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THE CORRELATION BETWEEN THE DEGREE OF MEDIAL TEMPORAL LOBE ATROPHY BASED ON THE MEDIAL TEMPORAL ATROPHY (MTA) SCORE USING MAGNETIC RESONANCE IMAGING (MRI) AND COGNITIVE IMPAIRMENT BASED ON THE MINI-MENTAL STATE EXAMINATION (MMSE) SCORE IN ELDERLY PATIENTS

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ABSTRACT

Background: The increasing elderly population poses serious consequences related to health issues, particularly cognitive impairment. Cognitive impairment in the elderly has a significant impact on their quality of life, even in the early stages, such as mild cognitive impairment. Neurodegenerative diseases, such as Alzheimer's dementia, present serious challenges in diagnosis and management. Currently, there is no cure for these cognitive disorders, and the best approach is prevention or slowing their progression. **Objective**: This research aims to evaluate the relationship between the degree of medial temporal lobe atrophy using the Medial Temporal Atrophy (MTA) score through Magnetic Resonance Imaging (MRI) and cognitive impairment assessed by the Mini-Mental State Examination (MMSE) score in the elderly population. **Methods**: This study is an observational analytical research with a cross-sectional approach that aims to assess the relationship between the degree of brain atrophy using the medial temporal atrophy (MTA) score through magnetic resonance imaging (MRI) and cognitive impairment measured by the mini-mental state examination (MMSE) score in elderly patients. The research was conducted at RSUP dr. Wahidin Sudirohusodo Makassar from August 2022 until a sufficient sample size was reached. The study population included all patients aged over 55 years who underwent head MRI examination at RS dr. Wahidin Sudirohusodo Makassar, with consecutive sampling. In this study, a minimum of 32 samples is required as the sample estimation. All research procedures met ethical requirements and received approval from the Biomedical Health Research Ethics Commission at the Faculty of Medicine, Hasanuddin University Makassar. The collected data were analyzed using appropriate statistical methods, including various stages of data analysis such as univariate, normality test, and Spearman correlation test to explain the relationship between the variables under investigation. **Results**: The research results indicate that pathological medial temporal lobe atrophy is more common in the elderly age group, especially in the very elderly. All respondents in the very elderly age group experienced cognitive impairment, while the majority of the elderly and younger elderly did not. Furthermore, there is a significant negative correlation between the degree of medial temporal lobe atrophy (MTA) and the level of cognitive impairment (MMSE). The higher the degree of atrophy, the lower the cognitive function. These findings underscore the importance of monitoring the mental and cognitive health of the elderly, especially among the older population. **Conclusion**: There is a correlation between the degree of medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score using Magnetic Resonance Imaging (MRI) and cognitive impairment based on the Mini-Mental State Examination (MMSE) score in elderly patients.

Keywords: Medial Temporal Lobe, Medial Temporal Atrophy (MTA) Score, Magnetic Resonance Imaging (MRI), Cognitive Impairment, Mini-Mental State Examination (MMSE) Score.

INTRODUCTION

As the elderly population continues to grow in Indonesia, issues related to diseases caused by the aging process are also on the rise. Aging has an impact on the brain, which becomes more vulnerable to a decline in cognitive function with advancing age. Symptoms of aging include decreased energy, slower reactions, reduced creativity, and a decline in memory, especially short-term and past memories. Approximately 10% of individuals aged 65 and above experience a decline in cognitive function, while almost 15% of them develop Alzheimer's disease each year. During the aging process, particularly short-term and past memories tend to decline. [1]

Cognitive impairment, including memory disorders, is often accompanied by changes in emotional control, behavior, and motivation. Cognitive disorders, especially dementia, are common medical issues that can affect an individual's daily life. The prevalence of dementia is increasing significantly, both in developed countries and in Indonesia, and it can have serious health and economic consequences for society if not addressed. [2]

The significant impact of cognitive impairment in dementia affects the quality of life of the elderly, even in the early stages of mild cognitive impairment. The World Health Organization (WHO) defines dementia as a neurodegenerative syndrome with chronic and progressive abnormalities that disrupt various cognitive functions, such as calculation, learning capacity, language, and decision-making, without impairment of consciousness. Similar to other countries, Indonesia is predicted to experience a significant increase in dementia cases, from 1.2 million in 2015 to 1.9 million in 2030, and it is estimated to reach 3.9 million by 2050. [3] The number of individuals suffering from dementia has the potential for serious impact on health and socio-economic aspects if not anticipated. Cognitive disorders associated with dementia are known to have a significant impact on the quality of life of the elderly, even in the early stages of mild cognitive impairment. Although various brain degenerative diseases such as Alzheimer's, vascular dementia, and Parkinson's have been the focus of treatment, the results have been unsatisfactory. Further issues arise as the brain ages, such as an increased risk of falls that can lead to injuries and mobility limitations in the elderly. Aging is a natural process that cannot be stopped but can be slowed down. Currently, there is no medication to treat cognitive disorders, but behavioral changes and risk factor modifications can help slow down the progression of these disorders. [4]

The Mini-Mental State Examination (MMSE) is used as a tool for diagnosing cognitive impairment. MMSE was first introduced in 1975 as a clinical method to assess the cognitive status of patients suspected of neurodegenerative disorders like dementia. MMSE is a 10-minute test that covers language, memory, and calculation.[5] The maximum score is 30 points, with scores below 24 indicating possible cognitive impairment or dementia. Research shows that individuals with cognitive impairment have lower MMSE scores than those without cognitive impairment. MMSE can also help depict different stages of Alzheimer's, with lower scores indicating higher severity. [6]

In addition to MMSE, neuroimaging, particularly brain MRI, is necessary for further evaluation of patients with cognitive impairment. MRI aids in categorizing patients based on etiology and disease stage, which can impact the prognosis and patient outcomes. Medial temporal lobe atrophy (MTA) is a crucial marker, and the visual MTA assessment scale is used to evaluate the level of atrophy in MRI.[7] There is a significant correlation between the severity of cognitive impairment and medial temporal lobe atrophy, affecting patient diagnosis and management. Most individuals with cognitive impairment also have Alzheimer's pathology associated with medial temporal lobe atrophy, which is not common in normal elderly individuals. MTA is a strong indicator of neural degeneration in the medial temporal lobe, both in Alzheimer's dementia and cognitive disorders. [8]

The hippocampus (HPC), entorhinal cortex (EC), perirhinal cortex (PC), and parahippocampal cortex (PHC) are subregions of the medial temporal lobe (MTL) that are essential for various cognitive functions such as declarative memory and spatial navigation. Medial temporal lobe atrophy (MTA) often occurs in dementia and is frequently observed in mild cognitive impairment, but it can also be seen in normal aging. MTA has been shown to be a very strong predictor of the progression from mild cognitive impairment to Alzheimer's disease. There is evidence that the medial temporal lobe (MTL) shows age-related decline, and more notably, there is early decline in Alzheimer's dementia. Therefore, these findings assist in the clinical radiological evaluation of patients with suspected dementia disorders (Chauveau L, 2021). [9,10]

In a study conducted by Chatra K in 2021, a significant relationship was found between the severity of cognitive impairment and atrophy of the medial and anterior temporal lobes (with a p-value less than 0.05). Similar findings were also revealed in a study conducted by Loewenstein DA in 2009, where the severity of medial temporal lobe atrophy (assessed through MRI scans) was strongly related to the severity of degenerative pathology in the medial temporal region. The level of medial temporal lobe atrophy reflects the extent of nerve degeneration occurring in that area, both in cases of Alzheimer's dementia and cognitive disorders. Other studies have also shown that nearly all individuals with cognitive impairment tend to have Alzheimer's

dementia pathology and exhibit atrophy in the medial temporal lobe. [9,11]

Considering the context provided above and the limited number of previous studies on the relationship between the degree of medial temporal lobe atrophy measured through the Medial Temporal Atrophy (MTA) score using magnetic resonance imaging (MRI) and cognitive impairment based on the Mini-Mental State Examination (MMSE) score in elderly patients, the author is interested in conducting this study.

METHODS

This study is an analytical observational research with a cross-sectional approach, which assesses the correlation between the degree of brain atrophy based on the Medial Temporal Atrophy (MTA) score using magnetic resonance imaging (MRI) and cognitive impairment based on the Mini-Mental State Examination (MMSE) score in elderly patients. The research was conducted at RSUP dr. Wahidin Sudirohusodo Makassar. The study was carried out from August 2022 until the required sample size was obtained. The study population consists of all patients over 55 years of age who underwent head MRI examinations at RS dr. Wahidin Sudirohusodo Makassar. The research sample includes the entire accessible population that meets the inclusion and exclusion criteria. The sampling method used is Consecutive Sampling, where research subjects are obtained based on their admission sequence to the hospital. The total estimated minimum sample size needed for this study is 32 samples. This study meets ethical requirements and has received approval from the Biomedical Health Research Ethics Commission for human subjects at the Faculty of Medicine, Hasanuddin University, Makassar.

The data obtained are categorized based on data types, then analyzed using appropriate statistical methods using SPSS V.26.0 and presented in tables and narrative form. Data analysis includes univariate and bivariate tests. Univariate data analysis is performed to determine the distribution of characteristics of patients who underwent MRI examinations. Numeric data are presented in tables that include frequency, percentage, and mean ± SD, while categorical data are presented in tables based on predefined categories. Prior to analyzing numeric data, a normality test is conducted using the Kolmogorov-Smirnov (KS) test, followed by bivariate analysis using the Spearman correlation test.

RESULTS

The distribution of the sample based on general characteristics such as gender, education, and age is presented in Table 1. The distribution of the variable degree of medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score using Magnetic Resonance Imaging (MRI) is shown in Table 2. Based on the descriptive analysis of the Mini-Mental State Examination (MMSE) score variable, it is evident that the lowest MMSE score is 21.00, and the highest is 29.00. The average MMSE score is 25.3056 with a standard deviation of 2.41211. A standard deviation value lower than the mean indicates that there is relatively little variation in the MMSE data among the respondents. Based on the MMSE Score Category variable, out of a total of 36 respondents in this study, the majority of respondents, which is 75.0%, did not experience a decline in cognitive function, while 25.0% of the respondents did experience a decline in cognitive function.

Based on the chi-square analysis, for the age category in relation to the degree of right medial temporal lobe atrophy based on the MTA Score, it is found that the P-value (P value = 0.032) obtained is smaller than the significance level alpha of 5% or 0.05. This means that there is a significant correlation between the age category and the right MTA Score. For the age category in relation to the degree of left medial temporal lobe atrophy based on the MTA Score, the P-value (P value = 0.081) obtained is larger than the significance level alpha of 5% or 0.05. This means that there is no significant correlation between the age category and the left MTA. In the analysis of the age category in relation to the MMSE category, the P-value (P value = 0.005) obtained is smaller than the significance level alpha of 5% or 0.05. This means that there is a significant correlation between the age category and the MMSE category. In the analysis of gender in relation to the MMSE category, the P-value (P value = 0.248) obtained is larger than the significance level alpha of 5% or 0.05. This means that there is no significant correlation between gender and the MMSE category. In the analysis of education in relation to the MMSE category, the P-value (P value = 0.554) obtained is larger than the significance level alpha of 5% or 0.05. This means that there is no significant correlation between education and the MMSE category. In the analysis of the degree of right medial temporal lobe atrophy based on the MTA score in relation to the MMSE category, the P-value (P value = 0.010) obtained is smaller than the significance level alpha of 5% or 0.05. This means that there is a significant correlation between the degree of right medial temporal lobe atrophy based on the MTA score and the MMSE category. In the analysis of the degree of left medial temporal lobe atrophy based on the MTA score in relation to the MMSE category, the P-value (P value < 0.001) obtained is smaller than the significance level alpha of 5% or 0.05. This means that there is a significant correlation between the degree of left medial temporal lobe atrophy based on the MTA score and the MMSE category.

The analysis of the relationship between variables using Spearman correlation (Table 3) shows that the correlation between age and right MTA as well as left MTA yields a significance value smaller than alpha (5% or 0.05), indicating a significant correlation. Therefore, it can be concluded that there is a significant correlation between age and the degree of medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score using Magnetic Resonance Imaging (MRI), and as age increases, the degree

of medial temporal lobe atrophy based on the MTA score using MRI tends to increase. Coefficients exceeding 0.3 - 0.6 suggest a relatively strong correlation between age and the degree of medial temporal lobe atrophy based on the MTA score using MRI. The statistical analysis of the correlation between age and the Mini-Mental State Examination (MMSE) score yields a significance value smaller than alpha (5% or 0.05), indicating a significant correlation. The coefficient is -0.537 (negative), meaning that as age increases, the MMSE score tends to decrease. Coefficients exceeding |0.4| suggest a relatively strong correlation between age and the MMSE score. The analysis of the correlation between right MTA and the MMSE score also yields a significance value smaller than alpha (5% or 0.05), indicating a significant correlation. The coefficient is -0.550 (negative), suggesting that as the degree of right medial temporal lobe atrophy based on the MTA score increases, the MMSE score tends to decrease. Coefficients exceeding |0.4| indicate a relatively strong correlation between right MTA and the MMSE score. The analysis of the correlation between left MTA and the MMSE score yields a significance value smaller than alpha (5% or 0.05), indicating a significant correlation. The coefficient is -0.686 (negative), suggesting that as the degree of left medial temporal lobe atrophy based on the MTA score increases, the MMSE score tends to decrease. Coefficients exceeding |0.4| also indicate a relatively strong correlation between left MTA and the MMSE score.

Discussion

The results of this study indicate that MTA scores of 0 and 1 are most commonly found in the 55-65 age group (elderly), while an MTA score of 2 is equally distributed between the 55-65 age group (elderly) and the 66-74 age group (young elderly). An MTA score of 3 is equally distributed between the 55-65 age group (elderly) and the 75-90 age group (older elderly), and an MTA score of 4 is most commonly found in the 55-65 age group (elderly). These results suggest that there is an increase in pathological atrophy (MTA scores 2 to 4) in all elderly age groups, including the elderly, young elderly, and older elderly. These findings are consistent with the research by Wahlund (2016), which stated that an MTA score of 2 is considered pathological in patients under 70 years of age, an MTA score of 3 is considered pathological in all patients under 80 years of age, and an MTA score of 4 is always considered pathological regardless of the patient's age.

Furthermore, the chi-square analysis indicates a significant correlation between age categories and right MTA scores, with a positive coefficient. This suggests that the older a person is, the higher the degree of right medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score.

In this study, the assessment of left medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score shows that MTA scores of 0 to 4 are most commonly found in the 55-65 age group (elderly). The results also show an increase in pathological atrophy (MTA scores 2 to 4), especially in the elderly age group. These findings are in line with the results of the Wahlund study (2016). However, the chi-square analysis indicates that there is no significant correlation between age categories and the degree of left medial temporal lobe atrophy based on the Medial Temporal Atrophy (MTA) score. The resulting P-value is greater than the 5% significance level, which is 0.081. Therefore, it can be concluded that there is no significant correlation between age and the degree of left medial temporal lobe atrophy.

In the assessment of right medial temporal lobe atrophy using the Medial Temporal Atrophy (MTA) score, the most commonly found score is MTA 1. Conversely, in the assessment of left medial temporal lobe atrophy using the MTA score, MTA 0 is the most frequently encountered score. Research conducted by Velickaite (2017) has noted that MTA scores can exhibit asymmetry with higher scores on one side compared to the other. Some studies have utilized the highest score on one side as a determining factor, while others calculate the average between the left and right MTA scores.

When assessing cognitive impairment based on the Mini Mental State Examination (MMSE) scores, the lowest score found was 21.00, while the highest score was 29.00. The average MMSE score is 25.3056 with a standard deviation of 2.41211. Out of a total of 36 respondents in this study, the majority, accounting for 75.0%, did not experience cognitive decline, while 25.0% of the respondents showed cognitive impairment. The research results indicate that respondents in the 55-65 age group (elderly) and the 66-74 age group (young elderly) generally did not experience cognitive decline. However, in the 75-90 age group (older elderly), all respondents experienced cognitive impairment. These findings align with other studies that suggest age has a significant impact on the total MMSE score, with higher age associated with lower MMSE scores. Statistical analysis using the chi-square test reveals a significant correlation between age categories and Mini Mental State Examination (MMSE) scores, indicating that as individuals get older, their MMSE scores tend to be lower. This correlation is quite strong, as evidenced by a coefficient value exceeding |0.4|.

In our research findings, the majority of respondents, both male and female, did not experience cognitive decline. Statistical analysis using the chi-square test shows that the p-value generated is greater than the 5% or 0.05 significance level. This means that there is no significant correlation between gender and the categories of the Mini Mental State Examination (MMSE). These results align with a study by Su Y et al. (2022), which also found no significant relationship between gender and MMSE scores. However, these findings differ from a study by Liu X et al. (2020), which found that gender does affect cognitive impairment. Similarly, the study by Guacomucci G et al. (2022)

indicated a significant difference between gender and cognitive impairment, with a higher proportion of dementia among women compared to men.

In our research, there was no significant correlation between educational level and the categories of the Mini Mental State Examination (MMSE). The results suggest that individuals with higher education or greater cognitive ability seem to be better equipped to cope with neurodegenerative pathology, possibly enabling them to maintain normal cognitive function for a longer period compared to individuals with lower educational levels. The impact of education may differ between men and women, and this can be explained through a multifactorial approach. Social factors such as education, occupation, physical activity, and social support can be essential contributors to cognitive reserve in individuals, ultimately influencing the development of cognitive disorders. Other research has also shown that these factors play a role in preventing or reducing the risk of cognitive impairment. [12]

In our study, we found a significant correlation between the Medial Temporal Atrophy (MTA) score and the Mini Mental State Examination (MMSE) score. This implies that the higher the degree of medial temporal lobe atrophy measured by the MTA score, the lower the MMSE score, indicating more severe cognitive impairment. These findings are consistent with other studies, such as the research by Chatra K et al. (2021), which also found a significant correlation between the severity of cognitive impairment and medial temporal lobe atrophy. Other studies, like Kaushik et al. (2020), also support these findings by showing that patients with Alzheimer's dementia who experience cognitive impairment have higher levels of medial temporal lobe atrophy. These findings suggest that the degree of medial temporal lobe atrophy can be used as an early indicator of cognitive impairment and may correlate with the severity of the disorder. Cognitive impairment in older age is often a sign of neurodegenerative diseases like Alzheimer's, and the assessment of medial temporal lobe atrophy can aid in early diagnosis. [14,15]

CONCLUSION

The research results indicate that pathological medial temporal lobe atrophy is more common in the elderly population, particularly in the elderly. All respondents in the elderly population experienced cognitive impairment, while the majority of the elderly and younger elderly did not. Furthermore, there is a significant negative correlation between the degree of medial temporal lobe atrophy (MTA) and the level of cognitive impairment (MMSE). The higher the degree of atrophy, the lower the cognitive function. These findings underscore the importance of monitoring the mental and cognitive health of the elderly, especially those who are older. With a better understanding of the risk factors associated with cognitive impairment, we can develop more effective intervention strategies to maintain the quality of life of the elderly.

RECOMMENDATIONS

The study findings suggest that the MTA-based score for the degree of medial temporal lobe atrophy can be valuable in early cognitive disorder diagnosis, facilitating more effective preventive interventions. This data can also serve as a foundation for future research that compares MTA with hippocampal volume for early cognitive disorder diagnosis and distinguishing dementia, particularly Alzheimer's disease, from normal aging in elderly patients. Furthermore, this data can be employed in future research with a more balanced sample distribution.

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Table 1. Characteristics of Respondents

Characteristics	Frequency	Percentage	Min	Max	Mean ± SD
Gender					
Male	18	50,0			
Female	18	50,0			
Education					
Elementary School	4	11,1			
Junior High School	3	8,3			
High School	15	41,7			
Bachelor's Degree (S1)	12	33,3			
Age			55,00	80,00	61,97
55-65 (Elderly)	27	75			
66-74 (Young Elderly)	6	16,6			
75-90 (Old Elderly)	3	8,33			
Master's Degree (S2)	2	5,6			

Table 2 Description of Medial Temporal Atrophy (MTA) Score Variable

MTA	Category	Frequency	Percentage
Right	MTA 0	5	13,9
	MTA 1	19	52,8
	MTA 2	7	19,4
	MTA 3	4	11,1
	MTA 4	1	2,8
Left	MTA 0	12	33,3
	MTA 1	10	27,8
	MTA 2	8	22,2
	MTA 3	6	16,7
	MTA 4	0	0,0

Table 3 Spearman Correlation Analysis Results

Relationship	Correlation Coefficient	Sig.	Remarks
Age with MTA right	0,339	0,043	There is a relationship
Age with MTA left	0,524	0,001	There is a relationship
Age with Mini Mental State Examination (MMSE) score	-0,537	0,001	There is a relationship
MTA right with Mini Mental State Examination (MMSE) score	-0,550	0,001	There is a relationship
MTA left with Mini Mental State Examination (MMSE) score	-0,686	<0,001	There is a relationship