Detection of Mesial Temporal Lobe Epilepsy in MRI Sequence T2 Flair MRI Image Using Computer Aided Diagnosis (CAD)

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Abstract. Epilepsy is a serious disorder in the brain. One of the most frequently found is temporal lobe epilepsy. This type of epilepsy is mainly caused by hippocampal sclerosis and treatment is often refractory so it needs surgery, this epilepsy is called mesial temporal lobe epilepsy (MTLE). MRI features for hippocampal sclerosis seen visually are a decrease in T1-weighted intensity and an increase in T2-weighted intensity. T2WI and T2 FLAIR are the sequences most often assessed for the diagnosis of hippocampal sclerosis. The assessment carried out by the practitioner to see the increase in intensity of the sequence is done visually. Visual assessment has flaws because of the limited vision and subjectivity of the practitioner, thereby producing several opinions to determine the level of intensity of the sequence. In this study a Computer Aided Diagnosis (CAD) method is proposed to assess quantitatively by assessing the intensity that exists in the FLAIR T2 sequence. This research uses Computer Aided Diagnosis (CAD) with computer programming, Image processing as a tool to find the intensity value and get a cut-off point value > 825, from this result then conduct a test by measuring the sensitivity value (90%), specificity (69%), positive predictive value (80%), negative predictive value (83%) and accuracy (81%). The of area under the curve is 0.8119, with the average ability to determine the pain is not sick is 0.71 - 0.91. The results of this study indicate that Computer Aided Diagnosis (CAD) is able to detect hippocampal sclerosis in ELTM well.

Keywords. MRI Brain, T2 FLAIR, CAD, Hippocampal Sclerosis, MTLE

1 Introduction

Epilepsy is a serious disorder in the brain. This disorder affects 50 million people worldwide, 80% of them are in developing countries [1]. Epilepsy disorders can affect anyone in the whole world, children, adults, parents and even newborn babies. The

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prevalence and incidence of epilepsy in Indonesia is not known with certainty. The results of the Epilepsy Study group of the Indonesian Neurologist Association in several hospitals on five major islands in Indonesia (2013) found 2,288 people with epilepsy with 21.3% new patients [2].

The most common epilepsy is temporal lobe epilepsy. Temporal lobe epilepsy (TLE) is the most common focal epilepsy among adults [3]. This type of epilepsy is mainly caused by hippocampal sclerosis and treatment is often refractory so it needs surgery, this epilepsy is called mesial temporal lobe epilepsy (MTLE) [4]. Hippocampal slerosis is the most common neuropathological finding in patients undergoing surgery in patients with temporal lobe epilepsy. The magnetic resonance imaging (MRI) modalities of hippocampal sclerosis are characterized by an increase in intensity in the T2 and FLAIR sequences in the hippocampal area [3].

The use of magnetic resonance imaging (MRI) modalities is an important modality in helping detect structural pathological conditions in the brain, one of which is to assess hippocampal sclerosis [5]. MRI features for hippocampal sclerosis include hippocampal atrophy, disrupted internal hippocampal structure, and decreased T1-weighted and increased T2-weighted signals. Hippocampal atrophy is the most common change associated with mesial temporal sclerosis seen in 86% of cases followed by an increase in FLAIR sequences in 80% of cases [6]. Sequences that are often used qualitatively T2WI and T2 FLAIR. FLAIR is considered the most useful image for detecting hippocampal sclerosis, and FLAIR T2 is the most sensitive to all types of lesions (85%) [7,8]. Because visual analysis alone has inaccurate accuracy in detecting hippocampal sclerosis, by adding quantitative imaging using Computer Aided Diagnosis (CAD), it can be a support for diagnosing hippocampal sclerosis, the use of computers can minimize errors and speed up the physical calculation process [9].

Digital image processing can make it easier for practitioners to identify hippocampal sclerosis by knowing the special features contained in the image to be tested, and giving an overview of the results of the image testing. Practitioners can also distinguish FLAIR T2 MRI images between patients with epilepsy or normal by looking at the state of the hippocopy, whether there is an increase or not. Therefore, it is necessary to study effective digital image processing on MRI T2 FLAIR images of patients diagnosed with hippocampal sclerosis. One method that is effective in extracting the characteristics of an image using the mathlab method. The mathlab method used is crop features and Region of Interest (ROI) to see the intensity value of hippocampal sclerosis. Therefore, it is necessary to study effective feature extraction methods on MRI T2 FLAIR images of patients diagnosed with hippocampal sclerosis. One effective method in finding the intensity value in hippocampal sclerosis is an image using the Computer Aided Diagnosis (CAD) method [9].

Image processing is the processing of pixels in a digital image for a specific purpose. Interpreting the need for a light source so that the object can reflect the reflected light the light will be recorded by optical devices including the senses of human vision, cameras, scanners and others. The reflection is recorded by a digital machine, so the image obtained is also a digital image [10].

2 Method

This research was carried out using the FLAIR T2 sequence in MRI examination of hippocampal sclerosis on coronal cuts. MRI images of the brain sequence T2 FLAIR coronal section in the ELT case to see the suitability of the CAD program with a qualitative assessment. This type of research is analytic, with cross sectional approach. This research

will be analyzed with comparative assessment using digital image processing applications in diagnosing hippocampal sclerosis so as to obtain sensitivity, specificity, positive predictive value, negative predictive value and accuracy. The subjects of this study were all MRI images of Epilepsy (hippocampal sclerosis) with the T2 FLAIR sequences coronal slices with 3 mm slices and normal patients as controls. Using cross tabulation to compare intensity values in MRI epilepsy images using the Computer Aided Diagnosis (CAD) technique.

3 Results and Discussion

The results of brain epilepsy MRI images used in this study are shown in Figure 1. These images show normal epilepsy images and image hippocampal sclerosis images. The image is then carried out computer-based processing to get the value of intensity.
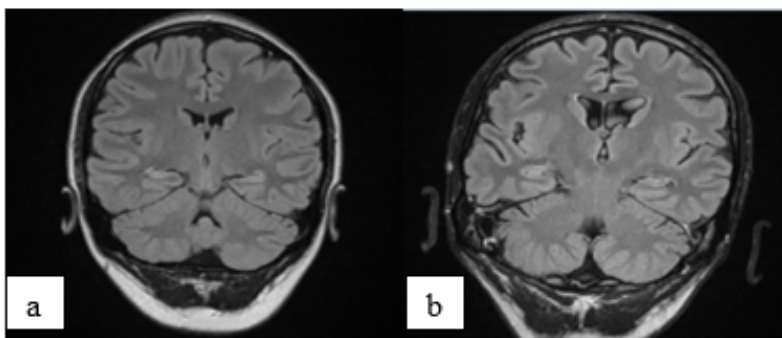
Fig. 1. Normal epilepsy images (a)**, and** hippocampal sclerosis images (b).
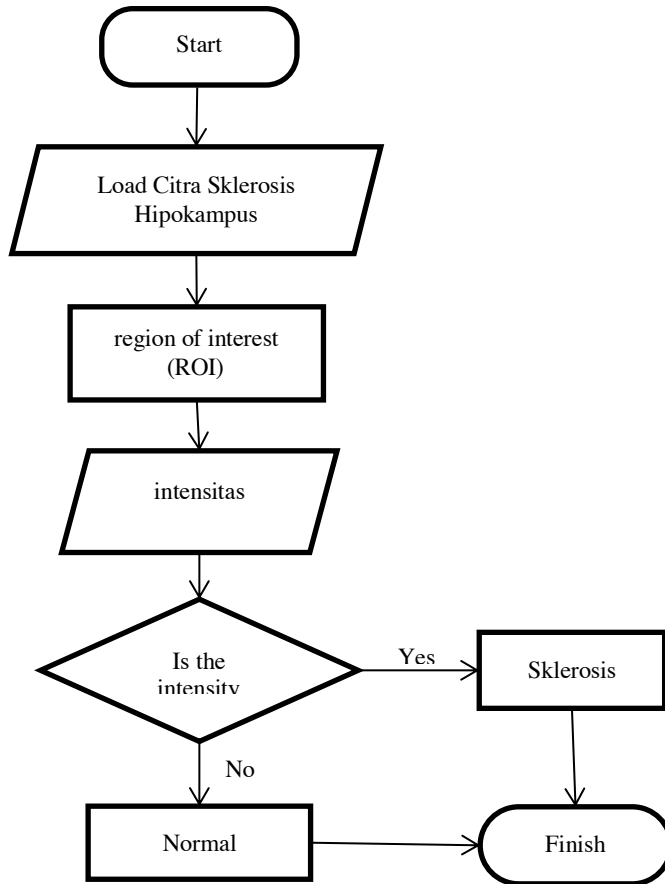
The assessment is carried out with a CAD computer programming tool to assess quantitatively in the hippocampal area, by using the ROI technique with a size of 4 mm x 4 mm in the hippocampus area. From the results of ROI get the right intensity value of 678.25 and left of 657.25 for image a, while image b, obtained the intensity in the right hippocampus is 1407.5 and in the left hippocampus is 1407.75. The study was conducted in 24 normal patients, and an average intensity of 655 was obtained with a standard deviation of 94.72. The sample has a value with a maximum intensity of 816 and a minimum intensity value of 504.75. While the intensity value in patients with hippocampal sclerosis with a study sample of 46, obtained an average value of intensity of 1353.31 with a standard deviation of 362.68. The sample has a maximum value of 2212.5 and a minimum value of 809, following the recapitulation of the research sample in table 1.

Table 1. Recapitulation of Matlab Test Data Samples

	average	Max	Min	STD
Normal	655	816	504,75	95
Sklerosis	1353	2212	809	363

The data processing values in table 1. are then determined as cut-off points to determine the status of sclerosis by looking at the value at its intensity. From the results of the data processing in table 1 the statistical cut-off point obtained statistically uses the statistical method, the method of determining the statistical cut-off point can also be used by clinicians to get an initial picture, before finally finding a clinical cut-off point. Using statistics makes it easy for clinicians to estimate the balance between sensitivity and

specificity in a single point. The cut-off point value set is 825. If the cut-off point specified ≤ 825 is declared normal and vice versa if> 825 is declared sclerosis. After getting the results from the computer programming cut-off point with CAD mathlab application as a tool to test the data. The flow chart with the programming is shown in Figure 2.

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                           │ No                   │
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                    │   Normal     │─────────│  Finish  │
                    └──────────────┘         └──────────┘
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Fig. 2. *CAD Flow Chart*

Figure 2. is a CAD application design flowchart starting with Star by clicking the run button, then inputting the MRI brain epilepsy image in the DCOM format (*img=dicomread*). After the DCOM image is displayed, then perform the crop command (imgc = imcrop; img, position) which aims to determine the desired area, then use ROI to see the intensity value of the image. From the resulting cut-off point, then carry out the command to determine sclerosis and normal (*if in > 825, set (handles.text3,'string','sclerosis') elseif in <= 825, set (handles.text3,'string','normal'.*
From the results of determining the sclerosis and not sclerosis proceed with data processing using a 2 x 2 table, which in the table produces two decisions, according to the results of a qualitative assessment with mathlab processing using a CAD program. The following results of the calculation of the 2 x 2 test table in hippocampal sclerosis are shown in table 2.

Table 2. Comparative Table of FLAIR MRI T2 Assessment Results Between CAD Programs and Qualitative Assessments

		Qualitative Assessment		
		Positive	**Negative**	**Total**
CAD	**Positive**	37	9	46
	Negative	4	20	24
	Total	41	29	70

FLAIR MRI T2 image samples were tested using a CAD program using the Graphical User Interface (GUI) with the Region of Intersest (ROI) command, first cropping the area to be roi. The area in the Region Of Intersest (ROI) part of the hippocampus that has sclerosis, the results of the ROI will be tested cross table.

The results of the cross table aim to find the value of sensitivity, specificity, positive predictive value and negative predictive value by using a cut-off point value with the Receiver Operating Characteristic (ROC) procedure. This study aims to produce a physician's aid quantitatively in assessing the intensity of clinical epilepsy hippocampal sclerosis whether it is in accordance with the results of a qualitative assessment.

In the comparative table of FLAIR TRI MRI assessment above, there are a total of 70 samples. There were 37 samples that were declared sclerosis by the CAD program and also stated sclerosis by qualitative assessment. There were nine samples that were declared sclerosis by the CAD program and were declared not sclerosis by qualitative assessment. There are four samples that were declared not sclerosis by the CAD program and were declared sclerosis by a qualitative assessment, and there were 20 samples that were declared not sclerosis by the CAD program and were also declared not sclerosis by a qualitative assessment. From the results obtained above the value obtained by using a cut off point that has been previously determined, the cut-off point value is 825. From the results of this 2 x 2 table get the results of sensitivity (90.24%), specificity (68.96%), positive predictive value (80.43%), negative predictive value (83.33%) and accuracy (81.42%). Next create a Receiver Operating Characteristic (ROC). Making ROC curves is used to find a bargaining point between sensitivity and specificity. The results of the ROC curve in the sclerosis hippocampus are shown in figure 3.
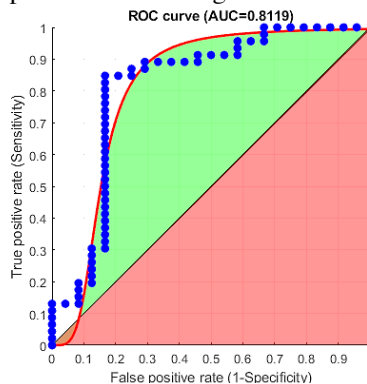
Fig. 3. *ROC Hippocampal Sclerosis Curves*

From the receiver operating characteristic (ROC) results, it produces a value in the under the curve (AUC) area of 0.811 or $\geq 70\%$. From the AUC value it can be interpreted that the average ability to classify sclerosis or not sclerosis is in the range of 0.712 - 0.910. Compliance with the AUC value of 81.1% means that in 100 patients who were declared sclerosis by a qualitative assessment, the CAD program was able to determine the presence or absence of sclerosis at 81%. To ensure analysis by looking at the area under the curve table in table 3.

Table 3. ROC Curve Analysis

AUC	Standar Error	p-value
0.8118	0.0504	<0.001

The test value shows a p-value of < 0.001 (p-value < 0.05), there is a difference in ability between the assessment using the CAD program with a qualitative assessment to assess the intensity of sclerosis. On the results of the p-value between the assessment using the CAD program with a qualitative assessment in assessing different intensities, this is due to differences in isointens and hyperintensity in the image of the hippocampal sclerosis to be confounding, thus causing the CAD program assessment with different qualitative assessments.

The difference between the assessment in the CAD program with a qualitative assessment is due to the resulting image is less informative and there are some samples whose results are different from the actual state of the image. When a radiologist sees hyperintense in the image of the hippocampus, the assessment concludes hippocampal sclerosis, and when assessed using a CAD program gets different results from a qualitative assessment.

4 Conclusion and Suggestions

The results of this study, showed the sensitivity value in the CAD program has a value of (90.42%), specificity (68.96%), positive predictive value (80.43%), negative predictive value (83.43%) and accuracy (81.42%). then it can be stated that, CAD as a tool to determine hippocampal scelrosis has good accuracy. The advantage of using this method using the CAD program is that the intensity assessment results have a more objective value, while the weakness of the CAD program cannot be used as a diagnostic tool, it can only be used as a tool to assist radiology specialists in assessing intensity. Further research can be done on this topic by comparing it with hispatology, so that more accurate research results

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