Original Article

The Role of Brain Magnetic Resonance Imaging (MRI) as an Early Detector of Cognitive Impairment

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Abstract

Background: Along with the increase of the health and prosperity level will affect the life expectancy in Indonesia, there has also been an increase in degenerative disease cases. One of the problems arises is cognitive impairment. The mild version of this impairment is often associated with the increase risk that will eventually lead to dementia. Therefore, early detection of this impairment is necessary. **Objective:** This study is aimed at proving the correlation between Fazekas scale on brain MRI and MoCA-Ina score in defining the degree of cognitive impairment. **Methods:** This study employed observational analytic design and cross sectional study for its data collection method. The Fazekas scale on brain MRI of 32 patients was read by 3 radiologist, while the MoCA-Ina scoring was done by a competent neurologist. Both tests were done double blindly. Later on, the correlation between Fazekas scale and MoCA-Ina score would be assessed using Spearman Correlation. **Results:** Statistical calculation conducted using Spearman Correlation reveals that the coefficient is -0.519 with significant score (*P*) 0.002, which is smaller than α: 0.05. Therefore, it can be concluded that there is a strong negative correlation between Fazekas scale and MoCA-Ina score. **Conclusion:** Fazekas scale evaluation on brain MRI is necessary to be performed as it helps predicting the decline of one's cognitive function, so that an early therapy can be acted upon to prevent dementia in the future.

Keywords: *Cognitive impairment, fazekas scale, moca-ina score*

Introduction

A mild cognitive impairment (MCI) is often associated with the rise of risks that will eventually develop into dementia until 10%–15% per year compared with the healthy participant of the research.[1,2] MCI is a transition from normal aging to dementia, in which there has been four to six time increase of risk on dementiadiagnosis in the future. MCI has attracted the attention of researchers in the past few years.[3] They have been doing research on predicting MCI patients who might develop into dementia.[4]

Montreal Cognitive Assessment (MoCA) is a test developed to help evaluating MCI.[5] White Matter Hyperintensities (WMH) has a significant contribution toward the loss of independence at old age which is signified by the three-fold higher risk of stroke and two-fold higher risk of dementia.[6] Visual assessment is a simple way that is important to be practiced on a daily basis.[7] There are some visual assessment methods for WMH, and one of them is Fazekas scale that has been proven to have more effectiveness compared to the other two scales.[7,8] The researchers were interested to find out whether or not there was a correlation between Fazekas scale on head magnetic resonance imaging (MRI) and MoCA-Ina score in determining the degree of cognitive impairment to provide early therapy and inhibit dementia.

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Subjects and Methods

Research subject

This study employed observational analytic design which used cross-sectional study for the data collection on hospitalized patients and outpatients in Radiology Department of Dr. Saiful Anwar Hospital Malang. Their head MRI results showed the emergence of Fazekas scale. There were 32 individuals in total who were consecutively chosen. The subject is patients that had a previous head MRI results with T2-weighted images (T2WI) and fluid attenuation inversion recovery (FLAIR) sequences with the findings of Fazekas scale only 133-day-gap between the MRI and MoCA-Ina examinations. This research was granted permission by the Ethical Committee of Dr. Saiful Anwar Hospital Malang with the reference letter no. 400/14/K.3/302/2015. In addition, patients had also completed the consent forms before the examination was performed.

Montreal Cognitive Assessment-Ina score examination

The materials and equipment used in this research were MRI Philips Ingenia 3T, head coil and film to print the result of head MRI, and MoCA-Ina checking paper. The sequences used in MRI were T1-weighted images (T1WI), T2WI, and FLAIR with axial view. Fazekas scale on the result of MRI would be read by three radiology specialists who had minimum 5 years of experience. It was also ensured that those radiology specialists did not have any information on the previous MoCA-Ina score of the patients (if already available). When differences prevailed, the radiologists had to come into an agreement from the majority for the conclusion to make. The examination to get MoCA-Ina score was done in neurology section which was comfortable and free of noise. MoCA-Ina examination was performed by a competent neurologist.

Statistical analysis

All the data obtained from the research was kept in a log book and also stored in a computer file. The correlation between Fazekas scale and MoCA-Ina score would be tested using Spearman Correlation with trust level of 95%, $\alpha = 0.05$, and was declared significant when $P < 0.05$.

Results

In 2 months (November–December 2015), 32 participants who met the inclusive criteria were collected. Of all those participants, two patients brought the result of their head MRI not from RSU Dr. Saiful Anwar Malang from which also it was found out that there was only 133-day-gap between the MRI and MoCA-Ina examinations. The participants were female and male, 21–81 years old, and with elementary school up to doctorate degree of educational background. It was found that there were 14 (43.8%) patients with Fazekas scale 1, 15 (46.9%) patients with Fazekas scale 2, and 3 (9.4%) patients with Fazekas scale 3. From the distribution of MoCA-Ina score, it was obtained that the maximum score was 28, and the minimum was 6 with the average score of 19.16. Further, Spearman correlation was used to investigate the correlation between Fazekas scale and MoCA-Ina score.

Based on the testing, the coefficient of Spearman correlation was − 0.519 with the significant score (*P*) of 0.002, that was smaller than α: 0.05. Therefore, it can be concluded that there is a strong negative correlation between Fazekas scale and MoCA-Ina score. It indicates that the higher Fazekas scale, the lower the MoCA-Ina score will be.

However, from the cross tabulation between Fazekas scale and cognitive function, it was obtained that there were four research participants (80%) with normal cognitive function in Fazekas scale 1 and one subject (20%) with normal cognitive function in Fazekas scale 2. Then, Chi-square test was also conducted. However, because there were two columns with the scores below the expected count, the calculation was then performed using Fisher's exact test with the significant score of 0.142, higher than the score of α: 0.05. Hence, it can be concluded that there is no significant correlation between Fazekas scale and cognitive function.

Based on the information in Table 1, it was found out that there were five research participants out of 32 (15.6%) who possessed normal cognitive function and 27 research participants (84.4%) who suffered from the cognitive function decline. In Fazekas Scale 1, 10 out of 14 research participants (71.4%) suffered from

Table 1: Cross Tabulation between *Fazekas* scale and cognitive function

	Cognitive		Total
	Normal	Not normal	
Fazekas			
Scale 1			
Count	4	10	14
% within cognitive	28.6%	71.4%	100%
Scale 2 and 3			
Count	1	17	18
% within cognitive	5.6%	94.4%	100%
Total			
Count	5	27	32
% within cognitive	15.6%	84.4%	100%

cognitive function decline and in Fazekas scale 2 and 3, 17 out of 18 research participants (94.4%) also suffered from cognitive function decline.

Discussion

Of all those participants, two patients brought the result of their head MRI with sequences T1WI/T2WI/FLAIR, not from Dr. Saiful Anwar Hospital Malang from which also it was found out that there was only 133-day-gap between the MRI and MoCA-Ina examinations. It is based on a study in eight patients with Parkinson's disease who have done MoCA test 133 days apart. The mean change in MoCA scores between the first and second administration was 0.5, and the mean change in MoCA scores between examiners was 0.6.[9]

Thirty research participants underwent MRI examination in Saiful Anwar Hospital uses MRI Philips Ingenia 3T. There were no differences or effect of MRI machine specification because the use of basic sequences of MRI (T2WI and FLAIR) in assessing the Fazekas scale. Most of the research participants' condition/pathology was a clinical thrombotic stroke, only a small portion with other clinical such as cephalgia, vertigo, and suspicion of meningoencephalitis. They were 21–81 years of age, with the most distribution at the age of above 50 years old as there were 25 out of 32 research participants (78.125%) belonged to that classification. All seven participants who were below 50-year-old had Fazekas Scale 1. Fazekas scale 2 was found only in the research participants who were 50 years old and older. Meanwhile, Fazekas scale 3 was found in the research participants who were above 70 years old. It is in line with a theory which says that hyperintense lesion on the white matter can be caused by aging factor and geriatric disorder.[10,11]

Fazekas scale 1 can be considered normal (associated with aging). Meanwhile, Fazekas scale 2 is considered abnormal when found on <75 years old patients, and Fazekas scale 3 is considered abnormal when it is found in any age group.[12] It was revealed in this research that 13 out 15 participants with Fazekas scale 2 were those below 75 years old and 14 out of 15 participants (93%) suffered from cognitive function decline. All participants with Fazekas scale 3 suffered from cognitive function decline. This brain white matter latent lesion development which is correlated with the disease of intracranial small blood vessels is known to be associated with stroke cases or the decline of cognitive function.[11] Some ischemic vascular mechanisms provide major pathogenesis for the decline of cognitive function that can develop into dementia.[13]

Based on the educational background, as many as 10 (31.3%) had <12 years of education (elementary and junior high school) and MoCA-Ina normal cutoff conversion was applied to them based on the research conducted in China. Based on that research, taking Chinese people as the participants, dementia and MCI were identified on the cutoff score of 24/25 for patients with more than 6 years of education experience, 20/21 for those with less than 6-year educational experience, and 17/18 if the patients were illiterate.[14] MoCA is an effective screening device to evaluate the decline of cognitive function on patients with different educational backgrounds. However, its test sensitivity and specification might vary depending on the regional convention and one's educational background.[15] This research employed MoCA-Ina cutoff score based on the educational background the way the similar research was conducted in China for the reason that such research has never been done before in Indonesia.

Based on the statistical calculation using Spearman correlation, there is a strong negative correlation between Fazekas scale and MoCA-Ina score with its significant score of 0.002. This is in line with the previous study conducted by Macfarlane *et al*. that discovered the reversed correlation between Mini-Mental State Examination (MMSE) with the weight of hyperintense lesion on white matter.[15] This research is also in line with the research conducted by Talamera *et al*.[16] with 202 healthy adult Philipinos as the research participants and used WMH from which a finding was resulted stating that there was a significant decline of Mini-Mental State Exam (MMSE) test score and MoCA Test along with the increase of WMH, where the most significant occurrence was found in Fazekas scale 2 and Fazekasscale 3.

However, when Fazekas scale was correlated with cognitive function decline using Fisher's exact test, the result obtained was not significant. This problem can be solved by expanding the participants of the research or evaluating the cognitive function using other cognitive tests. This way is suggested so that the evaluation on one's cognitive function decline will not only be based on one particular cognitive test. It is possible to be conducted because as it was described on Table 1, there were only 5 out of 32 participants (15.6%) who possessed normal cognitive function and 27 participants (84.4%) suffered from cognitive function decline. In Fazekas scale 1, there were 10 out of 14 research participants (71.4%) who experienced decline in cognitive function, and there were 17 out of 18 participants (94.4%) who suffered from cognitive function decline. The data imply that research subject's

high Fazekas scale will result in a higher rate of cognitive function decline.

Conclusions

There is a strong negative correlation between Fazekas scale and MoCA-Ina score. It indicates that the higher the Fazekas scale, the lower the MoCA-Ina score will be. However, there is no correlation between Fazekas scale with one's cognitive status.

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Conflicts of interest

There are no conflicts of interest.

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