Differences of electroencephalography wave with eyes-closed between older women with dementia and without dementia

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ABSTRACT

Electroencephalograph (EEG) is an alternative tool to detect brain abnormalities, but research on dementia patients is still limited. This study aimed to determine the differences in EEG waves with closed eyes between older women with dementia and non-dementia. This research uses a cross-sectional method. Examination of dementia using MMSE (Mini-Mental State Examination) with a cut-off value of 23 and examination of brain waves using InteraXon Muse Headband EEG (InteraXon, Canada) for 10 minutes at rest with eyes closed. The study sample consisted of 27 women with dementia and 27 non-dementia women with a mean age of 74.65 years from nursing homes and public health centers in Bandung, Indonesia. Data analysis used independent sample t-test and Mann-Whitney test. The results showed that there were significant differences in Delta AF7 ($p = 0.007$), Delta TP9 ($p = 0.039$), Delta TP10 ($p = 0.024$), and Theta AF7 ($p = 0.017$). Older women with dementia have lower slow waves (delta and theta waves) than older women without dementia. In

conclusion, older women with dementia had decreased EEG waves, including those in Delta AF7, Delta TP9, Delta TP10, and Theta AF7, compared with older women without dementia. Further research can be done with a larger number of respondents and provide stimulation during the EEG examination.

Keywords:dementia;EEG

INTRODUCTION

Dementia is a significant cognitive impairment syndrome so that it is unable for the sufferer to perform daily independent functions optimally (Gale et al., 2018). Dementia is a term that describes a variety of conditions that affect brain function, including memory, perception, and language (Meyer & O'Keefe, 2020). In 2030, the incidence of dementia in the world will reach 74.7 million (Prince et al., 2016). As many as 68% are found in low and middle-income countries so that Indonesia is predicted to be in the top 10 countries with the most dementia sufferers in the world and Southeast Asia (ALZ, 2019).

In the early stages, the symptoms of dementia are latent so that it becomes a challenge for researchers to diagnose dementia early. One of the techniques to diagnose dementia is the neuroimaging technique. The electroencephalograph (EEG) has an important role in making discoveries about cognition, brain function, and dysfunction (Cohen, 2017). EEG has a high temporal resolution, non-invasive, low-cost, and painless. EEG collects and records the electrical activity of nerves in different parts of the brain simultaneously and has been a highlight of research and clinical applications. The three main effects of Alzheimer's disease shown on EEG are the slowdown, reduced complexity, and decreased synchronization (Wang et al., 2016). Another research has also shown that cognitive decline in Alzheimer's disease is associated with slower EEG activity (Jeong et al., 2016). Alzheimer's disease patients show signs of a recurring pattern of abnormalities in the theta and beta frequency bands (Núñez et al., 2020).

The gender-specific risk for dementia is still not known, but, from the research results, the incidence of dementia is higher in women; one of the reasons is that men have a higher cardiovascular risk than women so that life expectancy of women is higher than men (Chêne et al., 2015). EEG is a tool to determine the electrical activity in the brain that can be used as a dementia detection tool, but the research is still limited. The purpose of this study was to determine the differences of EEG waves with eyes-closed between older women with dementia and without dementia.

METHODS

Participants of the Study

This study used a cross-sectional research method. Subjects of this study were the subjects who had met the criteria, including those aged > 60 years, could communicate well and were not in a state of severe physical and mental illness. The sites of this research were two nursing homes and the elderly community. Subjects consisted of 54 older women who were divided into two groups, namely dementia, and non-dementia groups. The examination of dementia used MMSE (Mini-Mental State Examination) containing 30 questions with a cut-off value of 23 (Arevalo-Rodriguez et al., 2015).

Ethical Consideration

This research had received approval from the Research Ethics Commission of Padjadjaran University (No.1266 / UN6.KEP / EC / 2018). The respondent's code of ethics used ethical principles from the Helsinki Declaration by asking the respondent's agreement first through informed consent.

Measurement of EEG

Brain wave data were collected using the InteraXon Muse Headband EEG device (InteraXon, Canada) with a sampling rate of 500 Hz (data per second) and Muse Monitor software (James Clutterbuck, Canada). EEG headband includes the Frontal 7 (AF7), Frontal 8 (AF8), Temporoparietal 9 (TP9), and Temporoparietal 10 (TP10) channels (Hashemi,

2016). The Power Spectral Density of each wave was generated from the Muse Monitor software. Data recording was carried out for 10 minutes for each respondent in a relaxed sitting condition with eyes closed. The respondents were not given any stimulation. Delta Wave (δ) was 1-4 Hz, Theta Wave (θ) was 4-8 Hz, Alpha Wave (α) was 7.5-13 Hz, Beta Wave (β) was 13-30 Hz, and Gamma Wave (γ) was 30-44 Hz. Power Spectral Density (PSD) is a quantity or quantitative parameter of brain waves, where the value is directly proportional to the amplitude of the wave. In this case, the PSD was expressed in dB/Hz scale, where dB = 10·log (raw) dB = 10·log (raw data) (Krigolson et al., 2017).

Data Collections

Characteristics of research subjects consisted of age, education, and marital status. Education level was divided into two, namely low and high education. Low education consisted of graduates from elementary and junior high school. Meanwhile, higher education consisted of graduates from senior high school and higher education. Marital status included married and unmarried/widowed.

Statistical Analysis

Data were analyzed by using SPSS version 25 with a confidence value <0.05. The Kolmogorov Smirnov test was used to determine whether data were normally distributed or not. Fisher test, independent sample t-test, and Mann-Whitney test were used to determine the difference of variables between the two groups.

RESULTS

Based on the characteristics of the respondents, the average age of the dementia group was 78.67 years, while the average age of the non-dementia group was 70.63 years. The MMSE scores were 18.74 for the dementia group and 28.15 for the non-dementia group. The low level of education was found as the highest (58.1%) in the dementia group. The marital status of the dementia group was mostly unmarried/widowed (61%). The results showed that there

were significant differences in age (p = 0.003), MMSE (p <0.001), education (p = 0.018), and marital status (p = 0.005) between the two groups (Table 1).

Table 1 Characteristics of elderly women with and without dementia

Characteristics	**Dementia (n=27)**	**Non-Dementia (n=27)**	**p**
Age, mean (sd), yr	78.67 (8.23)	70.63 (9.39)	0.003*
MMSE, mean (sd), score	18.74 (3.29)	28.15 (1.41)	<0.001*
Education, n (%)			0.018*
Low	25 (58.1)	18 (41.9)	
High	2 (18.2)	9 (81.8)	
Marital status, n (%)			0.005*
Unmarried/Widowed	25 (61.0)	16 (39.0)	
Married	2 (15.4)	11 (84.6)	

*p < 0.05

The results showed that there were significant differences in the waves of Delta TP9 (0.039), Delta AF7 (0.007), Delta TP10 (0.024), and Theta AF7 (0.017). The results showed that the Delta TP9, Delta AF7, Delta TP10, and Theta AF7 waves in the dementia group were lower than in the non-dementia group (Table 2).

Table 2 EEG wave differences between elderly women with and without dementia

EEG Wave Power Spectral Density	**Dementia(n=27) mean (sd), dB/Hz**	**Non-Dementia (n=27) mean (sd), dB/Hz**	**P**
Delta TP9	0.84 (0.27)	1.00 (0.28)	0.039*
Delta AF7	0.61 (0.38)	0.87 (0.29)	0.007*
Delta AF8	0.77 (0.30)	0.88 (0.36)	0.237
Delta TP10	0.83 (0.31)	1.02 (0.27)	0.024*
Theta TP9	0.65 (0.28)	0.66 (0.20)	0.940
Theta AF7	0.16 (0.35)	0.36 (0.21)	0.017*
Theta AF8	0.32 (0.23)	0.43 (0.27)	0.114
Theta TP10	0.59 (0.24)	0.65 (0.18)	0.345
Alpha TP9	0.94 (0.27)	0.85 (0.18)	0.382
Alpha AF7	0.36 (0.30)	0.47 (0.15)	0.106
Alpha AF8	0.46 (0.25)	0.52 (0.14)	0.263
Alpha TP10	0.86 (0.26)	0.85 (0.16)	0.894
Betha TP9	0.82 (0.39)	0.69 (0.19)	0.144
Betha AF7	0.55 (0.46)	0.54 (0.34)	0.930
Betha AF8	0.67 (0.45)	0.66 (0.34)	0.917
Betha TP10	0.77 (0.33)	0.74 (0.20)	0.702

*p < 0.05

DISCUSSIONS

The study shows that there were significant differences in age, MMSE, education (p=0.018), and marital status between the two groups. This suggests that age, education, and marital status influence the occurrence of dementia. This study is consistent with a previous study that shows that the incidence of dementia increases 8.63 times at age 75 years and 2.48 times at age 95 years (Savva et al., 2009). Besides, prevalence and incidence studies show that low education level increases the risk of dementia (Meng & D'arcy, 2012). Other studies have shown that dementia is higher in unmarried people (relative risk = 1.42) and widowed (1.20) compared to married people (Sommerlad et al., 2018).

The results showed that the differences of EEG waves in the older women with dementia were in Delta TP9, Delta AF7, Delta TP10, and Theta AF7 waves. The results showed that the Delta and Theta waves in the dementia group were lower than in the non-dementia group. The results of previous studies have also shown that theta waves are associated with verbal memory, attention, and executive functioning (Finnigan & Robertson, 2011). These results are inconsistent with studies that show that the theta relative power is increased in AD patients compared with a control group with the closed eye EEG test (Van der Hiele et al., 2007).

Delta waves undergo synchronization or strengthening. Delta wave values are higher than Alpha and Beta waves. Based on previous research, Delta wave synchronization is associated with decreased CSF amyloid β42, which is an indicator of the dementia spectrum (Smailovic et al., 2018). This study is inconsistent with studies reporting that severe Alzheimer's disease causes increased activity in the Delta and Theta frequency bands, as well as decreased activity in the Alpha and Beta bands (Houmani et al., 2018). This is probably because the respondents in the dementia group in this study suffered from mild and moderate dementia and the EEG examination was carried out in a resting condition with closed eyes. The respondents were not given any stimulation. Research shows that closed and open eyes

produce different EEG sizes in topography and power levels (Barry et al., 2007). Also, all of the respondents in this study were women. The results of previous studies show a significant difference in the EEG waves between men and women (Hashemi et al., 2016).

Several studies on the relationship of dementia with EEG changes have been found (Chowdhury, 2018). A closed-eye control group study shows minimum Alpha and Beta waves. Meanwhile, an increase in Delta waves (44%) and a decrease in Beta waves (27%) are found in the closed-eye dementia group. Delta and theta waves (71.6%) are also significantly higher in the dementia group than in the control group. An EEG records electrical activity in the brain and measures voltage fluctuations due to the activation of brain neurons. We can use EEG techniques to detect abnormalities (Engedal et al., 2020).

CONCLUSION

Older women with dementia have decreased EEG waves in Delta AF7, Delta TP9, Delta TP10, and Theta AF7 waves compared to those without dementia. Furthermore, further research can be carried out on elderly with dementia with a higher number of respondents, both men, and women, as well as providing stimulation during the EEG examination.

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