. al (1992), the use of TI in T2 FLAIR sequences is longer than T1 TIR making it difficult to distinguish when there is a pathology (lesions) on the organ because both have hipper intense signal intensity. While on T1 TIR sequences have a short TI thus minimizing phase error, and if there is any pathology (lesions), it becomes more apparent and detail boundaries between surrounding tissue are visible.

## CONCLUSION

In comparing the use of brain MRI between T1 TIR with T2 FLAIR sequences coronal oblique slices, to see better overall criteria, using T1 TIR sequences is better because it has a mean rank higher than T2 FLAIR sequences, amounting to 5.00 versus 0.00. These values indicate that the image information on T1 TIR sequence is much better than the T2 FLAIR.

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